Graduate School of Energy Science,
Kyoto University

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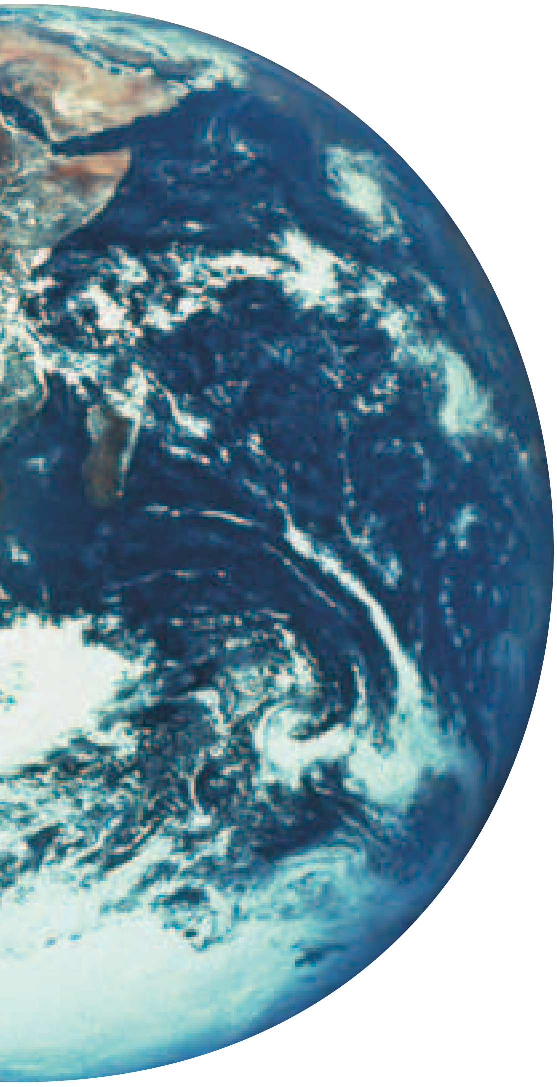
http://www.energy.kyoto-u.ac.jp

Kyoto University
Graduate School of Energy Science

Contents

Introduction from the Dean

Prof. Keiichi Ishihara



Energy security and environmental protection are perhaps the most important issues for the sustainable development of our modern society. They have a great influence on the trends of politics, economy and industry, especially in Japan, which has minimal natural resources and professes to be a scientific, technology-oriented nation. In 2011, the earthquake off the Pacific coast of Tohoku, and the subsequent accident at the nuclear power plant gave us the opportunity to re-recognize that energy problems are closely related to the life of the individual and require the efforts of all members of society. Additionally, climate change at the global scale has become clearly overt and numerous large-scale natural disasters have happened each year in all parts of the world including Japan.

To solve such varied problems of energy and environment, the Graduate School of Energy Science was founded in 1996, gathering together experts in wide-ranging academic areas including technology, science, agriculture, economics, and law, among others. Since then, the Graduate School has been working on the creation of a novel learning base for energy science, the development of technology for energy and the environment, the cultivation of excellent human resources with specialized knowledge in energy and environment, and on making a contribution to society.

The Graduate School counts 22 chairs and 17 cooperative chairs from the Institute of Advanced Energy, the Research Reactor Institute, and the Graduate School of Human and Environmental Studies. These chairs cover a spectrum of advanced and interdisciplinary research fields. The Graduate School has four departments, i.e., the Department of Socio- Environmental Energy Science, the Department of Fundamental Energy Science, the Department of Energy Conversion Science, and the Department of Energy Science and Technology.

The Graduate School accepts 130 students in its master's program and 35 students in its doctoral program each year. Students, especially those in the doctoral course, may enroll in the Graduate School on a part-time basis, meaning they need not resign from their professional occupations. To cultivate talented individuals toward excellence, it is especially important that students study both the natural and social science, and improve their practical skills. The Graduate School has devised a special curriculum featuring not only a variety of subjects in the natural and social science, but also off-campus research projects, which can be conducted, for example, in industry or national research institutes.

Students who graduate from the master's program pursue a variety of directions, for instance, some work in government, some in firms that deal with electricity, machinery, chemicals, automobiles, heavy industries, steel, gas, ceramics, fibers and so on. Those having graduated from the Doctoral program have pursued careers as researchers and expert professionals in universities, both national and international institutions, and private companies.

The Graduate School also has English-based courses both in the doctoral program (for all departments) and in the master's program (for three departments), these come under the banner of the International Energy Science Course (IESC). In the curriculum of the IESC, around 12 subjects are currently provided in English by both Japanese and foreign professors. Both the acquisition of required credits and undertaking research are possible in English (no Japanese requirement). An online application is open to applicants for the IESC, with initial online document submission and remote interview-based screening enabling candidates to take the entrance examination in their home country.

To further promote internationalization in the university, we frequently organize international symposia, short-term research internships and summer and winter schools. Furthermore, we have developed double master's degree programs and double doctoral programs with partner universities. Under these schemes, students can pursue their study in two universities and be awarded two degrees on fulfillment of both universities` requirements.

We welcome individuals who have motivation high enough to challenge the significant energy and environmental problems that are currently the most pressing global issues. We invite such individuals to join the Graduate School and succeed in partnership with our faculty members in creating a new world of energy science.

Graduate School of Energy Science, Kyoto University

Graduate Sch

Energy

Department of Socio-Environmental Energy Science

Helps students develop problem-solving capabilities for broad energy issues.

Energy

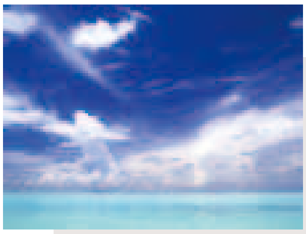
Department of Fundamental Energy Science

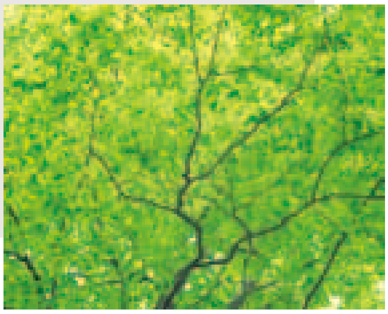
Focuses on basic science training (chemistry and physics) as related to energy problems.

The New Interdisciplinary Field

for Solutions to

Energy Problems





ool of Energy Science, Kyoto University

Department of Energy Conversion Science

Helps students obtain a thorough understanding of the principles and applications of energy conversion systems suited to natural environments.

Department of Energy Science and Technology

Trains students in thermal science and processing technologies for highly-efficient energy utilization.

Graduate School of Energy Science, Kyoto University

Department of Socio-Environmental Energy Science

seeking ideal energy and social systems in harmony with the natural environment.

The Department of Socio-Environmental Energy Science aims to establish ideal energy systems harmonizing with natural and human environments to sustain the continuous development of human civilization. For this purpose, various energy problems are systematically analyzed from sociological, political, economical, biological and environmental perspectives.

Department Organization

Division	Groups	Focus
Social Science of Energy	* Engineering for Social Systems * Energy Economics * Energy Ecosystems	Primary subjects of study include the technological and biological treatment of energy production, storage, distribution, utilization and its waste. Concurrently, great stress is placed upon the safety, economic, and environmental feasibility of available energy, targeting the ideal social system for energy utilization.
Socio-Environmental Energy Systems	* Energy and Information * Energy and Environment	The main focus is on the planning, design and evaluation of energy systems from, energy production to energy utilization, and safety countermeasures for environmental protection. The harmony of energy systems with society and the environment is seen as vital.
Societal Energy Science	* Energy Policy * Societal Energy Education * Energy and Communication	Research topics focus on energy policy and education related to international, societal and technological issues such as energy security and disaster prevention, and also on systems of human communication for safety culture related to energy supply and demand.
International Energy Issues	(visiting professors)	International energy issues

Curriculum

For the Master's Program

- Advanced Study on Socio-Environmental Energy Science 1, 2, 3, 4
- Socio-Environmental Energy Science I, II
- Energy, Society and Engineering
- Energy Economics
- Energy Systems Analysis and Design
- Energy Ecosystems
- Human Interface
- System Safety
- Atmospheric Environmental Science
- Energy Societal Education
- Energy Policy
- Energy Communication
- Environmental Economics
- Energy Sociology
- International Energy
- Field Research Project on Socio-Environmental Energy Science
- Special Fundamental Study 1, 2
- Industrial Ethics
- Special Seminar on Interdisciplinary Energy Science
- Future Energy:Hydrogen Economy (in English)
- Energy Systems and Sustainable Development (in English)

For the Doctoral Program

- Social Engineering of Energy, Adv.
- Energy Economics, Adv.
- Energy Ecosystems, Adv.
- Energy and Information, Adv.
- Energy and Environment, Adv.
- International Energy, Adv.
- Advanced Seminar on Socio-Environmental Energy Science (in English)
- Zero-emission Social System (in English)
- Field Research Project on Energy Science (in English)

Department of Socio-Environmental Energy Science

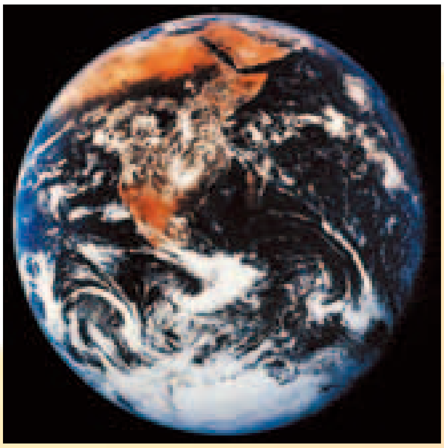
■ Social Science of Energy

Multidisciplinary Fusion of Social Science and Natural Science

Engineering for Social Systems

What is the progress of a society, and what kind of society is desirable and prospected? Our research field involves sustainable use of energy and resources, which is vital for a perspective of our future society. Energy and resources are indispensable for social activities, and we systematically evaluate the production, storage, and distribution, based on an integrated view obtained from both technological and sociological aspects. The investigated are, for instance, the energy environmental assessment of recycling and industrial manufacturing, the research and development of functional environmental materials, and the effectiveness of energy environmental education. Our final goal is to propose a social system, where social activities and use of energy and resources are harmonized with environment.

(Prof. Keiichi ISHIHARA, Assoc. Prof. Hideyuki OKUMURA)



Energy and environmental issues must be tackled both sociologically and technologically based on a global perspective.

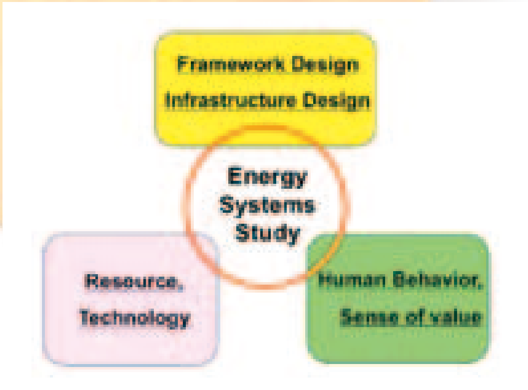
■ Social Science of Energy

Evaluation and Design of Energy Systems including Human Behavior and Decision-making

Energy Economics

Energy supply-demand systems are the research focus of the energy economics research laboratory. These systems comprise resource production, conversion, transportation, storage and end use. They are naturally influenced by the use of resources such as minerals, water and land, and also by technological development and human behavior related to energy use. "Energy-systems Study", the main research topic in our group, develops methodologies for evaluation, planning and framework design of energy supply-demand systems by evaluating the interactions between a variety of components in the systems mentioned above from both microscopic and macroscopic viewpoints including efficiency, satisfaction, economy, equity and sustainability.

(Prof. Tetsuo TEZUKA, Assoc. Prof. Benjamin C. MCLELLAN, Assoc. Prof. Seiichi OGATA)



Energy Systems Study

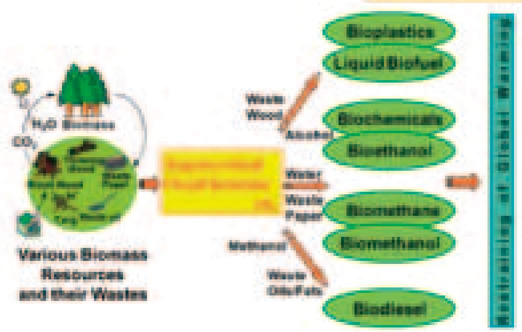
■ Social Science of Energy

Environmentally Friendly Conversion of Biomass to Fuels, Chemicals and Materials

Energy Ecosystems

Independent of fossil resources and harmonized with the global environment, sustainable approaches for biomass utilization have been explored in the laboratory, aiming at the future establishment of the biomass-based sustainable society. The research includes the quantification of chemical components of various kinds of biomass resources based on taxonomical classification, and their conversion technologies to renewable biofuels and biochemicals through supercritical/subcritical technologies and pyrolysis treatment. Advanced bioethanol, biodiesel and other liquid/gas biofuels have been studied so as to establish the biorefinaries for useful biofuels, biochemicals and biomaterials.

(Assoc. Prof. Haruo KAWAMOTO, Assist. Prof. Eiji MINAMI, Specific Assist. Prof. H. F. Rabemanolontsoa)



Biorefinaries to various biofuels, chemicals and useful materials

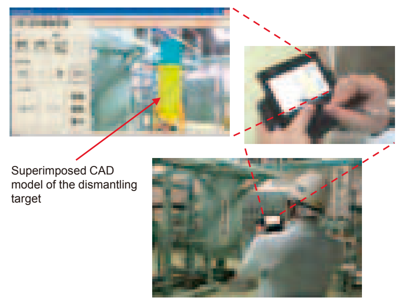
Socio-Enviromental Energy Systems

Harmony between Technology and Society - Advance in Human-Machine Interface

Energy and Information

To construct future energy society, it is necessary to consider and organize the ideal systems from the viewpoint of human, society and technology. Aiming at symbiosis and harmony between humans and technology, the Energy and Information group have been applying advanced information and communication technology to conduct researches such as proposal of eco-friendly lifestyles, system development for safety and reliability of energy systems and improvement of intellectual productivity in energy saving office.

(Prof. Hiroshi SHIMODA, Assoc. Prof. Hirotake ISHII)



Dismantling planning support system based on augmented reality technology

Socio-Enviromental Energy Systems

Analysis and Evaluation of Energy-related Atmospheric Environmental Issues

Energy and Environment

Environmental burdens associated with human activities, especially energy production and utilization are assessed from the viewpoint of atmospheric environmental science and Life Cycle Thinking (LCT) to realize a sustainable society. Environmental impact of anthropogenic air pollutants is evaluated in terms of human health effect of particulate matters, international impact of the long-range transported secondary pollutants, and regional radiative effect of aerosols. Combination of atmospheric environmental science with input-output approach is tackled to conduct a comprehensive analysis of the relationship between environmental issues and overall economic activity.

(Prof. Susumu TOHNO, Assoc. Prof. Takayuki KAMEDA, Assist. Prof. Kouhei YAMAMOTO)

System for assessment of the radiative effects of atmospheric aerosols

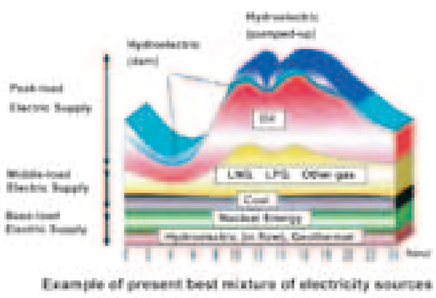
Societal Energy Science

Global Energy Policy - Focusing on Future Use of Nuclear Energy -

Energy Policy

Sustainable energy future could only be achieved through intensive efforts both on technology development and policy implementation, from the viewpoint of energy security and environmental protection. Among the various energy sources to be used, our laboratory focuses on the various issues related to the future use of nuclear energy and its impact on global energy policy. Our interest covers the best mixture of electricity sources and primary energy, investigations of nuclear-specific topics including non-proliferation, physical protection and safeguards of nuclear materials, and technological aspects related to the introduction of an advanced nuclear energy system, including experimental studies on nuclear fuel cycle.

(Prof. Hironobu UNESAKI, Assist. Prof. Yoshiyuki TAKAHASHI)



The best combination of electricity sources

Energy Department of Socio-Environmental Energy Science

Department of Socio-Environmental Energy Science

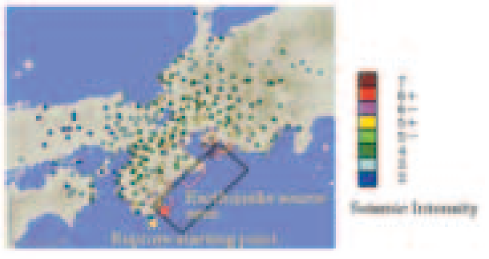
Societal Energy Science

Strategy of Disaster Prevention in Energy System : Safety culture

Social Energy Education

Social consensus regarding energy problems is essential to sustaining the development of humankind. In our laboratory, the strategy of disaster prevention is studied to construct safety nuclear system focusing upon anti-earthquake procedures and environmental risk assessment during nuclear accident.
Current research topics are 1) estimation of hazards, 2) strategy of earthquake disaster reduction for stable energy supply, 3) Study on the strong ground motion prediction to mitigate earthquake disaster, 4) systematization of disaster prevention system.

(Prof. Katsuhiro KAMAE, Assoc. Prof. Hirotoshi UEBAYASHI)



Earthquake hazard (seismic intensity) map for the hypothetical Tonankai earthquake (M8.1)

Social Science Energy

Risk and Communication concerning Energy Problems

Energy and Communication

Contemporary society is a "risk society", in the sense that how to deal with global risks, represented by energy problems, is an urgent issue of society as a whole. Simultaneously, expansion of horizontal communication by information networks produces risks on the one hand, while also producing opportunities to deal with various risks on the other hand. From a sociological point of view focusing on such both sides of "risk / chance", we approach the problem of risk and communication in contemporary society.

(Prof. Jun YOSHIDA)

■ **International Energy Issues**

Sustainable Global Systems

Presently, energy consumption is highest in the developed world. Energy consumption in developing countries, however, will increase rapidly in the near future. The global issues and problems set to arise as a result are studied in this program.

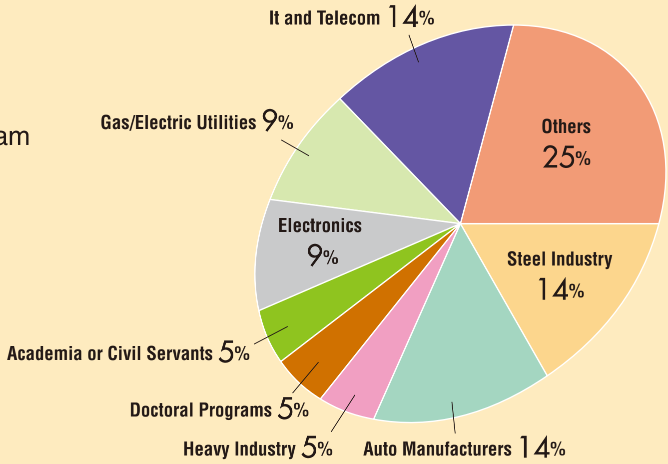
(Visiting Prof. Makoto TAKAHASHI)

Energy
Department of Socio-Environmental Energy Science

Post-Graduation

Academic Year 2016

Graduates of the Master's program in the Department of Socio-Environmental Energy Science:



Department of Fundamental Energy Science

Fundamental Science for the Exploration of New Energy Sources

We offer education and conduct research on fundamental science, seeking for solutions to energy problems. The research fields covered by this department include physical chemistry, material chemistry, electrochemistry, solid state chemistry, biochemistry, quantum mechanics, electromagnetics, statistical mechanics, plasma physics and nuclear physics.

Department Organization

Division	Groups	Focus
Energy Reactions	* Energy Chemistry * Quantum Energy Processes * Functional and Solid State Chemistry	This division focuses upon education and research on chemistry for elementary processes, chemical reactions, reaction processes, substances and materials as related to production, control and the conversion of various kinds of energy such as quantum, thermal, chemical and electrical energy.
Energy Physics	* Plasma and Fusion Science * Electromagnetic Energy * Plasma Physics	This division conducts research and teaching on energy physics based on mechanics, electromagnetism, statistical physics, and material physics. We target a thorough understanding of various physical processes that appear in fundamental energy science. We also pursue the peaceful use of nuclear fusion energy.
Plasma Science	* Fusion Energy Control * High-Temperature Plasma Physics	Plasma physics and controlled nuclear fusion are the main research and educational subjects. In particular, nonlinear and synergetic effects concerning plasma transport and heating are investigated in complex toroidal systems such as stellarators/heliotrons. Current research includes experimental, theoretical, and computational studies on, 1) magnetic surface topologies, 2) the kinetic and magnetohydrodynamic properties of toroidal plasmas, 3) confinement and relaxation of energetic particles, and 4) neutral beam and electron/ion cyclotron heating.
Energy Materials Science	* Interfacial Energy Processes * Energy Nano Engineering * Biofunctional Chemistry * Bioenergy	Education and research activities are concerned with the chemical processes of materials and energy covering a wide field extending from quantum processes to molecular assemblies. This division aims to clarify the connection between microscopic and macroscopic aspects. Chemical principles and techniques enabling the effective utilization of energy resources are also actively pursued.
Nuclear Energy	* Fundamental Neutron Science * Energy Transport	To develop innovative high-performance nuclear systems for energy generation or neutron application, studies are focused on the scientific principle and neutronics design of nuclear systems, and on new principles and methods for energy transportation and storage.
Advanced Energy Creation	(visiting professors)	The division intends to discuss the guiding principle of advanced energy creation and its underlying physics and technological basis from the perspective of fundamental energy science by visiting professors.

Curriculum

For the Master's Program

- Advanced Study on Fundamental Energy Science 1, 2, 3, 4
- Fundamental Energy Science Advanced Seminar on Energy Science Ⅰ, Ⅱ, Ⅲ, Ⅳ
- Fundamental Energy Science
- Physical Chemistry for Energy Science
- Energy Electrochemistry
- Inorganic Chemistry for Energy Science
- Introduction to Functional and Solid-State Chemistry
- Inorganic Solid State Chemistry
- Fundamental Plasma Simulation I, II (in English)
- Magnetohydrodynamics
- Fundamental Energy Science Computer Programming
- Plasma Physical Kinetics
- Nanotechnology for Energy
- Material Science for Energy
- Processes for Photonics and Electronics
- Molecular Science of Fluids
- Biofunctional Chemistry
- Structural Energy Bioscience
- Fusion Plasma Engineering
- High-Temperature Plasma Physics
- Plasma Heating
- Plasma Diagnostic
- Energy Transport
- Neutron Mediated Systems
- Introduction to Experiments Nuclear Reactor
- Advanced Energy Creation, I
- Physics of Superconductivity
- Field Research Project on Fundamental Energy Science
- Special Fundamental Study 1, 2
- Industrial Ethics
- Special Seminar on Interdisciplinary Energy Science

For the Doctoral Program

- Functional and Solid-State Chemistry, Adv.
- Physical Chemistry for Energy Science, Adv.
- Materials Science for Energy, Adv.
- Plasma Simulation Methodology I, II (in English)
- Topics in Plasma Dynamics, Adv.
- Special Topics in Advanced Energy Creation, II
- Technology for Advanced Energy, Adv.
- Present and Future Trends of Fundamental Energy Science, Adv. (in English)
- Special Topics in Advanced Energy I, II
- Field Research Project on Energy Science

Department of Fundamental Energy Science

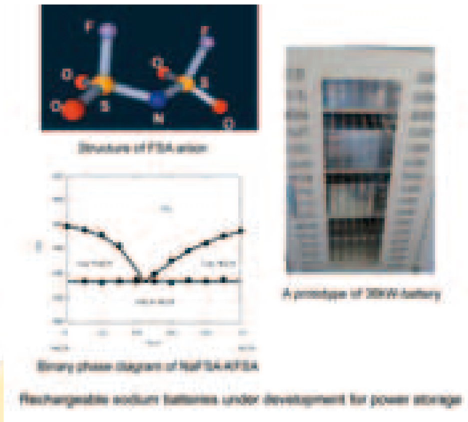
Energy Reactions

Energy Science on the Molecular Scale

Energy Chemistry

Rechargeable batteries and fuel cells are the key technologies for the utilization of renewable energies. Our research interests are concerned with the chemical substances and materials, devices and systems strongly related to energy conversion, storage, and utilization. Chemical education and research programs in our laboratory are mostly based on inorganic, electrochemical and physical chemistry, developing new substances and functional materials, raising able scientists contributing to our society in many energy-related aspects.

(Prof. Rika HAGIWARA, Assoc. Prof. Kazuhiko MATSUMOTO)



Energy Reactions

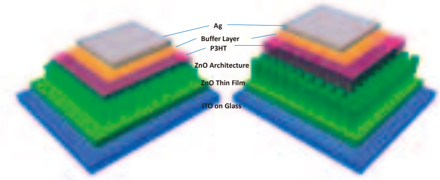
Materials Design for Energy Conversion through Utilization of Quantum States

Quantum Energy Processes

We are interested in the development of energy conversion systems utilizing light. We design new materials and processes for highly efficient light emitting, power generation, and/or other outputs via the relaxation process from the photoexited state to the ground state of organic molecular materials and inorganic semiconductors. Particularly, studies are focused on the fundamental science for showing important functions of light-harvesting, photoelectron conversion, charge transport, storage, and light-emitting through the development of nanosized structures made of organic and inorganic materials.

(e-mail: sagawa@energy.kyoto-u.ac.jp)

(Prof. Takashi SAGAWA, Assoc. Prof. Kan HACHIYA)



Inorganic-organic hybrid solar cells: glass-ITO/ZnO nanoparticle (left) or nanorod (right)/conducting polymer (P3HT)/buffer layer/Ag

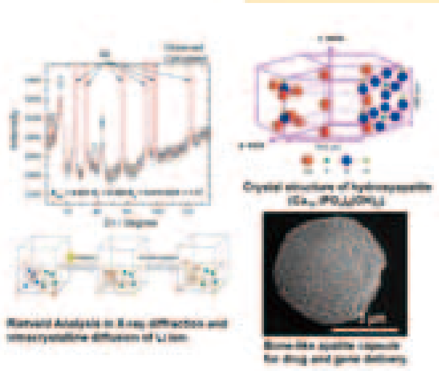
Energy Reactions

Creation of Functional Solid Material for Highly Efficient Energy and Environmental Concinnity

Functional and Solid State Chemistry

We are devoted to designing, synthesizing and analyzing the functional solid state materials for efficient energy production, conversion as well as application to achieve the sustainable environmental concinnity. Our research interests focus on the development of novel energy materials such as electrodes or electrolytes of rechargeable batteries, solid oxide fuel cells or electrochemical sensors, and also on the investigations of their mechanisms in terms of electrochemistry, inorganic chemistry, solid state chemistry and X-ray crystallography. We have revealed the structural change of electrodes in the relaxation process at the charge-discharge cycles (see figure). We are also exploring the biocompatible ceramics through the soft chemistry process from aqueous solutions for biomimetics or drug delivery systems.

(Assoc. Prof. Shigeomi TAKAI, Assist. Prof. Takeshi YABUTSUKA)



Energy Physics

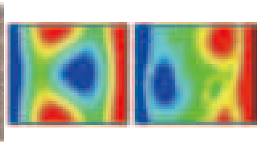
Study of Theoretical Plasma Physics Targeting the Understandings of Nuclear Fusion, Laser-matter Interaction and Astrophysics

Plasma and Fusion Science

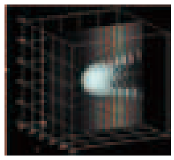
Plasma and Fusion Science "Plasma", the most natural material state in the universe, is a charged particle system with an extremely high degree of freedom. The study of complex phenomena produced by such plasmas is crucial in nuclear fusion; expected to become the next generation energy source, space and astrophysics, and new material science. For this purpose, we develop statistical turbulent theory, nonlinear dynamics, and methodology of various numerical simulations. In particular, we challenge large scale numerical simulations utilizing massively parallel super computers based on kinetic and fluid models. We also attack the problems of high power laser-matter interaction which opens up a new science field such as laser driven compact accelerator and laboratory astrophysics.
(e-mail : kishimoto@energy.kyoto-u.ac.jp)

(Prof. Yasuaki KISHIMOTO, Assist. Prof. Kenji IMADERA)

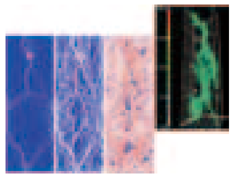
Turbulence simulation in fusion plasmas



Magnetic reconnection simulation in fusion/astrophysical plasmas



Simulation of high energy generated by the interaction of the cluster and the high-intensity laser



Simulation of the lighting in compressed neon gas

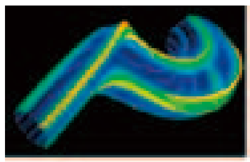
Energy Physics

Effective Use of Plasmic Electro-magnetic Energy

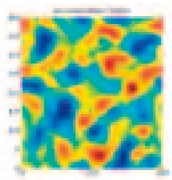
Electromagnetic Energy

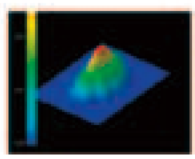
In order to realize the controlled thermonuclear fusion reactor, it is very important to confine and control extremely high temperature plasmas in the strong magnetic field. Various physically interesting phenomena can be observed in such plasmas. Education and research on plasma theories, numerical simulations and theoretical analyses of plasma confinement experiment are performed to understand various phenomena concerned with the confinement and heating of high temperature fusion-oriented plasmas. Theoretical and numerical studies are conducted with respect to the integrated plasma modeling for magnetically confined torus plasmas.

(Prof. Yuji NAKAMURA, Assoc. Prof. Akihiro ISHIZAWA)

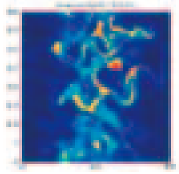


MHD instability of non-axisymmetric helical plasmas





Pressure distribution in an equilibrium with magnetic islands



Impurity diffusion in drift wave turbulence

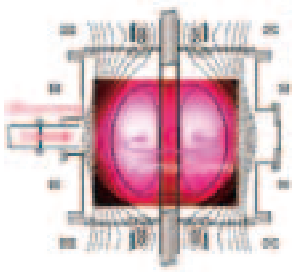
Energy Physics

Research on Plasma Physics by Means of Radio-frequency Electromagnetic Waves

Plasma Physics

Our group studies magneto-hydro-dynamics and kinematic processes in magnetically confined toroidal plasmas by means of radio-frequency heating and current drive. These studies are closely related to fusion plasma research and, to some extent, to space plasma physics. We also study electron cyclotron resonance(ECR) plasma production and develop plasma diagnostic tools such as heavy ion beam probe system. These plasma studies serve as fundamental experiments on the nonlinear phenomena of charged particles in the electromagnetic field.

(Prof. Hitoshi TANAKA, Assoc. Prof. Masaki UCHIDA)



Microwave Spherical Tokamak

Magnetic field line is closed by the plasma current and confines the plasma.

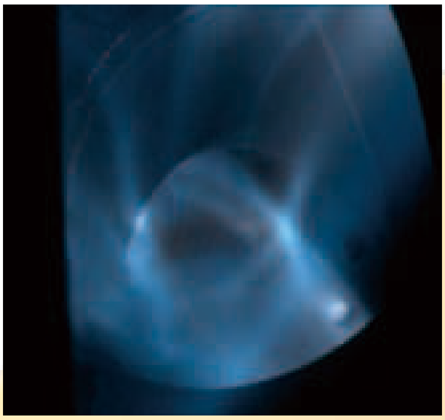
Plasma Physics

Fundamental Study of Physics and Technologies for the Control of High Temperature Fusion Plasmas

Fusion Energy Control

The control of plasma energy in a magnetic bottle is essential for the fusion energy system. The main objectives of this section are to promote physical and technological understanding of plasma properties and to establish the principles of plasma energy control in the fusion energy system. Current topics are: 1) control of magnetic field topology for improved plasma confinement, especially in helical magnetic configurations, 2) plasma production/heating control, 3) control and stabilization of high temperature plasma, and 4) control of heat flux, particles flux and plasma-material interactions.

(Prof. Tohru MIZUUCHI, Assoc. Prof. Takashi MINAMI, Assist. Prof. Shinji KOBAYASHI)



A snapshot of toroidal plasma (tangential view) in Heliotron J, an advanced helical device at Institute of Advanced Energy, Kyoto University.

Plasma Physics

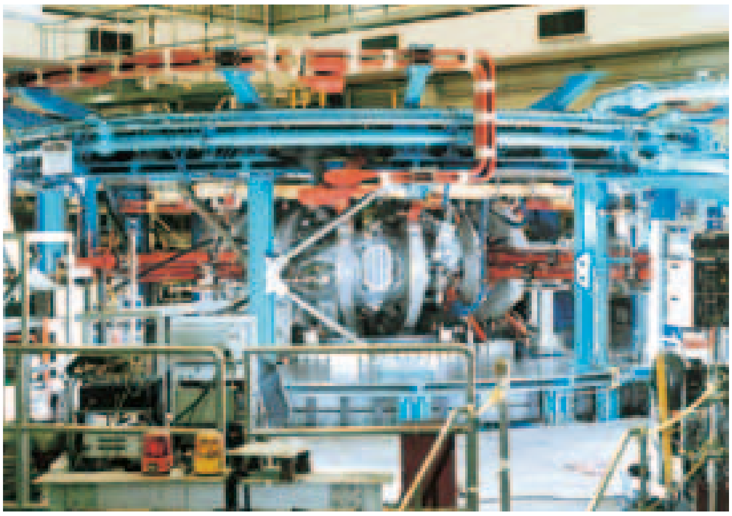
Fusion Plasma Physics Exploration as a Future Energy Source

High-Temperature Plasma Physics

Controlled thermonuclear fusion has been a kind of "dream" for eternal and Zero-emission energy source. In order to contribute this long-term mission for human being, we are operating a middle-size unique magnetic fusion experimental device, Heliotron J. We are currently focusing on the heating physics of ions using ICRF electromagnetic wave, various kinetic and nonlinear phenomena induced by energetic ions, detection of impurity ions, etc. Diagnostics of plasma particles, spectral radiations, and magnetic signals with the aid of both advanced measurements and computer simulation are powerful tools to this end. Developing pioneering new topics with students are always encouraged.

(Assoc. Prof. Hiroyuki OKADA, Assoc. Prof. Shinichiro KADO, Assist. Prof. Satoshi YAMAMOTO)

ICRF Antennae for Plasma Heating



Plasma Confinement Device: Heliotron J

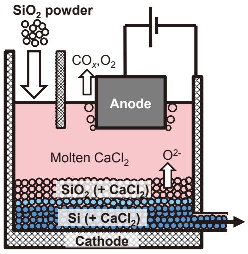
■ **Energy Materials Science**

Electrochemical and Biochemical Approaches toward the Expanded Introduction of Renewable Energy

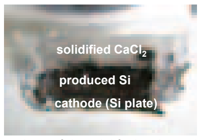
Interfacial Energy Processes

We are studying materials and systems to realize renewable energies like photovoltaics and bioenergy as the major primary energy source for human beings. We use electrochemistry and biochemistry as the core academic fields. For examples, we are developing "a new electrochemical production method of solar silicon" and "large-scaled secondary batteries with high safety" by using molten salts and ionic liquids as electrolytes and controlling electrode-electrolyte interface. We also focus on the highly efficient production of ethanol from biomass using genetic engineering, aiming to solve the global crises such as exhaustion of fossil fuel and global warming.

(Prof. Toshiyuki NOHIRA, Assoc. Prof. Tsutomu KODAKI, Assist. Prof. Takayuki YAMAMOTO)

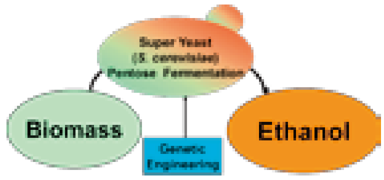


A new production method of Si by molten salt electrolysis.



A photo of the solidified molten salt and the produced Si on the bottom.

A crystalline Si rod made from the Si powders by floating zone melting.



Strategy for construction of efficient ethanol production system from biomass.

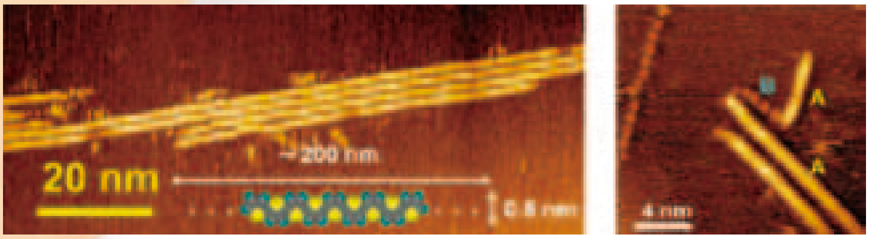
■ **Energy Materials Science**

Molecular Assembling on Surface Aiming at Organic Devices for Energy

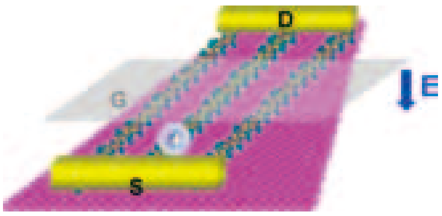
Energy Nano Technology

Nanoscience and technology, ultimate methods for making new materials from assembling single molecules, are studied aiming at molecular devices for energy use. We have developed 'Electrochemical Epitaxial Polymerization' technique which is a totally new molecular assembling technique of molecular wires on metal surface from single molecules. By the use of this technique, unprecedented materials for energy use will be developed. Organic electronic devices such as field effect transistors and solar cells will be developed using our new techniques. Studies of theoretical biophysics are also in progress.

(Prof. Hiroshi SAKAGUCHI, Prof. Masahiro KINOSHITA, Assist. Prof. Takahiro KOJIMA, Assist. Prof. Takahiro NAKAE)



Electrochemical-epitaxially polymerized conducting-polymer wires on metal surface



'Molecular wires' transistor

Energy
Department of Fundamental Energy Science

■ **Energy Materials Science**

Development of Highly Efficient Energy-Transformation Systems by Biomacromolecules

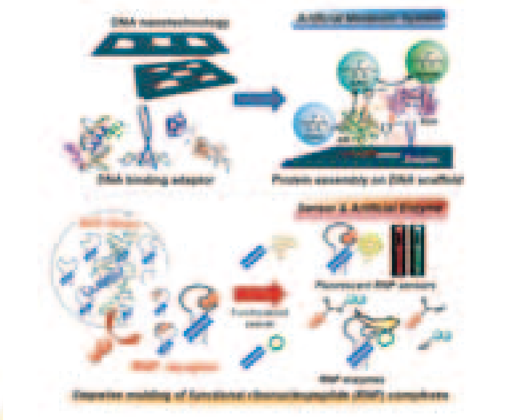
Biofunctional Chemistry

The research interests in our group focus on the design of novel biomacromolecules and their assemblies for the application of energy conversion, catalysis and signal transduction in water, the solvent of life. We take synthetic, organic chemical, biochemical and biophysical approaches to construct novel proteins and protein/nucleic acid complexes with sensing or catalytic functions, and also to develop the assemblies of proteins and nucleic acids that emulate the function of biological systems.

A stable complex of a peptide and RNA, namely, ribonucleopeptide (RNP), provides a new framework to construct macromolecular receptors for small molecules. The modular structure of RNP receptors enables further functionalization of RNPs into fluorescent biosensors and enzymes. Structure-based design and/or library-oriented screening provide alternative strategy to construct protein-based biosensors that assess intracellular dynamics of second messengers and metabolites.

Cellular energetic processes consist of multiple chemical reaction steps with various enzymes cooperating in a specific manner to catalyze the sequential reaction steps. Such natural systems are effectively reconstructed in vitro when the individual enzymes are placed in appropriate orientations. DNA nanostructures such as DNA origami, and protein “adapters” are used for the construction of “molecular switchboard” to arrange enzymes and other proteins with nanometer-scale precision that drives an artificial metabolic pathway consisting of multi-step chemical reactions for effective energy utilization.

(Prof. Takashi MORII, Assoc. Prof. Eiji NAKATA, Junior Assoc. Prof. Arivazhagan RAJENDRAN, Assist. Prof. Shun NAKANO)



Rational design of biomacromolecular assembly on the DNA nanostructure, the molecular switchboard, realizes a bio-inspired energy utilization system, such as the artificial metabolic system and artificial photosynthesis (upper).
Receptors, biosensors and enzymes are constructed from structurally characterized and protein-RNA complexes (lower).

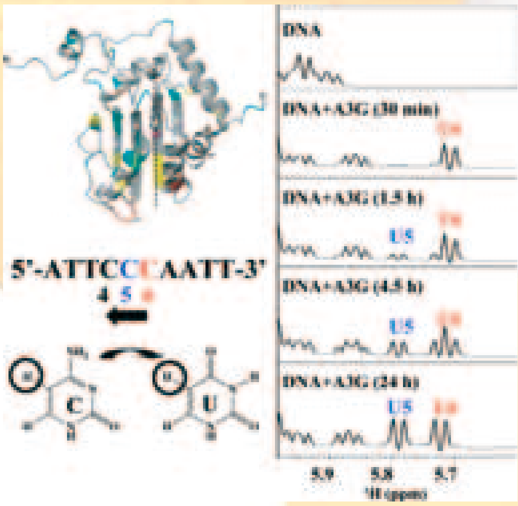
■ **Energy Materials Science**

Toward Biorefinery through the Development of Biomass and Biomolecules Based on Structural Biology

Bioenergy

We explore the way how biomolecules such as proteins (involving enzymes) and functional nucleic acids (DNA and RNA) work at atomic resolution based on structural biology with NMR. We determine both static and dynamical structures with the aid of our own development of the new methodology and elucidate the underlying mechanism of functions of these biomolecules. For example, recently we have successfully developed the way to monitor the base conversion reaction by anti-HIV enzyme, A3G protein, in real-time by NMR for the first time. This new method has provided critical information on how this enzyme makes the catalytic action on DNA. Currently, we are developing the way to extract energy and valuable materials that can be used as starting materials of various products from wood biomass. Thus, we pursue to contribute to the paradigm shift from oil refinery to biorefinery.

(Prof. Masato KATAHIRA, Assoc. Prof. Takashi NAGATA, Assist. Prof. Tsukasa MASHIMA)



Structure of A3G protein which possesses the anti-HIV activity and the interaction sites (colored) with target virus DNA (upper left). Real-time monitoring of the base-conversion reaction through deamination by A3G with NMR signals (lower left and right).

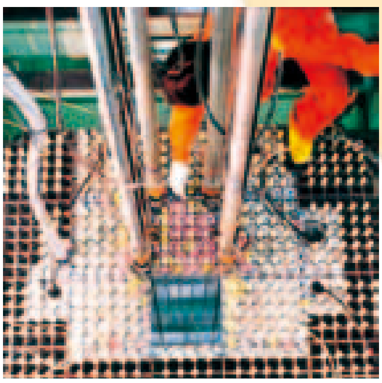
■ **Nuclear Energy**

Study of Innovative High-Performance Systems for Nuclear Energy Utilization in Next Generation

Fundamental Neutron Science

The scientific principle and neutronics design of nuclear systems are investigated to develop innovative high-performance systems for nuclear energy utilization in the next generation. Specifically, basic studies on the nuclear characteristics of 1) high-performance nuclear reactors of the next generation, 2) accelerator driven system for transmutation of high-level nuclear waste, 3) reactors for the thorium fuel cycle, 4) nuclear criticality safety, and 5) radiation detection for various applications including nuclear security are performed mainly through reactor physics experiments.

(Prof. Tsuyoshi MISAWA, Assoc. Prof. Cheol Ho PYEON, Assist. Prof. Yasunori KITAMURA)



VIew of the reactor physics experiment using the Kyoto University Critical Assembly (KUCA)

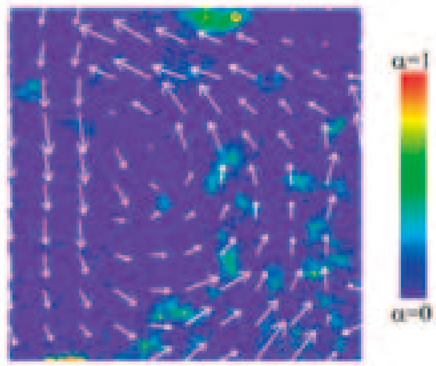
■ **Nuclear Energy**

Evolution of Thermo-Fluid Science toward Ultimate Science and Innovative Technology

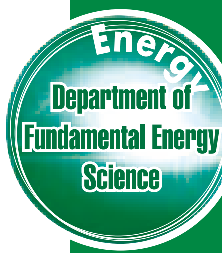
Energy Transport

This group is dedicated to basic research on the safe and efficient utilization of high intensity thermal energy produced by a next generation nuclear energy system, indispensable as an energy source in the 21st century. From this point of view, current research programs involve experimental and theoretical studies on heat removal in extremely high flux from advanced nuclear energy systems such as a nuclear fusion reactor and an accelerator-driven system (ADS), multiphase flow phenomena which are encountered in various energy systems, and the development of novel methods for fluid measurement such as particle beam radiography.

(Prof. Yasushi SAITO, Assoc. Prof. Kei ITO, Assist. Prof. Xiuzhong SHEN, Assist. Prof. Daisuke ITO)



Velocity and void fraction profile in a liquid-metal two-phase flow measured by combined technique of neutron radiography and PTV method.
α is the time averaged local void fraction.



■ **Advanced Energy Creation**

Development of Organic Self-Assembling Materials

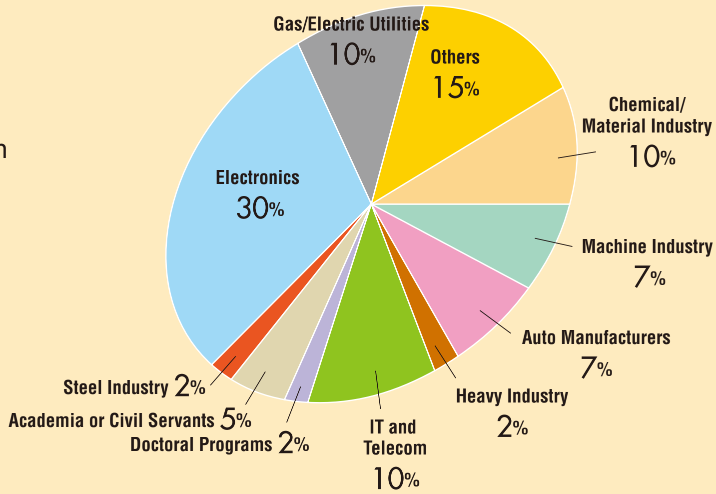
Organic self-assembling materials have attracted much attention for next-generation functional devices with several specific properties being highly oriented, light-weight, flexible, and easily applicable to large-area processing combined with introduction of electronically and optically functionalized groups. We have conducted research and development activities of optoelectronic devices such as wavelength converters, which have been expected to be the highly efficient energy-harvesting and energy-generating devices. In this context, the outlines, the state-of-the-art, and the future perspectives in this rapidly-progressing field will be introduced.

(Visiting Prof. Hirotaka IHARA)

Post-Graduation

Academic Year 2016

Graduates of the Master's program in the Department of Fundamental Energy Science:



Department of Energy Conversion Science

Energy Conversion Systems and their Functional Design in the 21st Century

In order to contribute to the development of a human society that coexists with the natural environment, and to establish efficient clean energy systems, we offer education and conduct research on the generation, conversion, control and utilization of various kinds of energy from the perspectives of science and engineering.

Department Organization

Division	Groups	Focus
Energy Conversion Systems	* Thermal Energy Conversion * Conversion Systems	With the objective of unifying fundamental theories on energy conversion and transportation, functional design and constitutive elements of systems, and investigating safety and highly-efficient energy conversion systems in harmony with the environment, the foundation and methodology of the related evaluation, design and control are being studied.
Design for Energy Conversion Functions	* Materials Design for Energy Systems * Design for Functional Systems	In order to convert, transport and store energy with high efficiency, areas of study include the functions to be embodied in a variety of machines and their composed systems, the principles for the diversification of energy conversion, constitutive materials for hardware systems, the design of associated machineries and software, and the foundation and application of their safety and reliability.
Functional Energy Conversion	* Advanced Energy Conversion * Highly Qualified Energy Conversion * Functional Energy Conversion Materials	In order to investigate highly-efficient safety energy conversion processes in harmony with the environment and to build systems, areas of study include the establishment of theories, application/evaluation and functional conversion systems from the manifold perspectives of fusion science and engineering, optical science, thermochemistry, advanced atomic energy, energy materials science and engineering, etc.
Innovative Energy Conversion	(visiting professors)	

Curriculum

For the Master's Program

- Energy Conversion Fundamentals
- Rate Processes
- Heat Engine Systems
- Thermal Energy System Design
- Combustion Science and Engineering
- Fracture Mechanics for Energy Systems
- Science for System Integrity
- Theory of Plasticity
- Estimation Mechanics of Materials
- Continuum Thermodynamics
- Fundamentals of Fusion Energy System
- Advanced Energy System Technology
- Particle Energy Conversion
- Electromagnetic Energy Conversion
- Functional Energy Conversion
- Materials for Energy Conversion
- Advanced Energy Conversion Science
- Engine Combustion Analysis
- Nuclear Power Plant Engineering
- Advanced Engine Systems
- Field Research Project on Energy Conversion Science
- Special Fundamental Subject 1, 2
- Industrial Ethios
- Special Seminar on Interdisciplinary Energy Science
- Exploratory Project I, II , III, IV Conversion Science I, II, III, IV
- Fusion Energy Science and Technology
- Energy Conversion System Design and Functional Design
- Field Research Project on Energy Science

For the Doctoral Program

- Energy Conversion Fundamentals, Adv.
- Environmental Protection Science
- Continuum Thermodynamics
- Nuclear Power Plant Engineering, Adv.
- Field Research Project on Energy Science
- Advanced Energy Conversion Science
- Engine Combustion Analysis, Adv.
- Advanced Engine Systems, Adv.

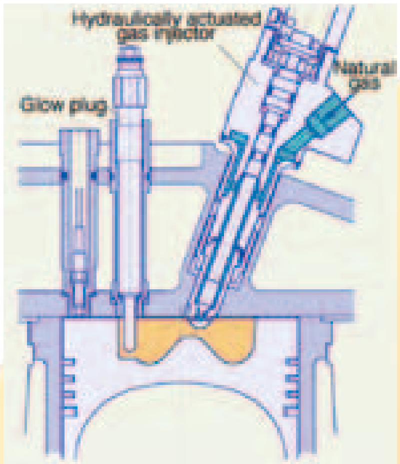
Energy Conversion Systems

Energy Conservation and the Mitigation of the Environmental Impact of Thermal Engine Systems

Thermal Energy Conversion

Our research interests focus on improvements in thermal efficiency and the mitigation of pollutant emissions in thermal engine systems. Current research subjects are: 1) the prediction of combustion processes in internal combustion engines, 2) the development of technologies for reducing pollutant emissions from engines, 3) fundamental studies on ignition and combustion of fuel sprays and jets, 4) the utilization of alternative fuels for combustion systems, and 5) engine systems for reducing and recovering energy loss.

(Prof. Takuji ISHIYAMA, Assoc. Prof. Hiroshi KAWANABE, Assist. Prof. Naoto HORIBE)



Direct Injection Gas Engine

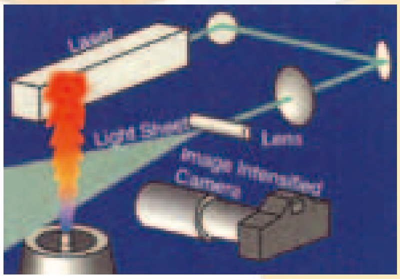
Energy Conversion Systems

Optimum Design and Control of Energy Conversion Systems

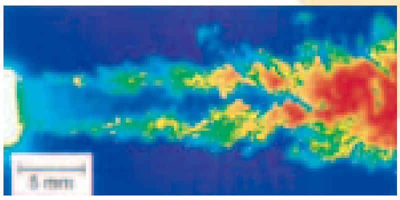
Conversion Systems

The aim is to design, control and access energy conversion systems with high efficiency and safety while protecting the environment, and in addition, the investigation of physical and chemical processes in thermo-fluid substances is made to establish optimum conversion systems. Special attention is paid to the following issues and their related matters: 1) ignition and combustion of homogeneous and heterogeneous mixtures, 2) chemical reaction kinetics of pollutant formation, 3) kinetics and fluid dynamics of turbulent diffusion flames, 4) laser diagnostics and image analysis for combustion research, and 5) numerical simulation of turbulent flows and combustion.

(Assoc. Prof. Jun HAYASHI)



Laser Diagnostics and Image Analysis of Flame Structure


Tomographic Image of a Jet

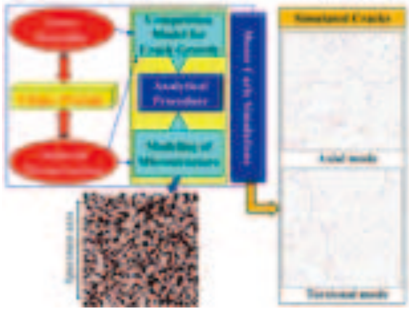
■ **Design for Energy Conversion Functions**

Design for Materials to Create New Functions and Energy-Related Machinery

Materials Design for Energy Systems

The function, deformation and strength characteristics of materials and machinery, which are applied to the energy conversion systems, should be adequately assessed. In this group, theoretical and experimental investigations are carried out to establish the most suitable methodology for the design of such materials and machinery. Works conducted in this group are summarized as follows; i.e., (1) strength evaluation of engineering materials based on fracture mechanics, (2) experimental and analytical investigations on biaxial fatigue of metals, (3) evaluation of static and fatigue strength of ceramic thin-film coated materials, and (4) experimental and analytical assessments of strength properties in porous ceramics, and so on.

(Prof. Toshihiko HOSHIDE)



Analytical procedure and simulated cracking morphology

Department of Energy Conversion Science

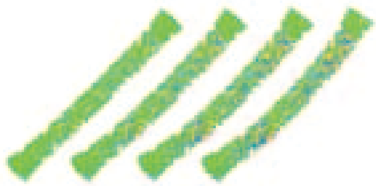
■ **Design for Energy Conversion Functions**

Design of Advanced Functional Material Systems and Nondestructive Evaluation of Their Integrity

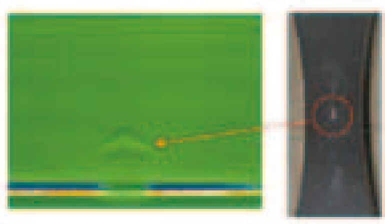
Design for Functional Systems

Advanced energy conversion systems in various fields require the component materials to possess not only sufficient stiffness and strength but also various functions such as electromagnetic and thermal properties as well as reliability when subjected to extreme environments such as large stress, high temperature and intense electromagnetic fields. This research group aims to develop a framework to analyze the behavior of such materials based on continuum thermo-electromagneto-mechanics and to design highly functional and smart material systems. In addition, modeling of complex materials with internal structures and new nondestructive methods are developed to evaluate the functional and structural integrities of material systems by means of acoustic, thermal and electromagnetic material properties including their interactions.

(Prof. Shoji IMATANI, Assoc. Prof. Katsuyuki KINOSHITA, Assist. Prof. Masataka ABE)



Direct simulation of bending process of porous metal.



Visualization in the sample by a phased array ultrasonic testing system.

■ **Functional Energy Conversion**

Design, Development and Assessment of Fusion Energy Systems

Advanced Energy Conversion

In this century, constraints of fossil resource and global environmental problem should be resolved while sustainable development and growth mainly in developing countries are required. Innovative energy technology based on advanced science is inevitable to completely reform the entire energy system, and fusion is expected as a promising candidate. For this purpose, we are carrying out the research and development of advanced fusion energy system by experimental, numerical and design study, as well as integrated assessment as a part of future energy system from the aspect of society and environment.
We are studying the design of fusion device and its system based on the advanced energy conversion component such as blanket and divertor that attracts attentions from international collaborators. We are also investigating hydrogen production process and propose carbon free gaseous and liquid fuel supply from waste biomass. This biomass-fusion hybrid concept enables fusion to be applicable earlier to drastically replaces fossil fuel. We also develop a unique small compact fusion neutron beam device that can be used for analytical, medical and various applications. Tritium behavior in the plant system and in the environment is evaluated to assess reactor safety. This energy evaluation study further involves all the carbon free renewable energy technology and analysis from biological, environmental, economical and social aspects for the sustainability of the entire social system.

(Prof. Satoshi KONISHI, Assoc. Prof. Ryuta KASADA, Assist. Prof. Keisuke MUKAI)

Fig. Future recycling society with fusion-biomass hybrid system.

■ **Functional Energy Conversion**

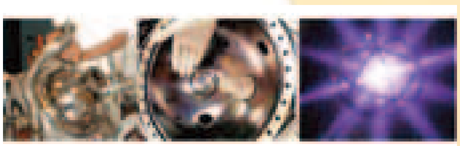
Highly Qualified Energy Conversion through Advanced Control of Charged Particle Beams

Highly Qualified Energy Conversion

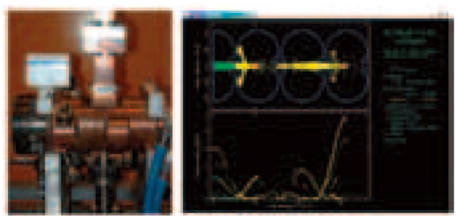
Intensive investigations of wave heating and current drive in fusion plasmas, high-brightness electron beam production and control for free electron lasers, and compact fusion proton/neutron source for versatile applications are being conducted. Particular emphasis is put on studies of interactions between charged particles and electromagnetic fields. Physics and technology related to microwave waves are investigated for plasma heating and diagnostics. In addition, an innovative, very simple beam-gas and beam-beam colliding fusion called IECF is studied experimentally and theoretically for bulk explosive detection, medical application, and future advanced D-3He fusion. Computer simulations are extensively applied to all phases of research.

(Prof. Kazunobu NAGASAKI, Assoc. Prof. Kai MASUDA, Assist. Prof. Shinsuke OHSHIMA)

Plasma production, heating and current drive by electron cyclotron waves



Inertial electrostatic confinement fusion



Microwave electron gun and electron dynamics simulation in the gun

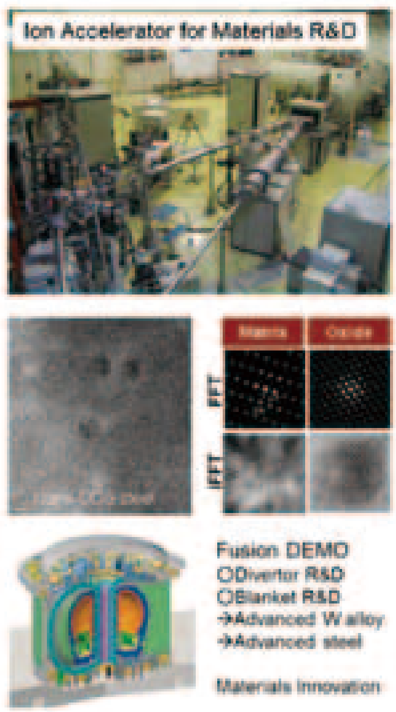
Functional Energy Conversion

Basic Research and Development of Nuclear Energy Materials

Functional Energy Conversion Materials

Energy systems with high efficiency, high performance and high functions are demanded for highly efficient energy utilization. Advanced materials development is essential for realization of such an advanced energy system. In this research group, understanding materials behavior, searching key technologies of materials development and basic research on lifetime estimation of the plant materials have been carried out for development of innovative structural materials with high performance. In the resent study on advanced ferritic steels for fusion blankets and next generation nuclear systems, the role of nano-sized oxide particle dispersion played in the obtained high performance of the ODS steels were investigated with a high energy ion accelerator.

(Prof. Akihiko KIMURA, Assoc. Prof. Kazunori MORISHITA, Assist. Prof. Kiyohiro YABUUCHI)



Innovative Energy Conversion

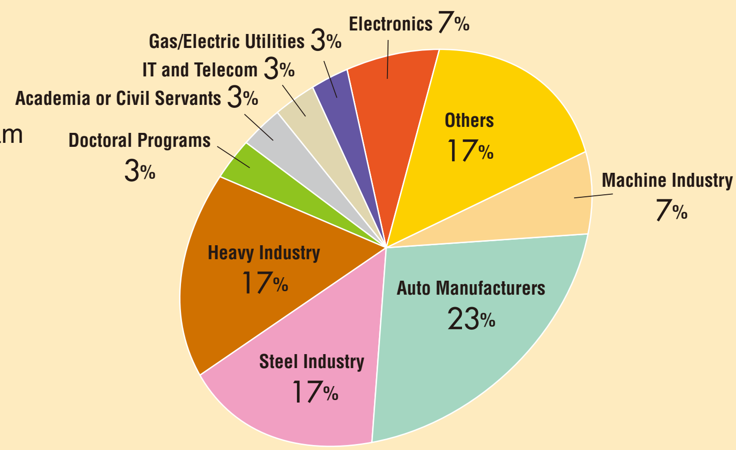
Education and research are conducted for innovative energy conversion.

(Visiting Assoc. Prof.)

Post-Graduation

Academic Year 2016

Graduates of the Master's program in the Department of Energy Conversion Science:



Graduate School of Energy Science, Kyoto University

Department of Energy Science and Technology

To Establish Environmentally Friendly Process Technologies to Sustain the Development of Our Society

We offer education and research opportunities for the development of more efficient utilization of direct and indirect energy supplies based on disciplines such as resources, metallurgical, mechanical and electrical engineering.

Department Organization

Division	Groups	Focus
Materials Science & Engineering for Energy Systems	* Device Physics * Process and Energy	Fundamentals and applications of thermal science upon advanced energy device, advanced energy systems and superconducting apparatus.
	* Materials Process Science * Thermochemistry	Fundamentals and applications of thermochemistry for the creation, development and processing of materials for energy.
Resources and Energy	* Resources and Energy Systems * Advanced Processing of Resources and Energy * Mineral Processing	Education and research on supply systems and advanced processing of energy resources and materials, and related space technologies.
High Quality Energy	* Quantum Radiation Energy Science * The Physics of Energy Materials * Photon Energy Science	Education and research on the generation and application of high-quality quantum-radiation energy materials, R&D for advanced energy systems and advanced photon energy with lasers.
Innovative Energy Science and Technology	(visiting professors)	

Curriculum

For the Master's Program

- Advanced Study on Energy Science and Technology 1, 2, 3, 4
- Introduction to Energy Science and Technology
- Advanced Energy Science and Technology
- Lecture on Advanced Integrated Circuits
- Thin Film Nanodevices
- Power System Engineering
- Materials Processing
- Functional Materials Processing
- Thermochemistry
- Resource and Energy System
- Ocean Resources and Energy Technology
- Numerical Approach to Working Processes
- Computational Physics
- Advanced Physical Chemistry
- Photon and Quantum Energy
- Electromagnetic Energy
- Effective Utilization of Energy
- Energy Development
- Field Research Project on Energy Science and Technology
- Special Fundamental Study 1, 2
- Industrial Ethics
- Special Seminar on Interdisciplinary Energy Science

For the Doctoral Program

- Applied Thermal Science, Adv.
- Energy and Processes, Adv.
- Resource and Energy System, Adv.
- Photon and Quantum Energy, Adv.
- Energy Development, Adv.
- Advanced Energy Science and Technology (in English)
- Field Research project on Energy Science

Department of Energy Science and Technology

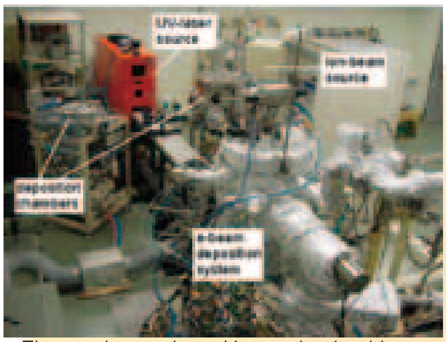
Materials Science & Engineering for Energy Systems

Crystal Alignment Techniques for Advanced Energy Materials

Device Physics

Our group focuses on high-performance devices based on utilization of renewal energy and highly efficient utilization of energy, and aims to the establishment of various crystal alignment techniques as production processes of materials for fully maximizing their functionalities. Currently, our targets are electronic materials containing superconductors and functional compounds for power generation. Novel crystal alignment processes, such as ion-beam technology, epitaxial thin-film growth and magnetic alignment, are investigated for precise and three-dimensional arrangement of crystalline grains like a single crystal.

(Prof. Toshiya DOI, Assoc. Prof. Shigeru HORII)



Electron-beam deposition and pulsed-laser deposition systems for fabrication of high-quality thin films

Materials Science & Engineering for Energy Systems

Applied Superconductivity Engineering and Thermal Hydraulics in Liquid Gases for Innovative Energy Systems

Process and Energy

Research topics of this group are

1) Applied superconductivity apparatus for advanced energy system, such as SMES (superconducting energy storage), Superconducting rotating machines, Fault current limiters etc.
2) Advanced electric power system including renewable energy sources.
3) Thermal hydraulics in Helium, Hydrogen, Nitrogen etc., for high density heat removal, essential for applied superconductivity systems.

(Prof. Yasuyuki SHIRAI, Assoc. Prof. Yoshiaki KASHIWAYA)

Experimental Setup for Liquid Hydrogen cooled Superconducting Energy Devices (right) and HTC Superconducting Fault Current Limiter (left)

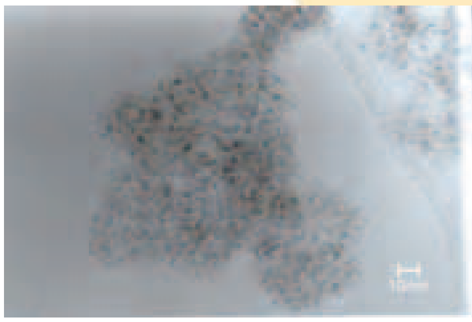
Materials Science & Engineering for Energy Systems

Electrochemical processing for functional materials

Materials Process Science

This group investigates production processes for functional materials based on electrochemistry. The current research topics in this group are as follows: 1) Functional surface treatment by aqueous/non-aqueous processing, 2) Formation of nanoparticles as catalysts for fuel cell, 3) Electrodeposition of compound semiconductors for solar cell, 4) Electrodeposition of alloys and composites, 5) Hydrometallurgical recycling process.

(Prof. Tetsuji HIRATO, Assoc. Prof. Masao MIYAKE, Assist. Prof Takumi IKENOUE)



Pt nanoparticles on carbon black produced by alcohol reduction process.

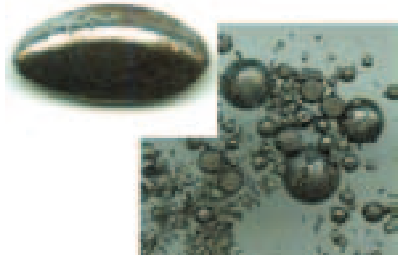
Materials Science & Engineering for Energy Systems

Thermochemistry for Energy Research

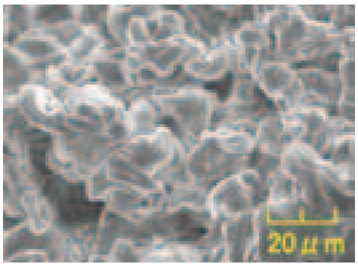
Thermochemistry

The main concern of this group is the fundamental and applied studies of physical chemistry and thermochemistry for a better understanding of existing materials, chemical and metallurgical processes and the generation of new concepts of material production and recycling, with a particular emphasis on minimizing the consumption of energies and resources, without affecting the global environment in future centuries.

(Assoc. Prof. Masakatsu HASEGAWA)



Iron droplet containing carbon, obtained through reduction with various waste



SEM micrograph of an inclusion compound containing chlorine

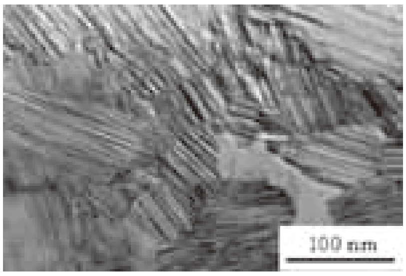
Resources and Energy

Eco-Metals & Nano-Metals for Next Generation Society

Resources and Energy Systems

Our group focuses on materials science related to resource, energy and environment for next generation society. The main topics are eco-metals for energy and resource saving e.g., superlight Mg alloys and their up-grade recycling, nano-metals for innovative technologies e.g., hydrogen-storing nanoporous metals and ferromagnetic nanocrystalline metals, and fracture mechanisms of rocks for stable supply of energy e.g., analyses of pore spaces and cracks.

(Prof. Mamoru MABUCHI, Assoc. Prof. Masataka HAKAMADA, Assist. Prof. Youqing CHEN)



Ferromagnetic nanocrystalline metals with nanolamellar structure

Energy Department of Energy Science and Technology

Resources and Energy

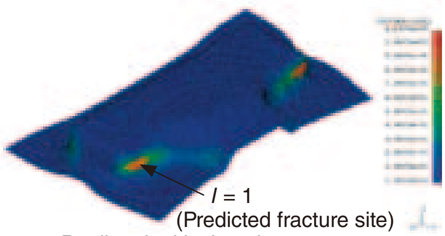
Computational Physics for Energy Resources and Materials Processing Technology

Advanced Processing of Resources and Energy

Materials for all products are supplied by resources, and energy is consumed in the process between material and product. The "advanced processing of resources and energy" deals with the total processing of resources and energy from a theoretical as well as practical perspective, using a mainly numerical simulation based on computational physics. Current research subjects include the analysis of multi-phase mixture flow in air-lifting pipes, the design of materials processing and workings, such as continuous casting, rolling and sheet forming, etc.

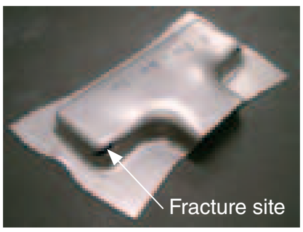
(Prof. Hirohiko TAKUDA, Assoc. Prof. Takayuki HAMA)

Forming limit prediction of high-strength steel sheets



Predicted critical stroke = 17.9 mm

Finite element simulation



Measured critical stroke = 17.8 mm

Experiment

Department of Energy Science and Technology

Resources and Energy

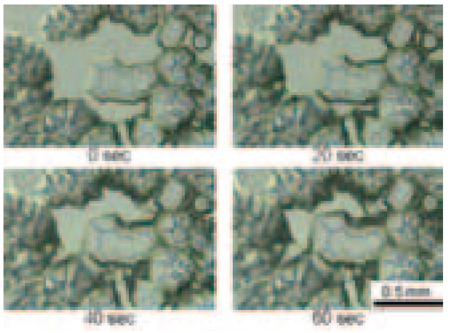
Contribution of mineral processing to energy, resources, and environment

Mineral Processing

Resources and energy processing in harmony with the environmental and the construction of recycling systems are necessary so that we can continue to live safely in the future.
Our group investigated mineral processing considering the protection of the environment and resources from the following various points of view.

1) Basic Properties of Methane Hydrate and CO_2 Hydrate
2) Utilization of the Methane Fermentation Technology
3) Environmental Purification, Resource Recycling, Mineral Processing

(Assoc. Prof. Hiromu KUSUDA, Assoc. Prof. Hitoshi FUJIMOTO, Assist. Prof. Eishi KUSAKA)



Crystal growth of methane hydrate (286.2K, 10.5MPa)

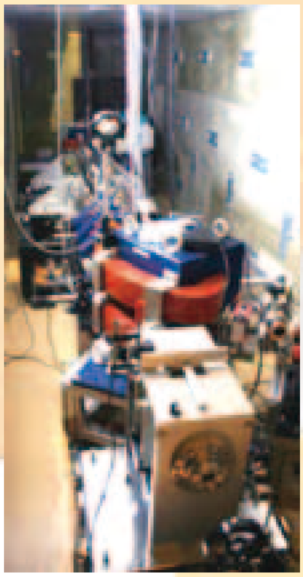
High Quality Energy

Generation of High-Quality Quantum Radiation Energy and its Application to Functional Materials

Quantum Radiation Energy Science

Generation and application of the mid-infrared free electron laser (KU-FEL) and compact THz radiation source to develop high efficiency energy conversion materials are studied. Fundamental photo-physics is studied by developing new measurement techniques. Laser-Compton backscattering gamma-ray has also been studied for nuclear security application. Biomass and low rank coal upgrading by using solvent degradation method has been developed. Evaluation of renewable energy system and policy, implementation methodology are investigated as well.

(Prof. Hideaki OHGAKI, Assoc. Prof. Toshiteru KII, Senior Lecturer Hooman Farzaneh, Assist. Prof. Heishun ZEN.)



KU-FEL accelerator and optical system

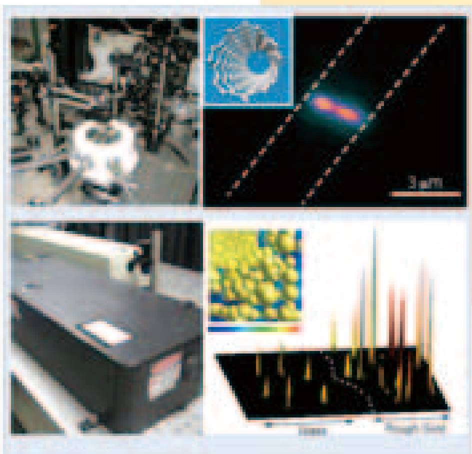
High Quality Energy

Manifestation of Optical Functionalities and Highly Efficient Photoelectric Conversion Based on Nano-science and Nano-technology

The Physics of Energy Materials

Recently, the efficient utilization of light energy including the solar light is required for the sustainable society. It is very important to create the nano-materials and composite nano-materials with potential applications and to investigate new optical functionalities of these nano-materials for this requirement. We are investigating the quantum physical process of the nano-materials (carbon nanotube, graphene, semiconductor/metal nanoparticles and these composite nano-materials) using advanced laser spectroscopy. Furthermore, we are exploring the scientific principle and applications of highly efficient photoelectric conversion processes in the nano-materials for next-generation solar cells. The Multi-Scale Testing and Evaluation Research Facility (MUSTER) is also used for development of new composite materials.

(Prof. Kazunari MATSUDA, Assoc. Prof. Tatsuya HINOKI, Assoc. Prof. Yuhei MIYAUCHI, Assist. Prof. Kouichi JIMBO)



Systems of advanced laser spectroscopy and optical images of nano-materials

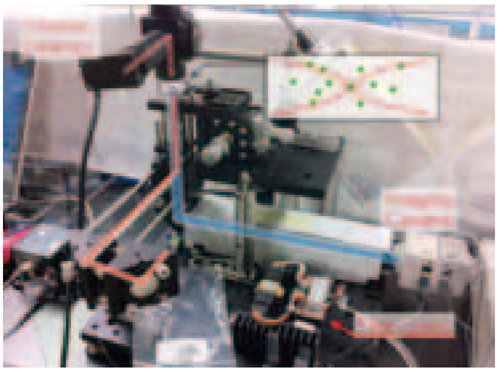
■ **High Quality Energy**

Generation and Applications of Advanced Photon Energy

Photon Energy Science

It is more than half century ago since a laser was invented, and it is not a special device only for specialists. Nowadays, it is widely used in many different fields to carry out the in-situ observation of various dynamics, synthesize nanomaterials, etc.
In our group, using different kinds of lasers as a tool, we explore novel nonlinear optical phenomena and study the optical response of various materials.

(Assoc. Prof. Takashi NAKAJIMA)



Laser trapping system

■ **Innovative Energy Science and Technology**

State-of-Art in Energy Science and Technology

Globally famous researchers and pioneers are annually invited as visiting professors or visiting associated professors, to introduce current issues and fronts in energy science and technology. The application of advanced electric devices, the new material development and its processing, resource exploration and evaluation of energy redistribution, economic analysis for metal recycling, etc. have been argued. The scientific and technological trends on energy utilization are demonstrated from international perspectives.

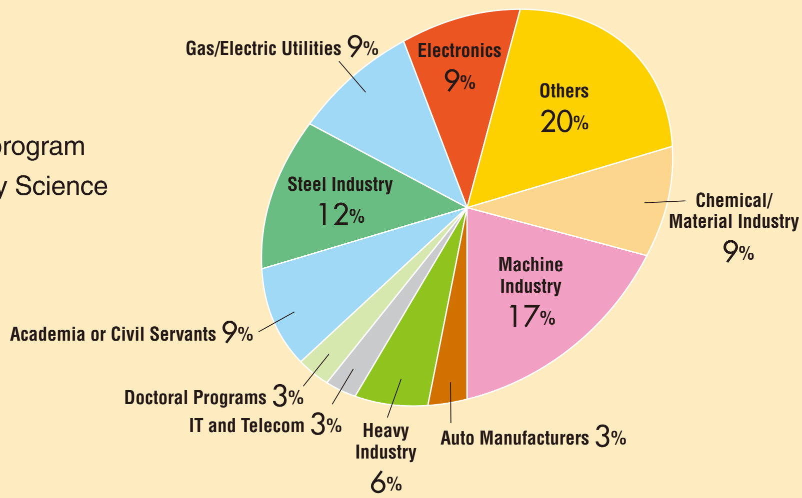
(Visiting Prof.)

Energy
Department of Energy Science and Technology

Post-Graduation

Academic Year 2016

Graduates of the Master's program in the Department of Energy Science and Technology:



Specialization and Profiles Table

Department	Division	Group	Academic Staff	Engineering: Civil Engineering, Environment	Engineering: Mechanical Engineering	Engineering: Electrical & Electronics	Engineering: Material Science	Engineering: Earth Resources	Engineering: Chemical Engineering	Engineering: Nuclear Engineering	Engineering: Mathematics & Information
Department of Socio-Environmental Energy Science	Social Science of Energy	Engineering for Social Systems	Prof. Keiichi ISHIHARA, Assoc. Prof. Hideyuki OKUMURA	○	○	○	◎	○	○		
		Energy Economics	Prof. Tetsuo TEZUKA, Assoc. Prof. Benjamin C. MCLELLAN, Assoc. Prof. Seiichi OGATA	○	○	○	○	○	○	○	○
		Energy Ecosystems	Assoc. Prof. Haruo KAWAMOTO, Assist. Prof. Eiji MINAMI, Specific Assist. Prof. H. F. Rabemanolontsoa	○			○		○		
	Socio-Environmental Energy Science	Energy and Information	Prof. Hiroshi SHIMODA, Assoc. Prof. Hirotake ISHII		○	◎				○	◎
		Energy and Environment	Prof. Susumu TOHNO, Assoc. Prof. Takayuki KAMEDA, Assist. Prof. Kouhei YAMAMOTO	◎	○	○	○	○	○	○	
	Societal Energy Science	Energy Policy *	Prof. Hironobu UNESAKI, Assist. Prof. Yoshiyuki TAKAHASHI		○	○		○		◎	○
		Societal Energy Education *	Prof. Katsuhiro KAMAE, Assoc. Prof. Hirotoshi UEBAYASHI	◎	○	○		○		○	○
		Energy and Communication ***	Prof. Jun YOSHIDA								
	International Energy problems		Visiting Prof. Makoto TAKAHASHI			○				○	◎
Department of Fundamental Energy Science	Energy Reactions	Energy Chemistry	Prof. Rika HAGIWARA, Assoc. Prof. Kazuhiko MATSUMOTO			○	○	○	○	○	
		Quantum Energy Processes	Prof. Takashi SAGAWA, Assoc. Prof. Kan HACHIYA			○	○	○	◎		
		Functional and Solid State Chemistry	Assoc. Prof. Shigeomi TAKAI, Assist. Prof. Takeshi YABUTSUKA			○	○	○	◎		
	Energy Physics	Plasma and Fusion Science	Prof. Yasuaki KISHIMOTO, Assist. Prof. Kenji IMADERA			◎	○			◎	○
		Electromagnetic Energy	Prof. Yuji NAKAMURA, Assoc. Prof. Akihiro ISHIZAWA			◎				◎	
		Plasma Physics	Prof. Hitoshi TANAKA, Assoc. Prof. Masaki UCHIDA			○				○	
	Plasma Science	Fusion Energy Control **	Prof. Tohru MIZUUCHI, Assoc. Prof. Takashi MINAMI, Assist. Prof. Shinji KOBAYASHI			◎			○	○	○
		High-Temperature Plasma Physics **	Assoc. Prof. Hiroyuki OKADA, Assoc. Prof. Shinichiro KADO, Assist. Prof. Satoshi YAMAMOTO			◎				○	○
	Energy Materials Science	Interfacial Energy Processes **	Prof. Toshiyuki NOHIRA, Assoc. Prof. Tsutomu KODAKI, Assist. Prof. Takayuki YAMAMOTO			○	○	○	◎	○	
		Energy Nano Technology **	Prof. Hiroshi SAKAGUCHI, Prof. Masahiro KINOSHITA, Assist. Prof. Takahiro KOJIMA, Assist. Prof. Takahiro NAKAE			○	◎	○	○		○
		Biofunctional Chemistry **	Prof. Takashi MORII, Assoc. Prof. Eiji NAKATA, Junior Assoc. Prof. Arivazhagan RAJENDRAN, Assist. Prof. Shun NAKANO				○		○		
		Bioenergy **	Prof. Masato KATAHIRA, Assoc. Prof. Takashi NAGATA, Assist. Prof. Tsukasa MASHIMA						○		
	Nuclear Energy	Fundamental Neutron Science *	Prof. Tsuyoshi MISAWA, Assoc. Prof. Cheol Ho PYEON, Assist. Prof. Yasunori KITAMURA		○	○		○		◎	○
		Energy Transport *	Prof. Yasushi SAITO, Assoc. Prof. Kei ITO, Assist. Prof. Xiuzhong SHEN, Assist. Prof. Daisuke ITO		◎	○			○	◎	○
	Advanced Energy Creation		Visiting Prof. Hirotaka IHARA								

*: Research Reactor Institute, **: Institute of Advanced Energy, ***: Graduate School of Human and Environmental Studies

Agri-culture				Natural Science					Social Sciences							
Wood Science & Technology	Forest Science & Resources	Applied Biology	Bio-Environmental Science	Physics	Chemistry	Biology	Mathematics	Mineralogy & Geology	Economics	Business Administration	Politics	Law	Pedagogy & Education	Sociology	Social Psychology	**Keywords**
				○	○	○	○	○	○	○	○	○	○	○		Social Technology, Non-Equilibrium Systems, Energy Efficiency, Environmental Materials, Resources and Recycling, Applied Thermodynamics, Environmental Education
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	Energy Systems Study, Energy-system Evaluation and Planning, Framework Design, Renewable Energy, Macroscopic Viewpoints, Sustainability, Energy-Minerals Nexus.
◎	◎	○	○		○	○			○							Ecosystem, Biomass Energy, Chemical Conversion, Eco-Materials, Functional Bio-Carbon
			○	○		○	○			○			○	○	○	Human Interface, Man-Machine System, Augmented Reality, Communication Design
			○	○	○				○							Atmospheric Environment, Aerosol, Environmental Imapct Assessment, Global Warming, Life Cycle Thinking, Input-Output Analysis
				○	○				○		○	○				Energy Policy, Nuclear Energy, Energy Security, Nuclear Science, Non-Proliferation
													○			Social Energy Education, Safety Culture, Strategy for Earthquake Disaster Prevention, Earthquake Engineering, Environmental Risk Assessment, Radionuclide Behaviors
											○			◎	○	Communication, Risk Society, Information Network, Public Sphere, Reflexive Modernization
							○								○	Cognitive Neuroscience, Cognitive Engineering, Human Factors, Brain Function Measurement
				○	◎											Molten Salt, Ionic Liquid, Electrochemistry, Rechargeable Battery, Fuel Cell, Functional Materials, Fluorine Chemistry
		○	○	○	◎	○										Organic Molecular Materials, Inorganic Semiconductors, Photochemistry, Solid State Physics, Photophysics, Solar Energy Utilization
		○	○	○	◎	○	○	○								Inorganic Materials Chemistry, Solid State Chemistry, Electrochemistry, Secondary Batteries, Fuel Cells, Biomaterials, Bioceramics
				◎			○									Nuclear Fusion and Plasma Theory, Turbulent Transport Physics, Space and Astrophysics Plasma, Laser-Matter Interaction
				◎												Plasma Electro-Magnetic Energy, Plasma Radiation, Plasma Diagnostics, Nonlinear Physics, Physics of Complicated System
				◎												Plasma Physics, Plasma Dynamics, Radio-Frequency Heating, Non-Neutral Plasma, Nonlinear Physics
				◎	○		○									Plasma Physics, Fusion Plasma Control, Plasma Transport Control, Plasma Energy Control, Fusion Reactor System
				○			○									Plasma Physics, Plasma Heating, Plasma Confinement, Complex Systems, Fusion Science
		○			◎	○										Electrochemistry, Molten Salt, Si Solar Cells, Secondary Batteries, Genetic Engineering, Bioenergy
		○	○	○	◎	○	○									Material Science, Physical Chemistry, Organic Synthesis, Computational Physics and Chemistry, Biochemical Engineering
		○	○		◎	○										Bioenergy, Synthetic Biology, Molecular Design of Functional Biomacromolecules, Artificial Photosynthesis
	○	○	○	○	○	○										Biomass, Bioenergy, Molecular Biology, Structural Biology, Biochemistry, Physical Chemistry
				○			○									Reactor Physics, Nuclear Characteristics, Criticality Safety, Nuclear Transmutation, Neutronics
				○			○									Thermo-Fluid Engineering, Fusion Engineering, Nuclear Engineering, Multiphase Flow Science, Particle Beam Radiography, Fluid Measurement
																Energy and Environment Problem, Sustainable Industrial Social Structure Formation, Industry-Government-University Cooperation

Specialization and Profiles Table

	Division	Group	Academic Staff	Engineering: Civil Engineering, Environment	Engineering: Mechanical Engineering	Engineering: Electrical & Electronics	Engineering: Material Science	Engineering: Earth Resources	Engineering: Chemical Engineering	Engineering: Nuclear Engineering	Engineering: Mathematics & Information
Department of Energy Conversion Science	Energy Conversion Systems	Thermal Energy Conversion	Prof. Takuji ISHIYAMA, Assoc. Prof. Hiroshi KAWANABE, Assist. Prof. Naoto HORIBE		◎			○	○		
		Conversion Systems	Assoc. Prof. Jun HAYASHI	○	◎				○		○
	Design for Energy Conversion Functions	Materials Design for Energy Systems	Prof. Toshihiko HOSHIDE	○	◎		○	○			
		Design for Functional Systems	Prof. Shoji IMATANI, Assoc. Prof. Katsuyuki KINOSHITA, Assist. Prof. Masataka ABE	○	◎	○	○				○
	Functional Energy Conversion	Advanced Energy Conversion **	Prof. Satoshi KONISHI, Assoc. Prof. Ryuta KASADA, Assist. Prof. Keisuke MUKAI	○	○	◎		○	○	◎	○
		Highly Qualified Energy Conversion **	Prof. Kazunobu NAGASAKI, Assoc. Prof. Kai MASUDA, Assist. Prof. Shinsuke OHSHIMA		○	◎				◎	○
		Functional Energy Conversion Materials**	Prof. Akihiko KIMURA, Assoc. Prof. Kazunori MORISHITA, Assist. Prof. Kiyohiro YABUUCHI		◎		◎		○	◎	
	Innovative Energy Conversion				○						
Department of Energy Science and Technology	Materials Science & Engineering for Energy Systems	Devices Physics	Prof. Toshiya DOI, Assoc. Prof. Shigeru HORII			◎	◎		○		
		Process and Energy	Prof. Yasuyuki SHIRAI, Assoc. Prof. Yoshiaki KASHIWAYA		◎	◎			○	○	
		Materials Process Science	Prof. Tetsuji HIRATO, Assoc. Prof. Masao MIYAKE, Assist Prof. Takumi IKENOUE			○	◎	○	○		
		Thermochemistry	Assoc. Prof. Masakatsu HASEGAWA				◎	○	○		
	Resources and Energy	Resources and Energy Systems	Prof. Mamoru MABUCHI, Assoc. Prof. Masataka HAKAMADA, Assist. Prof. Youqing CHEN	○	○		◎	◎			
		Advanced Processing of Resources and Energy	Prof. Hirohiko TAKUDA, Assoc. Prof. Takayuki HAMA		◎	○	○	○			○
		Mineral Processing	Assoc. Prof. Hiromu KUSUDA, Assoc. Prof. Hitoshi FUJIMOTO, Assist. Prof. Eishi KUSAKA	○			○	◎	◎		
	High Quality Energy	Quantum Radiation Energy Science **	Prof. Hideaki OHGAKI, Assoc. Prof. Toshiteru KII, Senior Lecturer Hooman FARZANEH, Assist. Prof. Heishun ZEN		○	○	○		○	◎	○
		The Physics of Energy Materials **	Prof. Kazunari MATSUDA, Assoc. Prof. Tatsuya HINOKI, Assoc. Prof. Yuhei MIYAUCHI, Assist. Prof. Kouichi JIMBO		○	◎	◎	○	○	○	
		Photon Energy Science **	Assoc. Prof. Takashi NAKAJIMA		◎	◎	◎	◎	◎	○	
	Innovative Energy Sciece and Technology				○	○	○	○	○		

*: Research Reactor Institute, **: Institute of Advanced Energy, ***: Graduate School of Human and Environmental Studies

Agri-culture				Natural Science					Social Sciences							
Wood Science & Technology	Forest Science & Resources	Applied Biology	Bio-Environmental Science	Physics	Chemistry	Biology	Mathematics	Mineralogy & Geology	Economics	Business Administration	Politics	Law	Pedagogy & Education	Sociology	Social Psychology	**Keywords**
○																Thermal Engineering, Power Engineering, Internal Combustion Engine, Air Pollutant Control
																Thermo-Fluid Dynamics, Combustion Science and Engineering, Laser Diagnostics and Image Analysis, Computational Fluid Dynamics
				○												Strength of Materials, Reliability & Integrity, Fracture Mechanics, Fatigue, Computer Simulations
																Functional and Intelligent Materials, Continuum Mechanics, Computational Mechanics, Electromagnetic Materials, Nondestructive Evaluation by Ultrasonics and Electromagnetic methods
○			○	◎	○		○									Plasma Physics, Fusion Technology, Energy Utilization, System Design, Environmental Impact, Economical Evaluation
				◎			○									Plasma Physics, Fusion Science, Microwave Technology, Accelerator Physics, High-Brightness Electron Beam Compact Fusion Neutron Source Application
				○												Materials Science, Advanced Nuclear Materials, Hydrogen Energy, Computer Simulation, Material Design
				○												Engine Combustion, Optical Diagnostics, Strength of Elements, Devices for Next-generation Automobiles
				○	○											Crystal Alignment Techniques, Energy Materials, Thin Film Growth, Magnetic Alignment, Superconductors
																Applied superconductivity energy apparatus, Advanced electric power system, Thermal hydraulics in liquid gases
				○	◎											Materials Processing, Aqueous/Electrochemical Processing, Electrochemistry, Thin Film Coatings
					○											Chemical Thermodynamics, Thermochemistry, Steelmaking, Chemical Sensors
				○				○								Eco-Materials, Upgrade Recycling, Materials Nanotechnology
				◎			○									Thermal Fluid Engineering, Working Processes, Advanced Processing of Energy, Computational Physics, Process Simulation
				○	◎	○		○								Resources Processing Physical Chemistry, Resource Geology, Earth System Chemistry, Materials Tailoring
				◎	○	○	○		○					○		New Quantum-Radiation Energy, Free-Electron Laser, Accelerator Science, Radiation Measurement
				◎												Nanotechnology/science, Composite functional Materials, Nanomaterials, Solid State Physics, Quantum Electronics, Environment-Resistant Materials
				◎	◎											Laser Science, Nanomaterials, Optoelectronics, Nonlinear optics
								○								State-of-Art in Energy Science and Technology

Academic Programs

＊Admissions Policy

Based on our philosophy at the Graduate School of Energy Science, we are looking for new students like those described below across all fields of study, students and working people, and living in Japan or abroad.

- People with a desire to solve energy and environmental problems
- People with great individuality and creativity who are not bound by the established principles
- People who actively challenge new fields of study and research

＊Graduate School of Energy Science: Curriculum development and implementation policy (Curriculum policy)

The Graduate School of Energy Science, a Kyoto University graduate school, aims to foster human resources with wide perspective and multifaceted knowledge, who are able to resolve energy and environmental issues.

To that end, in addition to acquiring fundamental academic abilities and specialized knowledge of energy science, the graduate school curriculum also requires that its students learn humanities and social science subjects, as well as how to utilize such knowledge comprehensively.

Specifically, the education will be conducted based on the following policy.

(Master's Program)

1. The curriculum is developed and implemented so that it will further develop the fundamental academic abilities and specialized knowledge acquired through undergraduate curriculum education, and allow interdisciplinary education of natural sciences and humanities/social sciences without being constrained by the major, so that students acquire a wide spectrum of specialized knowledge and broad scholarship relating to their research fields.
2. Through research guidance, seminars and practical education, students will become professional engineers and researchers that can actively discover as well as resolve issues by acquiring the ability to propel research and give logical accounts of research findings, as well as ethics in their academic studies.
3. The curriculum fosters the ability to accurately identify the position of their research in their respective fields of expertise, and to discuss their research findings and significance at an international level.

(Doctoral Program)

1. The curriculum is developed and implemented so that it further develops the sophisticated specialized knowledge and broad scholarship acquired through master's program education, and at the same time, without excessive specialization, enable students to have a broad perspective in positioning their various researches in the wider scheme of the field.
2. Through research guidance, seminars and practical education, students will become creative and energetic researchers who challenge unexplored fields by equipping themselves with a particularly outstanding ability to plan and propel research; the ability to make logical accounts of research findings; and ethics in academic studies.
3. The curriculum will foster researchers with wide perspective and deep expertise who can answer the needs of society and become global leaders in cutting-edge research that resolves energy and environmental problems.

＊**Graduate School of Energy Science: Diploma conferment policy (Diploma policy)**

Master's (Energy Science)

Requirements for conferment of a Master's Degree in Energy Science are that students must be enrolled for a set period, take subjects stipulated in the graduate school curriculum handbook, which have been determined based on the curriculum policy of the Graduate School of Energy Science, earn exactly or more than the standard number of credits (30 credits) and, after receiving necessary research guidance, pass the master thesis screening and examinations.

Master thesis screening and examinations will focus on whether the thesis demonstrates research findings that are academically or practically beneficial to energy science, whether the applicant for master's degree possesses the ability to propel research, the ability to give logical accounts of research findings, a wide spectrum of specialized knowledge relating to his/her research field, ethics in academic studies etc.

Those that have made extraordinary progress in academic/research may shorten their enrollment period and complete their master's program early.

Doctoral (Energy Science)

Requirements for conferment of a Doctoral Degree in Energy Science are that students must be enrolled for a set period, take subjects stipulated in the graduate school curriculum handbook, which have been determined based on the curriculum policy of the Graduate School of Energy Science, earn exactly or more than the standard number of credits (4 credits) and, after receiving necessary research guidance, pass the doctoral thesis screening as well as the examinations.

Doctoral thesis screening and examinations will be based on whether the thesis demonstrates research findings that are significantly beneficial, academically or practically, to energy science, whether the doctoral degree applicant possesses the ability to plan and propel research and to give logical accounts of research findings, possesses a wide spectrum of sophisticated specialized knowledge relating to his/her research field, high ethics in academic studies etc.

Those that have made extraordinary academic/research progress may shorten their enrollment period and complete their doctoral program early.

＊Requirements for the Master'sProgram

A Master's degree candidate is required to take at least 30 credits from the following listed subjects, to submit a master thesis guided by his/her supervisor(s), and to pass thesis examinations. No credit is offered for a thesis.

Group A Subjects : Required subjects for the home department and a thesis.
Group B Subjects : Elective subjects offered by the home department.
Group C Subjects : Elective subjects offered by the three departments other than the home department.
Group D Subjects : Elective subjects offered by other graduate schools.

List of credit requirements and amounts:

Department	A	B[1]	B[2]	C	D
Department of Socio-Environmental Energy Science	8	≧ 14* **	≧ 8*		
	A	B		C	D
Department of Fundamental Energy Science	≧ 12*	≧ 10, ≦ 18*		≦ 10*	≦ 8*
Department of Energy Conversion Science	≧ 6	≧ 10, ≦ 22*		≧ 2, ≦ 10*	≦ 6*
Department of Energy Science and Technology	≧ 6	≧ 10		≦ 8*	≦ 6*

* Credits taken over these maximums will not be counted for the required 30 credits.
** Mandatory 4 credits from Required Subjects and minimum 10 credits from Elective Required Subjects

＊Requirements for the Doctoral Program

A Doctoral Degree candidate is required to take at least 4 credits from the subjects offered by the Graduate School, to submit a doctoral thesis guided by his/her supervisor(s), and to pass thesis examinations.

Number of Overseas Students

	Academic Year																	
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Master's Program	7	7	5	5	4	1	2	4	5 (2)	7 (2)	11 (2)	13 (4)	14 (2)	14 (1)	19 (5)	18 (3)	20 (2)	26 (5)
Doctoral Program	12 (3)	11 (4)	11 (4)	16 (11)	21 (18)	29 (25)	30 (25)	26 (24)	37 (30)	38 (30)	42 (33)	46 (31)	47 (28)	49 (27)	41 (24)	31 (17)	28 (16)	35 (15)
Others	4 (1)	2 (1)	0	0	1	1	1	5 (2)	6 (1)	6 (1)	2 (1)	3	3 (1)	3	4 (1)	2	6 (2)	6 (2)
Total	23 (4)	20 (5)	16 (4)	21 (11)	26 (18)	31 (25)	33 (25)	35 (26)	48 (33)	51 (33)	55 (36)	62 (35)	64 (31)	66 (28)	64 (30)	51 (20)	54 (20)	67 (22)

(As of may 1st of each year)

( ) : Students who were supported by the government.

I. The Number of Students to be admitted in Academic Year 2018

Department	Master's Program	Doctoral Program
Department of Socio-Environmental Energy Science	29	12
Department of Fundamental Energy Science	42	12
Department of Energy Conversion Science	25	4
Department of Energy Science and Technology	34	7
Total	130	35

Overseas students may elect to apply under a category set aside specifically for international students.

II. Qualifications for Applications

* Master's Program

Applicants for the master's program must satisfy one of the following requirements.

1. Graduation from a university in accordance with Article 83 of the School Education Law (Law No.26, 1947).
2. Receipt of a Bachelor's degree in accordance with Article 104 Paragraph 4 of the School Education Law (Law No.26,1947).
3. Completion of 16 years of school education abroad.
4. Completion of 16 years of school education of a foreign country through correspondence courses offered by a foreign school while staying in Japan.
5. Completion of a university's program of a foreign school in Japan designated by the Minister of Education, Culture, Sports, Science and Technology. This solely applies to those completing 16 years of school education of said foreign country.
6. Receipt of a degree equivalent to a bachelor's degree by completing a curriculum with a term of residence of at least three years (including completion of such a curriculum by studying relevant subjects in Japan via a correspondence course provided by a school in a foreign country and completion of a curriculum at an educational facility that has been accredited as having an approved curriculum under the educational system of said country and is designated as such in the preceding paragraph) at a university or other school in a country other than Japan (only those universities or schools for which the overall conditions of education and research activities have been assessed by a party authorized by the government of said country or an organization concerned, or those corresponding to such entities as designated by the Minister of Education, Culture, Sports, Science and Technology)
7. Completion of a professional program at a vocational school accredited by the Minister of Education, Culture, Sports, Science and Technology after the date validated by the Minister.
8. Designation by the Minister of Education, Culture, Sports, Science and Technology (Notification No.5 of the Ministry of Education, 1953).
9. Recognition by the Graduate School as having completed prescribed credit hours with excellent results during 3 years in a university in Japan or recognition by the Minister of Education, Culture, Sports, Science and Technology as having an equivalent academic level in accordance with Article 102 Paragraph 2 of the School Education Law.
10. Recognition by the Graduate School through individual entrance qualification screening as having academic standards equivalent to those of university graduates and be at least 22 years old.

* Doctoral Program

Applicants for the doctoral program must satisfy one of the following requirements.

1. Possession of a Master's Degree, Professional Master's Degree or Juris Doctor Degree.
2. Completion of a program abroad equivalent to the Master's Program or the professional degree program of Kyoto University Graduate School.
3. Completion of the a program equivalent to a Master's Program or professional degree program of Kyoto University Graduate School by completing a correspondence course conducted by a graduate school of a university abroad while residing in Japan.
4. Completion of a foreign graduate school program (only if the program is equivalent to a Master's Program or professional degree program of Kyoto University Graduate School) in Japan at an educational facility that has been accredited as having an approved program under the educational system of said country and is so designated by the Minister of Education, Culture, Sports, Science and Technology.
5. Completion of a curriculum at the United Nations University (under the provisions of Paragraph 2 of Article 1 of the Act on Special Measures Incidental to Enforcement of the Agreement between the United Nations and Japan regarding the Headquarters of the United Nations University, Act No. 72 of 1976), and receipt

of a degree equivalent to a Master's Degree.

6. Applicants who have passed a Qualifying Examination or equivalent assessment at an institution in another country,and are recognized by Kyoto University as having academic ability on a par with or higher than that of a person with a master's degree.
7. Designation by the Minister of Education, Culture, Science, Sports, and Technology.
8. Recognition by the Graduate School of Energy Science of Kyoto University as having a scholastic ability on a par with or higher than that of a person eligible under Paragraph 1 as a result of an individual screening of qualifications, where the applicant is aged 24 or over.

III. Entrance Examination Dates (Academic Year 2018)

＊Exam. for Master's Program is scheduled in August.

The Department of Fundamental Energy Science schedule an additional 2nd time entrance exam. in September. Also as for international applicants, there is a special selection in February.
The above is the information in 2017. Please confirm the guidelines for applicants in 2018 for details.

＊Exam. for Doctoral Program is scheduled in August 2017 and February 2018.

The number of doctoral course students to be admitted listed above are for the academic year starting in April 2018. A small number of students (including overseas students) is admitted to enter the doctoral course from October 2017 through examinations held on the same day.

In addition to the entrance examination dates listed above, a small number of students (including overseas students) may be admitted through examinations held in February. This is not the exact guide for the entrance examination. For details, please contact the admissions office of the Graduate School of Energy Science (see IV).

IV. For further information, contact

The admissions office
The Graduate School of Energy Science.
Kyoto University
Yoshida Honmachi, Sakyo-ku,
Kyoto 606-8501 JAPAN
TEL: (+81) 75-753-9212
FAX: (+81) 75-753-4745

INTERNATIONAL EXCHANGE AFFAIRS

1. International Collaborations

The Graduate School of Energy Science (GSES) has established international exchange agreements with top level universities and institutes to promote mutual cooperation on education and scientific research. Under the agreements, the following general forms of cooperation will be pursued:

(1) Joint research activities

(2) Invitations to academics and researchers for lectures and seminars, and participation in conferences, colloquia and symposia

(3) Exchange of scientific material and information

(4) Exchange of faculty members and students for study and research

Currently, agreements with over 25 counterparts have been concluded, in cooperation with other schools and institutes of Kyoto University.

2. Promoting Student Mobility

Since its establishment, the GSES has received students from outside of Japan, and has also promoted short-term study abroad for our own students. The GSES has started a student mobility program with ASEAN University Network (AUN) member universities in cooperation with other graduate schools of Kyoto University. The summer/winter school programs have been held in Kyoto to create opportunities for the undergraduate students from AUN member universities and Kyoto to study about energy in both home and host universities. Furthermore, a double master's degree program with some AUN universities and a double doctor's degree program with University of Bordeaux have been initiated.


AUN-KU Winter School : (left) debating, (right) field trip to a mega solar power plant.

3. Exchange of Researchers

GSES has invited visiting professors from abroad as teaching staff. They are selected from highly active researchers in various academic fields, who may collaborate with our faculty and give students an opportunity to learn specialized subjects in English.

Individual departments and chairs have received researchers from various countries such as France, Sweden, Singapore, Canada, China, Egypt, Malaysia, Australia, Thailand, and others. Annually, around 70 researchers are dispatched to universities and research institutions abroad, contributing greatly to development of the international academic network on energy science. In addition, members of the GSES have organized numerous international conferences. In the academic year 2016, the school organized or co-organized five international conferences in Japan (2), China (1) and Thailand (2).

International Energy Science Course

Energy is the challenge of our age, fundamentally involved in critical human survival issues of local and global concern such as climate change, economic growth, national and regional security. Individuals who have acquired systematic scientific knowledge in the relevant fields and broad and deep insight into underlying component technologies are therefore sought after across the world. To respond to this need, all the four departments of Kyoto University's Graduate School of Energy Science run postgraduate degree programs on energy in English-the "International Energy Science Course" (IESC). For the IESC, good command of academic English for course work and research is essential, while Japanese proficiency is not.

The two-year Master's program is a combination of coursework and research. Students are taught a wide spectrum of subjects - from the basics to cutting-edge research on production, storage, transportation and consumption of energy. At the same time, students conduct research on their own topic, chosen from a wide range of research areas offered by the school. The program aims to teach students methods for research and development of energy technology in support of a sustainable society.

Students are admitted based on application documents and an interview with staff of the Graduate School of Energy Science. The IESC Master's course commences in October each year. (Enrolment timing and conditions are subject to change. Please download the latest application guide from our website.) The research group or laboratory to which students will be assigned for their research is determined with consideration to their preferences and notified at the announcement of admissions results.

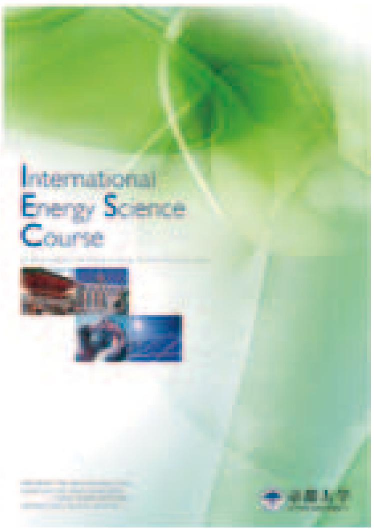
The IESC doctoral program provides Master's graduates with the opportunity to further their study toward a doctoral degree by conducting research of the highest standards. The medium of instruction is English and the standard course duration is three years full time. Prior contact to a prospective supervisor to discuss a research plan is essential.

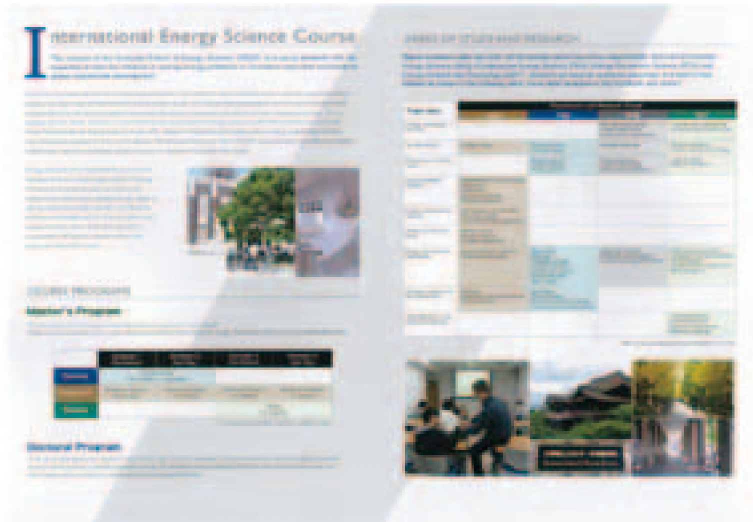
The IESC Master's program is offered by the departments of Socio-Environmental Energy Science, Fundamental Energy Science and Energy Conversion Science, while IESC Doctoral program is offered by all the four departments of Graduate School of Energy Science, including the department of Energy Science and Technology. For details of the research fields of these departments, please see pages 6-25 and the table on pages 32-35. For further information on the course, please see the website.

http://www.energy.kyoto-u.ac.jp/IESC/

A typical IESC class

	MASTER'S	DOCTORAL
Departments	Socio-Environmental Energy Science/ Fundamental Energy Science/ Energy Conversion Science	Socio-Environmental Energy Science/ Fundamental Energy Science/ Energy Conversion Science/ Energy Science and Technology
Degree conferred	Master's (Master of Energy Science)	Doctoral (Doctor of Energy Science)
Course duration	Two years, full-time	Three years, full-time
Required credits	Minimum of 45 credits	Minimum of 4 credits
Thesis & defence	Master's thesis, viva-voce	Doctoral thesis, viva-voce
Enrolment capacity	10 students per annum	10 students per annum
Enrolment	October	April and October
Application deadlines	January - February	June - July (April intake) January - February (October intake)





IESC brochure