National Institute of Advanced Industrial Science and Technology（AIST）
Department of Energy and Environment

Research Institute for Energy Conservation

AIST

Research Institute for Energy Conservation

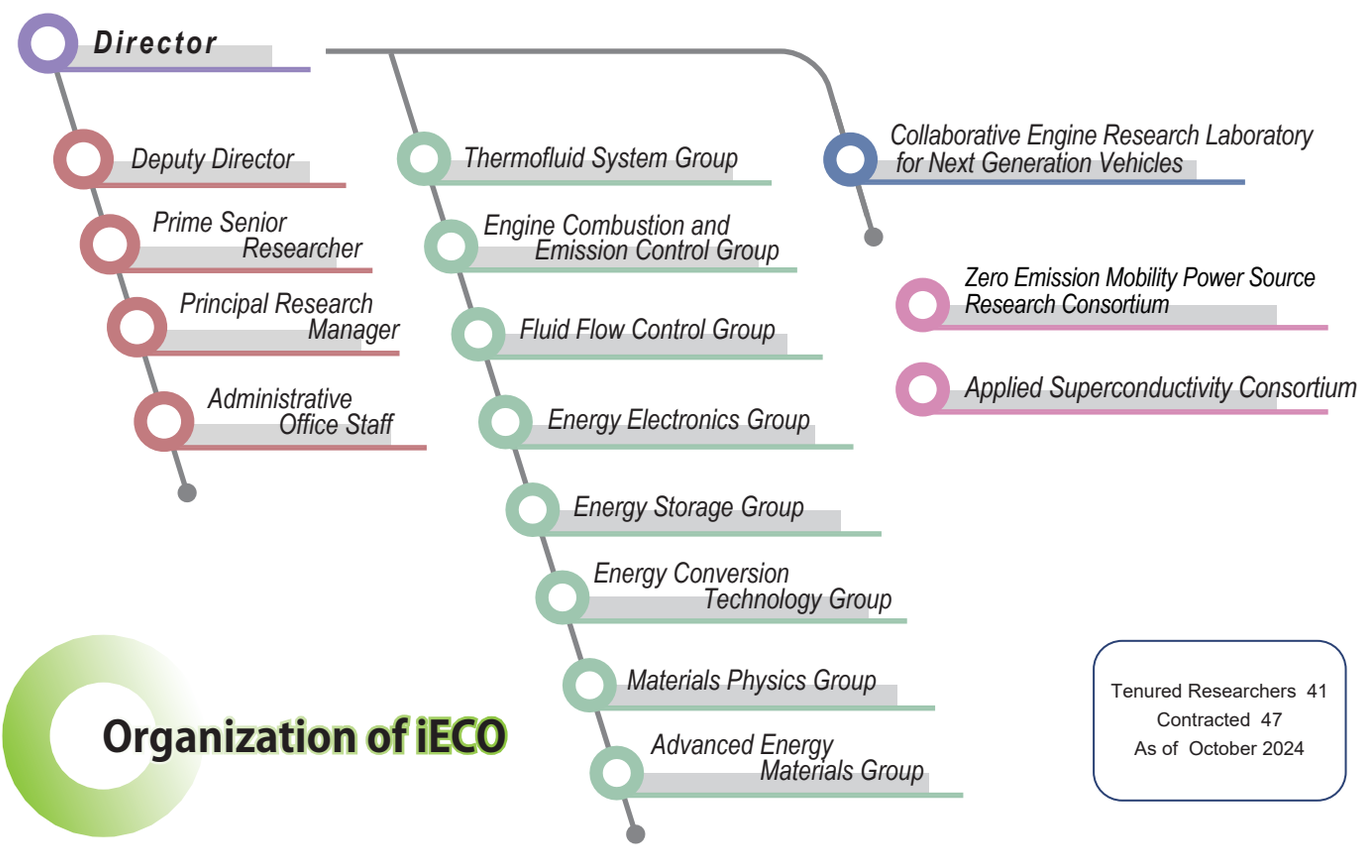
Outline of iECO

It is an urgent and global issue to utilize the limited energy resources and reduce the emission of greenhouse gases. The research institute for energy conservation (iECO) is promoting fundamental research for significant reduction of greenhouse gas and applied R&D on mobility energy for enhancement of industrial competitiveness.

In eight groups and two collaboration laboratories, we are conducting the following four main topics; (1) High conversion technology for hydrogen and ammonia gas turbine, fuel cells/electrolysis, and thermoelectric, (2) High efficient transport, storage and utilizing technologies for heat/electricity/light, (3) R&D on optimization of mobility energy and highly efficient propulsion system applied to automobiles and aircraft, and (4) Fundamental studies on thermos-fluid measurement technology and numerical simulation technology that support the above R&D.
We widely collaborate with other organizations, universities, and private companies by utilizing the above activities.

HORITA Teruhisa
Director

Organization of iECO



Tenured Researchers 41
Contracted 47
As of October 2024

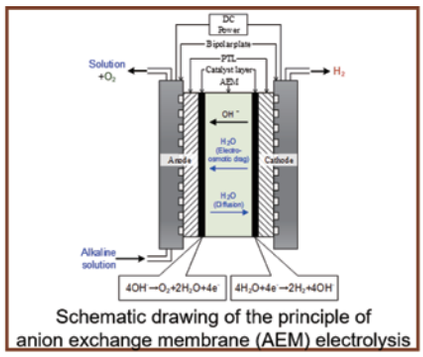
Thermofluid System Group

https://unit.aist.go.jp/ieco/tfs/

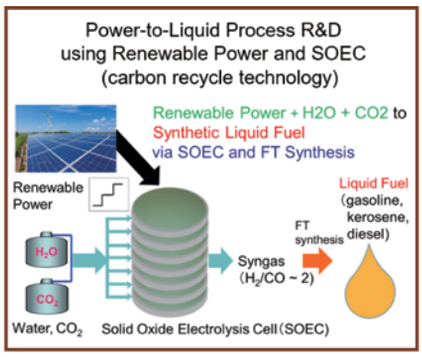
Our main mission is to construct a technical foundation for the approaching of the “sustainable society” . Our research topics include microfabrication, numerical simulation, and visualization technologies related to electronic device cooling, heat-pumps, and power generation cycles. In addition, our research covers the electrochemical energy conversion devices such as fuel cells, water electrolyzers, and co-electrolyzers.

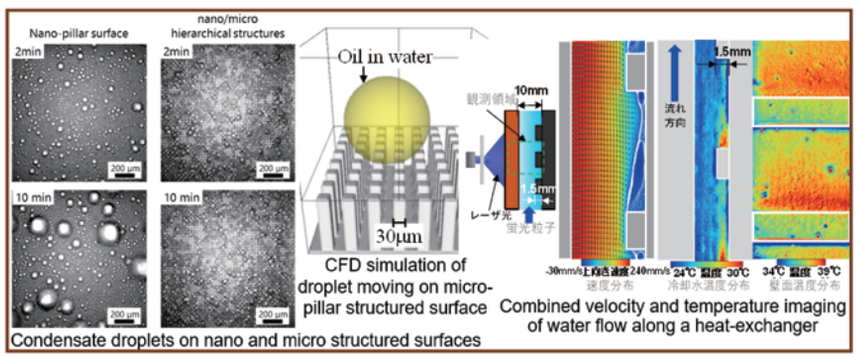
Keywords :

Water electrolysis
Solid oxide cell
Boiling cooling
Heat exchangers
Heat pipe (Vapor chamber)
Heat and flow visualization
CFD (Computational fluid dynamics)



Schematic drawing of the principle of anion exchange membrane (AEM) electrolysis





Condensate droplets on nano and micro structured surfaces

CFD simulation of droplet moving on micro-pillar structured surface

Combined velocity and temperature imaging of water flow along a heat-exchanger

Engine Combustion and Emission Control Group

https://unit.aist.go.jp/ieco/ec2/en/index.html

We are conducting research that contributes to the development of zero-emission mobility technologies for vehicles in order to achieve carbon neutrality by 2050. Specifically, we are engaged in basic and pioneering research on fuel, spray, combustion, and emission purification technologies for the development of highly efficient engine systems, as well as the development of vehicle simulation models and energy management research includes power source electrification.

Keywords :

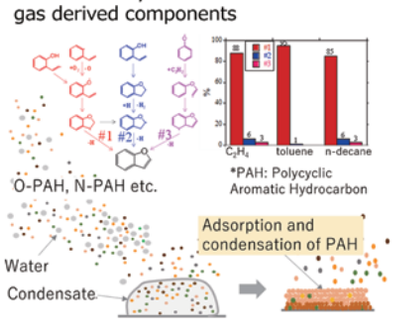
Internal combustion engine
e-fuel
Spray
Combustion
Catalyst
Vehicle simulation model
Energy management

● Research on next-generation engines using e-fuel

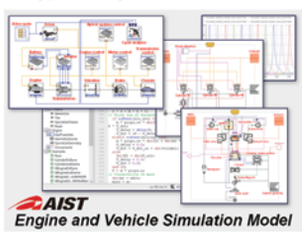

Ignition and combustion characteristics evaluation equipment


Single-cylinder engine

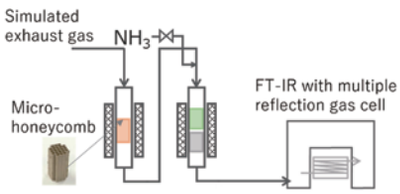
● Elucidation of deposit generation mechanism by combustion and exhaust gas derived components



● Vehicle simulation model development and energy management



● Development of evaluation methods for automotive catalysts



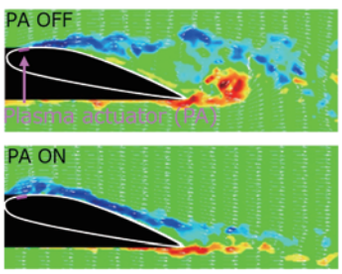
Fluid Flow Control Group

https://unit.aist.go.jp/ieco/ffc/

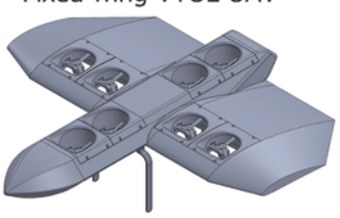
In order to improve the aerodynamic characteristics and efficiency of fluid machinery, it is necessary to develop advanced flow control devices such as sensors/actuators and to build control systems integrated them. This research group is engaged in the following research topics with the aim of realizing green innovation with the Sustainable Development Goals (SDGs) and strengthening industrial competitiveness.

1. Improvement of vehicle aerodynamic characteristics and fuel efficiency by using flow control devices
2. R&D of novel aircraft and flight control technology to improve flight performance and flight efficiency
3. Improvement of aerodynamic performance by secondary flow control of compressor and turbine rotors in turbomachinery

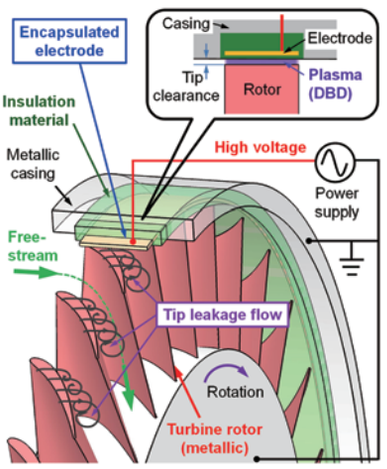
- Feedback control of flow separation on airfoil by PA



- Fixed wing VTOL UAV



- Active flow control for tip leakage vortex reduction of a turbine rotor by ring-type PA



Keywords :

Automotive aerodynamics, Drone, Gas turbine, Active flow control, Plasma actuator (PA), Plasma simulation, Sparse sensing, Flight control

Energy Electronics Group

https://unit.aist.go.jp/ieco/eeg/

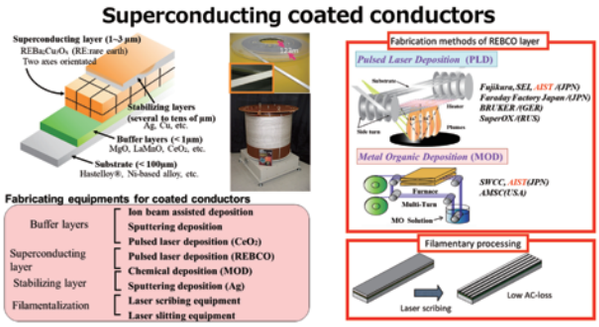
For effective utilization of energy resources and efficient use of energy, we are engaged in the research and development of following subjects.

1. R&D of basic technologies related to superconducting coated conductors for the promotion of electrification of mobility such as aircraft and automobiles
2. R&D of new materials and evaluation of new structures of chalcogenide and oxide semiconductor for solar cell applications and opto-electronic applications

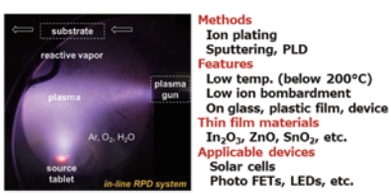
Keywords :

superconductivity
wire
aircraft electrification
solar cells
chalcogenides
transparent conductive oxide
photoelectron spectroscopy

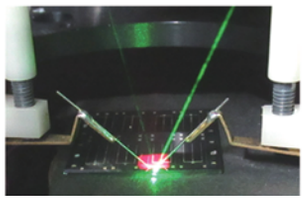
Superconducting coated conductors



High-mobility broadband TCOs Optoelectronic Devices



Fabrication and evaluation of low cost and earth abundant CZTS solar cell

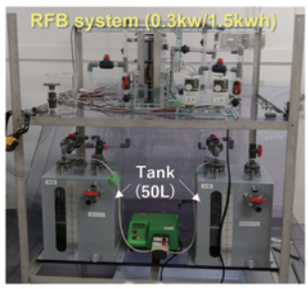


Energy Storage Group

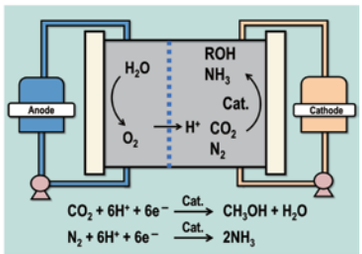
https://unit.aist.go.jp/ieco/est-2021/

Our group aims to develop highly efficient energy storage technologies that contribute to the reduction of greenhouse gases and the effective use of energy resources. Specifically, we are engaged in research on various elemental technologies (material and cell development, evaluation of stability and performance, and development of reaction system) that make up energy storage systems, including in addition of redox flow batteries (RFBs), lithium ion batteries (LiBs), and all-solid-state batteries, the development of new storage technologies using hydrogen and CO_2 or N_2 based on chemical/electrochemical reactions.

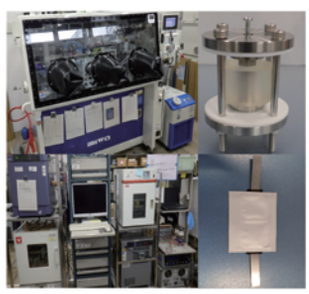
Keywords :
Redox Flow Batteries
Lithium-ion Batteries
All-Solid-State Batteries
CO_2 electroreduction
NH_3 electrosynthesis



Development of novel high-performance RFBs



CO_2 electroreduction
NH_3 electrosynthesis


Fabrication and evaluation of all-solid-state batteries


Stability evaluation for LiBs

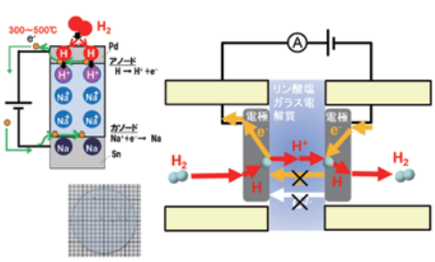
Energy Conversion Technology Group

https://unit.aist.go.jp/ieco/ect/

Research and development of highly efficient energy conversion technology is indispensable in meeting the increasing demands for electrification of energy. Our group is focusing on research and development of energy conversion devices operated at high temperatures – solid oxide fuel cells (SOFC) for converting with high efficiencies diverse types of fuels such as fossil and biomass fuels into electric power, and solid oxide electrolysis cells (SOEC) for converting surplus power from renewable energies into highly efficient and high-value added fuels. In particular, we play an important role as a public research institute in the ongoing efforts for the enhancement of SOFC durability/reliability through collaboration with companies and universities. As a future endeavor, even more highly efficient energy conversion devices based on solid state ionics phenomena are envisaged by carrying out comprehensive research and development including the development of evaluation technology, and thus further contribute to the realization of a low carbon society.

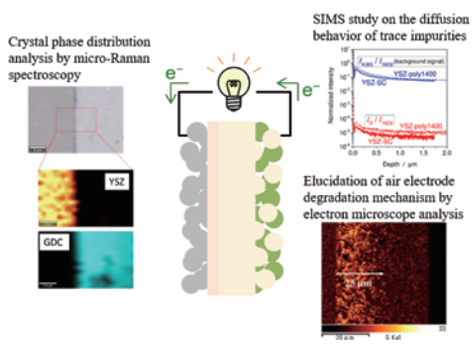
Keywords : Energy Conversion Devices, Solid Oxide Fuel Cell (SOFC), Solid Oxide Electrolytic Cell (SOEC), Solid State Ionics

Development of next-generation fuel cells



Proton Conducting Phosphate Glass Electrolyte

Solid Oxide Cell (SOC) Analysis



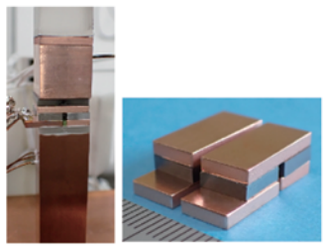
Materials Physics Group

https://unit.aist.go.jp/ieco/ieco-mp/

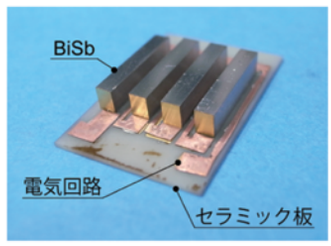
As a sustainable low-carbon society, it is strongly desired to develop technologies for efficient use of energy and for reducing carbon dioxide emissions. In order to respond the need of society, Materials Physics Group investigates physicochemical phenomena of thermoelectric materials, developing new materials, and development and evaluation of thermoelectric modules. Furthermore, our group develops the post lithium-ion batteries with high capacity and power, which is considered a promising next-generation storage system.

Keywords :

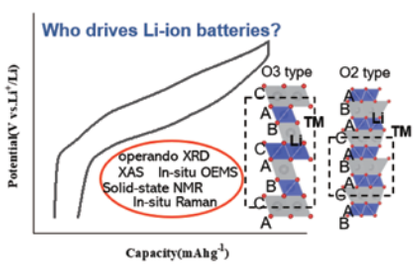
Thermoelectric materials
Thermoelectric power generation
Thermoelectric modules
Perovskite solar cells
Electrode materials
Lithium-S battery
Lithium-ion battery



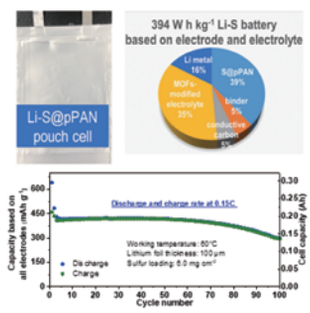
Development and evaluation of thermoelectric modules



Nernst effect modules



Toward high energy density Lithium ion batteries through developing of materials



Development of high-performance lithium-S batteries

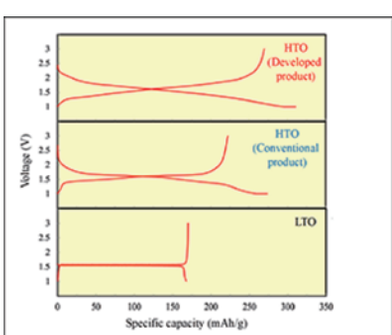
Advanced Energy Materials Group

https://unit.aist.go.jp/ieco/en/groups/index.html#ademat

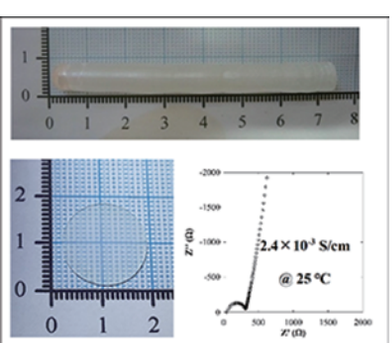
Lithium secondary battery is expected as devices for future low carbon society by widely use and development for large power supplies of automobiles, stationary, IoT etc. Therefore, it is important to be safety, long life, higher capacity, and low cost.
In our group, advanced oxide based materials, such as new electrode materials and solid electrolyte materials, have been developed for next generation liquid type lithium secondary battery and all solid lithium secondary battery. In addition, advanced material design has been promoted by development of new synthesis processes, and application of techniques such as crystal structure analysis and physical properties evaluation.

Keywords :

Inorganic material synthesis, Single crystal growth, Crystal structure analysis, Lithium secondary battery, All-solid lithium secondary battery



AIST original material, $H_2Ti_{12}O_{25}$(HTO). Highest capacity in titanium oxide negative electrode materials.

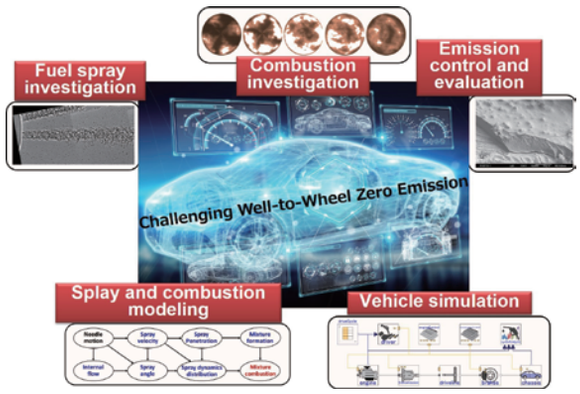


World's first large single crystal of solid electrolyte (LLZ) and the single crystal separator developed by AIST original technique.
Highest lithium ion conductivity in the oxide based materials at room temperature.

Collaborative Engine Research Laboratory for Next Generation Vehicles

https://unit.aist.go.jp/ieco/en/groups/index.html#cerlab

Electrifying cars, including hybrid cars, is essential for a sustainable mobility society. On the other hand, the combination of power trains is wide-ranging, the development process has become extremely complicated, and development in the automobile industry is shifting to Model-based development (MBD). In this lab, an MBD platform for evaluation as an automobile system is building with open source software, then, linked the results of various phenomena elucidation research and device development research undertaken by AIST. to. We are taking on the challenge of R&D on the ultimate (dream) automobile "zero-emission vehicle" with the comprehensive strength of AIST.



Model-based research image for zero-emission vehicles

Keywords :

Internal combustion engine, Electrification, Automotive fuel, Fuel spray, Engine combustion, Emission catalyst, Standardization, Vehicle simulation model, Well to Wheel, Zero emission

Zero Emission Mobility Power Source Research Consortium

https://zemconso.jp/articles

●Objectives and Purpose of Establishment

Aiming to realize zero-emission mobility through research into power sources, mainly engine systems, ZEM consortium promotes industry-academia collaboration while mutual improvement together through the discussion between academic members and corporate members, mainly The Research association of Automotive Internal Combustion Engines (AICE), on an equal footing.

Keywords :

Mobility, zero emissions, engine (internal combustion engine), power source, fuel, spray, combustion, catalyst, industry-academia collaboration, human resource development

Applied Superconductivity Consortium

https://unit.aist.go.jp/ieco/AISupercoN/

Superconductivity is a physical property exhibited by certain materials, where their electrical resistance becomes zero at cryogenic temperatures. This cutting-edge energy-conservation technology is expected to offer effective solutions to a wide range of global challenges.

To accelerate the widespread adoption of superconductivity-based innovations in society, it is essential to promote open innovation involving a broad collaboration between industries, universities, and public research institutions across the entire spectrum — materials,

cooling technologies and applied system development. Additionally, nurturing the next generation of talent is crucial. The 'Applied Superconductivity Consortium (AISupercoN)' aims to facilitate information sharing and dialogue among its members, providing opportunities for open innovation. Additionally, it focuses on accelerating the development of next-generation industrial talent.

Keywords :

High Temperature Superconductivity, Superconducting Wire and Bulk, High Field Magnet, Fusion/Accelerator, NMR/MRI, Superconducting Power Apparatus, SQUID, Quantum Computer, Cryogenics

National Institute of Advanced Industrial Science and Technology (AIST)
Department of Energy and Environment

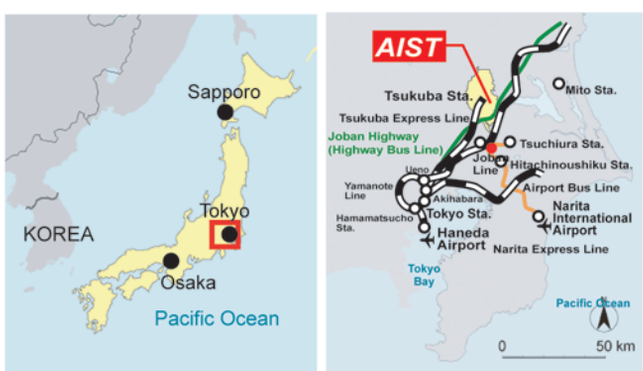
Research Institute for Energy Conservation

(Director's Office)

AIST Tsukuba East, 1-2-1 Namiki, Tsukuba, Ibaraki 305-8564, Japan
(Phone) +81-29-861-7239
ieco-info-ml@aist.go.jp
https://unit.aist.go.jp/ieco/en/

AIST Tsukuba Central2, 1-1-1Umezono, Tsukuba, Ibaraki 305-8568, Japan
(Phone) +81-29-861-5280

AIST Tsukuba Central5, 1-1-1 Higashi, Tsukuba, Ibaraki 305-8565, Japan
(Phone) +81-29-861-4542



2024.10