FREA

FUKUSHIMA RENEWABLE ENERGY INSTITUTE, AIST

Towards a Leading Research Center for Renewable Energy

The Fukushima Renewable Energy Institute, AIST (FREA) was established in April 2014 as the newest research base of the National Institute of Advanced Industrial Science and Technology (AIST) in line with the government's "Basic Guidelines for Reconstruction in response to the Great East Japan Earthquake" (July 2011).
FREA has two important missions: 1. To promote cutting-edge renewable energy research in collaboration with worldwide institutions , and 2. To contribute to the economic restoration in disaster areas through the clustering of new industries related to renewable energy.
FREA conducts research and development of a wide range of technologies required for the large-scale deployment of renewable energy in collaboration with industries and universities, and also provides training for young scientists as human resources for next generation.
We will continue to work in collaboration with our partners and do our best towards the restoration of disaster areas and the transfer of new technologies to the world.

Future technologies from Fukushima to the world.

Director-General, Yoshiro Owadano

FREA's Research Subjects

Renewable energy is valuable domestic energy resource for Japan and essential for the prevention of global warming as well as for sustainable development. There are high expectations for mass deployment of renewable energy, but its wide use raises various issues that must be solved, including output fluctuation, high cost and regional variation.
FREA focuses on six research subjects under three themes in order to solve these issues and accelerate the large-scale deployment of renewable energy.

Theme 1 System Integration to Facilitate a High Penetration of Renewable Energy

1. Research and Verification of Advanced Integration Technologies for Renewable Energy
2. Production and Utilization Technology for Hydrogen Energy Carrier

Theme 2 Further Cost Reduction and Efficiency Improvement of Renewable Energy

3. Advanced Technology for Wind Power Generation
4. High-Performance PV Modules Based on Thin Crystalline Silicon Solar Cells

Theme 3 Database Development for Proper Deployment of Renewable Energy

5. Technologies for Effective and Sustainable Use of Geothermal Resources
6. Suitability Assessment of Ground-Source Heat Pump System and its System Optimization Technology

Towards Restoration and Development of Disaster Areas

Industrial Human Resource Development Project

FREA has been providing opportunities for human resource development since FY2014 in the field of renewable energy for local university students through collaborative research and development activities.

Human resource development achievement (total number of trainees for FY2014–FY2015)

Postdoctoral researcher--	12
Technical staff----------	51
Research assistant*-----	27
Technical trainee---------	21

*The research assistant system is for employing talented graduate students on contract basis.


On-the-job training (OJT)


OJT completion ceremony

Program for Promotion of Technologies Developed by Industries in Tohoku Disaster Areas

FREA provides technical support for the industrialization of renewable-energy-related technologies owned by companies in disaster areas (Fukushima, Miyagi and Iwate Prefectures) that suffered tremendous damage in the Great East Japan Earthquake.
This program has resulted in successful technology development and industrialization that could lead to the creation of new industries in the areas.

AIST provided support for a total of 82 projects (38 companies). (FY2013–FY2015)
Three of the technologies have been commercialized so far.
(as of January 2016)


PV array string monitoring and diagnosis system


PV module bypass diode checker


High-performance crosslinking coagent for EVA encapsulants in PV modules

Theme 1 System Integration to Facilitate a High Penetration of Renewable Energy

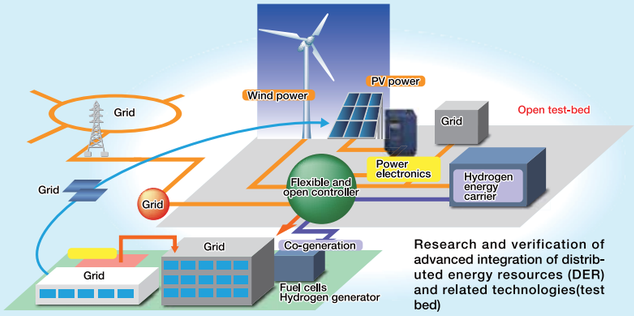
Research Subjects

Smarter "Production, Storage and Utilization" of Renewable Energy through Integration

Energy Network Team

- Smart system technologies for maximum introduction of renewable energy
- Establishment of platform for developing smarter DER system (distributed energy resources)
- Comprehensive evaluation technology for solar photovoltaic power systems
- System for producing, storing, and utilizing hydrogen with renewable energy
- Development of utility-friendly DER and its advanced control technologies

Laboratory for performance evaluation of PV modules



FREA' s concept of renewable energy network

This team will develop renewable energy network technologies to healthy and robustly introduce renewable energies that improve the energy self-sufficiency ratio and pose a low environmental burden.

To introduce electric power sources that naturally fluctuate with the weather conditions (e.g., solar and wind power generation) into the existing energy network, this team is conducting studies on the smart control of power conditioners (smart inverters) for stable electricity supply, the utilization of hydrogen energy storage systems and batteries for smoothing fluctuations, and system integration technologies for interoperability of multiple distributed energy resources (DER).

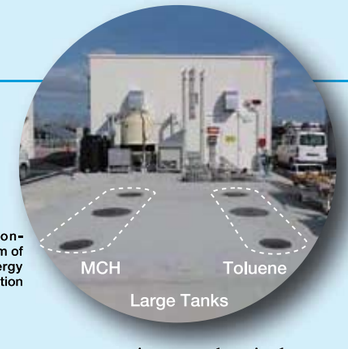
The team is developing technologies to make DER smarter and stabler. It also proposes a new energy supply model that considers electricity users' convenience by optimizing energy storage systems using batteries and hydrogen as well as smart demand response system through the integration of information and communication technologies (ICTs) and meteorological monitoring technologies.

Research Subjects

"Storing and Carrying" Renewable Energy as Hydrogen Energy Carrier

Hydrogen Energy Carrier Team

- Highly efficient hydrogen energy carrier production technology
- Highly efficient hydrogen energy carrier utilization technology
- Proposal of a unified system of hydrogen energy carrier production and utilization



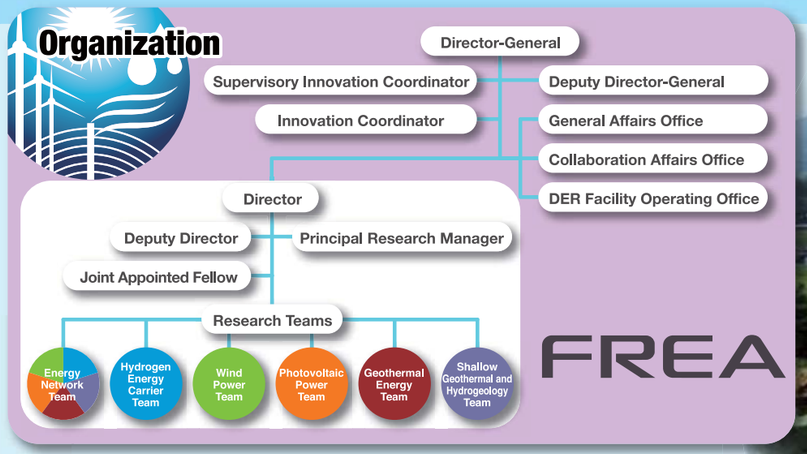
Unified demonstration system of hydrogen energy carrier production / utilization

Image of a community that uses renewable energy and hydrogen

Renewable electricity derived from PV power and wind power are clean and abundant, but is dependent on the weather and seasons, resulting in an imbalance between supply and demand. To solve this problem, studies are being conducted on safely storing and utilizing energy on a large scale by converting renewable electricity into hydrogen energy carriers.

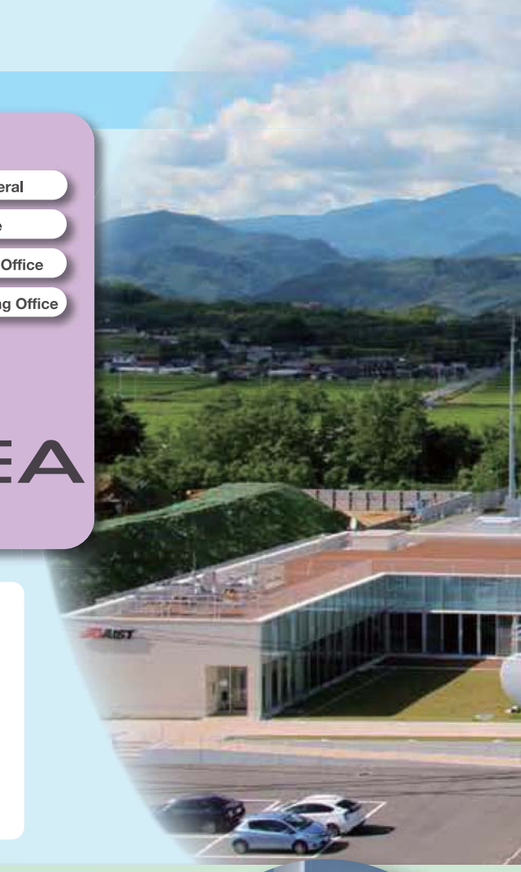
Hydrogen energy carriers are chemical compounds containing hydrogen (e.g., methylcyclohexane (MCH) and ammonia) and are suitable for long-term and stable storage and easy transportation because they are light and compact. This team has been developing highly efficient technologies for hydrogen energy carrier production using catalytic synthesis and hydrogen energy carrier utilization technologies including for use in co-generation engines and gas turbines as well as hydrogen power generation. In addition, the team is conducting large-scale demonstrations of a unified system for hydrogen production through water electrolysis, hydrogen energy carrier production through catalytic synthesis and the use of thermal engines.

Organization



Smart System Research Facility

The Smart System Research Facility was built to enhance the functions of the world's electric power systems in preparation for the age of renewable energy. The facility has the world's most advanced power supply equipment, anechoic chamber and environmental test laboratory for research, development and testing of inverters for PV power generation and power storage systems.



Theme 2 Further Cost Reduction and Efficiency Improvement of Renewable Energy

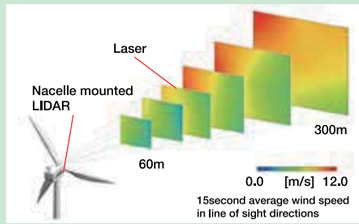
Research Subjects

High-Performance Wind Power Generation by "Foreseeing Wind Conditions"

Wind Power Team

- Establishment of measurement/evaluation technology using a nacelle-mounted LIDAR (laser anemometer)
- Improvement of wind turbine power output and reliability/lifetime through the development of feed-forward control
- Establishment of evaluation technology for more accurate prediction/forecasting of available resources, power generation, noise, etc.

Research wind turbine (Komaihaltec, Inc. KWT300)



Example of measured results using a nacelle-mounted LIDAR installed on the research wind turbine (distribution of wind speed in the line of sight)

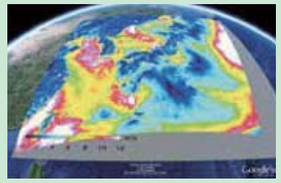


Image of offshore wind conditions database under development

It is essential to reduce power generation costs in order to accelerate the use of wind power generation. To achieve this, sophistication of software aspects including proper siting, evaluation of annual energy production, and forecasting of power generation during operation are required, in addition to improvement of wind turbine hardware.

To demonstrate the effectiveness of the elemental technologies for the next-generation wind turbines, the team launched real-time remote measurement/evaluation of wind data on the upwind side of a wind turbine by means of a nacelle-mounted LIDAR. The results are being used to establish control technologies for upgrading the wind turbine performance (higher availability and capacity factor, improved reliability and lifetime).

As a new alternative technology to high-cost in-situ wind measurements on the offshore, the team is developing a technology for evaluating offshore wind conditions using satellite remote sensing and numerical meteorological models to improve the accuracy and resolution of evaluated offshore wind conditions.

Thin crystalline silicon Bifacial solar cell, half the thickness of conventional cells (0.1 mm)

Research Subjects

Highly Efficient Solar Cells at Low Cost by "Capturing More Sunlight"

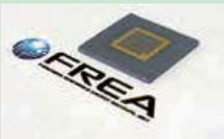
Photovoltaic Power Team

- Establishment of high-accuracy silicon ingot slicing technology
- Improvement of efficiency and cost reduction of crystalline silicon solar cells
- Fabrication techniques for next-generation highly efficient solar cells (smart stacking technology)
- Improvement of efficiency and reliability of crystalline silicon PV modules

Solar cell test production facility

To attain higher conversion efficiency of crystalline silicon solar cells (cells and modules) and lower production costs, research is in progress on new structures and fabrication processes for solar cells.

Higher efficiency and lower production costs of crystalline silicon solar cells are essential for the continuous deployment of photovoltaic power systems in the future. The PV power team is conducting advanced research and, in collaboration with industries, using a comprehensive facility equipped with test production lines from crystalline silicon ingot slicing to solar cell/module fabrication.



Smart stacked solar cell

The team is developing crystalline silicon based 'smart stacking' technology that laminates solar cells made of different materials to achieve next-generation solar cells with conversion efficiency higher than 30%.

Theme 3 Database Development for Proper Deployment of Renewable Energy

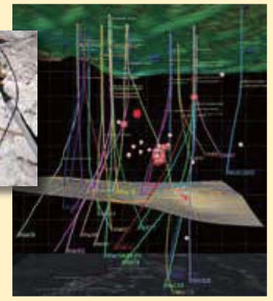
Research Subjects

Proper Use of "Gift from the Earth, Geothermal Energy"

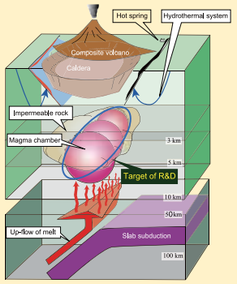
Geothermal Energy Team

- Understanding and visualization of phenomena in reservoirs
- Development of optimal creation and control technologies of reservoirs
- Development of sensing system for monitoring geothermal energy using microelectromechanical systems (MEMS), optical fibers, etc.
- Development of advanced database of geothermal resources
- Development of geothermal energy simulator
- Exploration of the possibility of exploiting supercritical geothermal resources originating from subduction zone

Exploration of geothermal resources (Kakkonda Shizukuishi, Iwate Prefecture)



Integration and visualization system of microseismic data (monitoring image of injected water behavior)



Concept of supercritical geothermal system

The team is conducting research and development to sustainably utilize geothermal energy on a suitable scale and in the proper form corresponding to underground conditions and social situations.

In the short term, the team is aiming to make direct contributions to sustainable and increased geothermal power generation through the development of a monitoring system for coexistence with hot springs, monitoring of changes in the reservoirs and reservoir simulation techniques.

In the long term, the team is aiming to introduce geothermal energy on a large scale as a base load power source through developing innovative power generation technology using supercritical geothermal resources originating from subduction zone and establishing methods for practical incorporation of geothermal energy into society.

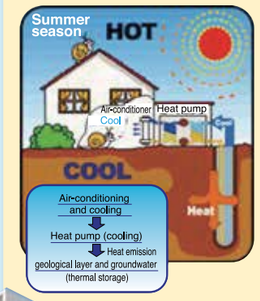
Matsukawa Geothermal Power Plant (Hachimantai, Iwate Prefecture)

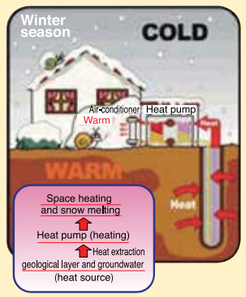
Research Subjects

Energy Saving in Air Conditioning Using "Constant Temperature Condition of Underground"

Shallow Geothermal and Hydrogeology Team

- Development of ground source heat pump (GSHP) system suitability maps based on geologic and groundwater field data
- Conceptual design of optimization technology for GSHP system
- Promotion of GSHP studies in Southeast Asia





Concept of a ground source heat pump system

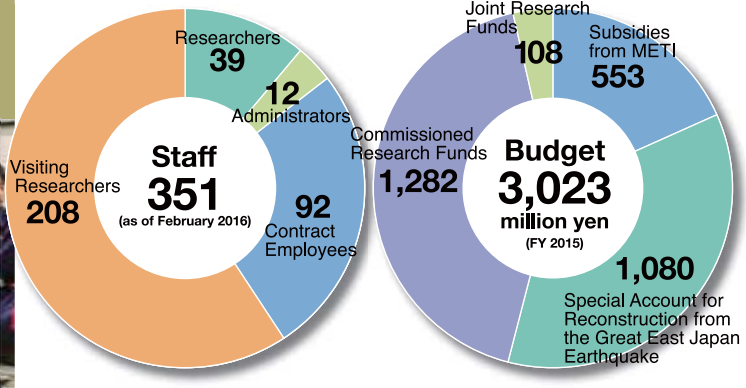
An example of suitability map considering regional groundwater flow

The team is aiming to reduce the costs of installing the GSHP system by "visualizing" the location and depth of boring. GSHP technology utilizes the subsurface heat energy, whose temperature is almost constant all year around, to save energy used for air conditioning, etc. To effectively use GSHP, it is important to understand the subsurface hydrogeological conditions of the site. Therefore, the team conducts geological boring surveys, groundwater temperature distribution surveys, and regional scale groundwater flow-heat transport modelling, to investigate the feasibility of a GSHP system (GSHP suitability) suitable for the subsurface environment of the area.

The team is also conducting studies on the development of GSHP systems suitable for different subsurface conditions.

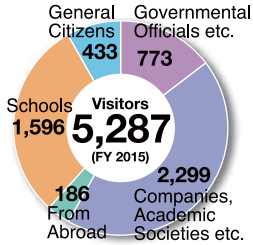
At FREA's GSHP demonstration test site, the team is conducting experiments with a combination of two types of heat exchangers used for shallow (1 - 2 m) and deep (40 - 50 m) underground levels, respectively. The Geological Museum of GSJ/AIST in Tsukuba City, Ibaraki Prefecture uses the same system to investigate the differences in operation method and efficiency in areas having different hydrogeological conditions.

Staff & Budget



Public Relations

FREA transmits latest R&D progress in various occasions.
This includes lectures, exhibitions, public events for local communities and laboratory tours for visitors.



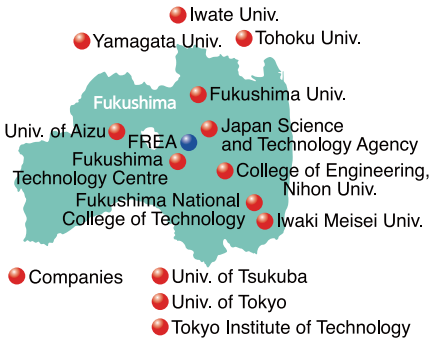
Cooperative Activities

FREA is actively promoting cooperation with private companies, universities and public research institutes for technology development and transfer of achievements.
FREA is also promoting international standardization of new technologies through strategic cooperation with world's leading research organizations.

Number of Ongoing Joint Research Projects -------- **108**
(as of February 2016)

- With private companies ---------- **78**
  - [Joint research under the Program for Promotion of Technologies Developed by Industries in Tohoku Disaster Areas ----------25]
- With universities and technical colleges ---------- **28**
- With public research organizations and others ---------- **2**

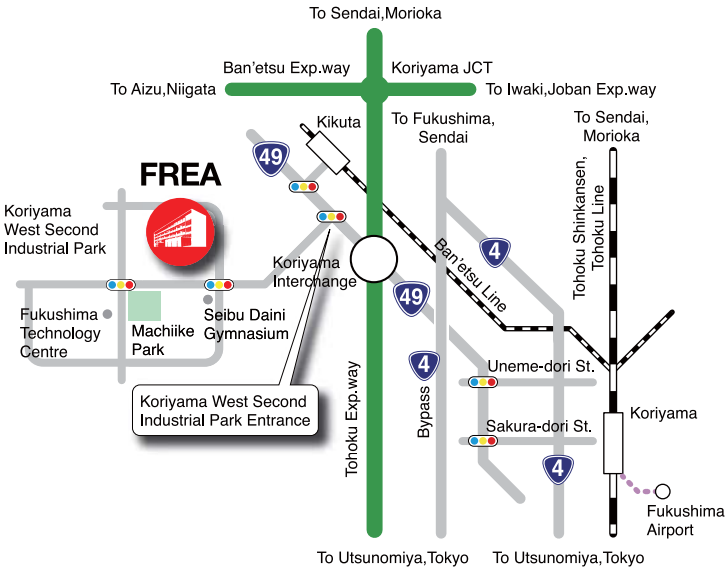
Domestic Cooperation



International Cooperation (formal agreements)

Access


Photo: Courtesy of JR East Japan



By car:
About 5 km from Tohoku Expressway "Koriyama IC" (about 10 minutes)
Proceed in the direction of Inawashiro (right) at the exit of the interchange.

By plane:
Take a limousine bus at Fukushima Airport for Koriyama Station. (It takes about 40 minutes and costs 1,100 yen.)

By train:
Take Tohoku Shinkansen (bullet train) to Koriyama. It takes about 1.5 hours from Tokyo to Koriyama.

From Koriyama Station:
1)Take a taxi at Koriyama Station. (It takes about 25 minutes and costs about 4,000 yen.)
2)Take a train (JR Ban'etsu West Line) at Koriyama Station, get off at Kikuta Station, then take a taxi (It takes about 10 minutes and costs about 1,200 yen.
3)Take a bus (Fukushima-Kotsu Bus) at Koriyama Station: bus station No. 8 for Koriyama Western Industrial Complex. (It takes about 40 minutes and costs 710 yen. Please note the limited number of bus services.)

FUKUSHIMA RENEWABLE ENERGY INSTITUTE, AIST (FREA)
2-2-9 Machiike-dai, Koriyama, Fukushima 963-0298, Japan
TEL: +81-24-963-1805, Fax: +81-24-963-0824, E-mail: frea-info-ml@aist.go.jp, http://www.aist.go.jp/fukushima/en/