

## Visiting Information

### KOREA INSTITUTE OF ENERGY RESEARCH



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# KOREA INSTITUTE OF ENERGY RESEARCH

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- Gasification Research

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## Future Fundamental Technology

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- Advanced Process Research

Recently, high oil prices have driven the world's economy toward the verge of a crisis. The reasons for such high oil prices include a strong demand for oil from newly emerging economies including Russia, India and China; political instability in oil producing countries; and speculative capital in the oil markets. Furthermore, a more fundamental cause is the fact that fossil fuel energy resources are limited and depleting.

Global competition in securing energy is becoming increasingly harsh and serious. The big powers have not excluded going to war in their optional strategies to secure energy resources. And South American countries including Brazil have begun to nationalize their energy-related properties.

Korea imports 97% of its total primary energy demand from overseas countries. The country is the fifth largest oil importer and the tenth largest oil consumer in the world. Energy independency is an urgent task to be dealt with within the world's harsh competition for energy security.

Through its R&D on energy during the past 30 or more years, the Korea Institute of Energy Research (KIER) has met the challenges of our times in order to help all sectors of the country, including industry and the daily lives of citizens, to use energy without inconvenience.

In coming years, KIER will continue to take initiatives in building energy technologies as a next-generation driving force for national growth, while making efforts to meet the challenges of our time, including high oil prices and climate change protocols.

## Energy Efficiency Technology

### :: Cogeneration and Boiler Research

R&D on cogeneration system, energy network (DHC and CES), boiler, burner system and heat exchanger aiming at high energy efficiency and low pollutant emission

- Cogeneration system integration and energy network
- DHC (District Heating and Cooling) and CES (Community Energy Supply) systems
- Organic Rankine or Stirling cycle based on cogeneration technology
- Oxy-fuel, biomass and other low NOx combustion technology for boilers
- HRSG (Heat Recovery Steam Generator) and boilers for power plant

### :: Industrial Combustion Technology Research

R&D on advanced combustion technology to enhance energy efficiency and reduce atmospheric pollutants and greenhouse gases related to combustion systems, such as industrial furnaces, boilers, incinerators, fuel cells and gas turbines

- High efficiency furnace technology
- Environment-friendly, high efficiency regenerative/oxygen combustion system
- Intelligent combustion control system
- Compact burner and micro reactor, including electrochemistry technology

### :: Automobile Energy and Environment Research

Research on high efficiency and environmentally friendly vehicles and transportation policies aimed to contribute towards national energy security and to reduce greenhouse gases and air pollutants in the automobile transportation sector

- Technological policies related to energy and the environment in the transportation sector
- Key technologies of environmentally friendly engines and vehicles for the next generation
- Application technologies of environmentally friendly fuels on next generation vehicles
- Performance evaluation of vehicle fuel economy and exhaust emissions

### :: Electric Energy and Lighting Research

Research on new technology for improving efficiency and for saving energy in the electric energy sector, and especially on high efficiency innovative lighting technology

- High flux technology of white LED (Light Emitting Diode) light sources
- Ballast technology for electrodeless fluorescent lamps
- Control and power conversion technology for fuel cell hybrid power systems
- Control and monitoring technology for distributed power systems
- Energy efficiency and performance testing of electric equipment

### :: Building Energy Research

R&D on energy saving technologies for buildings, including a building envelope, HVAC, control systems, and convergence technologies

- Green building and low energy building technology
- Integrated design measures of sustainable building systems
- Building utilities and air conditioning system technology
- Evaluation of sustainable buildings, building energy rating systems

### :: Waste Heat Energy Research

R&D on high efficiency heat exchangers and heat conversion to utilize the waste heat from industrial processes, buildings and facilities and high efficiency combined dryers

- System technology to use waste heat
- High efficiency heat exchanger and enhanced heat transfer technology
- Heat conversion technology
- High efficiency drying technology
- Refrigeration and cooling technology





## :: Synfuel Research

R&D on different processes to produce synfuel from coal and natural gas, and converting processes (reactors and catalysts) to generate high-value-added energy from sludge and heavy oil

- Fischer-Tropsch reaction system development for coal-derived synfuel production
- Gas to liquid (GTL) technology development
- Energy conversion process development (sludge and heavy oil)

## :: Greenhouse Gas Research

R&D on greenhouse gas (GHG) mitigation in order to actively meet the challenges stemming from climate change

- Development of materials and processes for capture, storage and treatment in mitigating greenhouse gases (GHGs)
- Post-combustion capture technology using adsorption, absorption and membrane in order to separate CO<sub>2</sub> from flue gas
- Pre-combustion capture technology using adsorption, absorption and de-carbonization in order to separate CO<sub>2</sub> from syngas
- Technology of high purity oxygen production using ion transport membrane (ITM) for oxy-fuel combustion to capture CO<sub>2</sub>
- Development of pollutant removal technologies in relation to GHGs mitigation

## :: Zero Emission Technology Research

R&D on ZETs (Zero Emission Technologies) for innovative ultra-clean coal energy plants, producing electricity and value-added energy products in order to cope with the situation of high oil prices in the 21st century

- Energy environment technology using fluidization process
- Chemical-looping combustion and gas production technology
- Value-added chemical production by coal carbonizer pyrolysis technology
- Fluidized bed-combustion co-generation boiler technology
- Fluidized bed CO<sub>2</sub>, H<sub>2</sub>S capture, and gas purification technology using dry sorbent
- Development of titania nano-coated beads using fluidized bed chemical vapor deposition (FB-CVD)

## :: Air Pollution Research

R&D on advanced technologies for reducing air polluting substances including greenhouse gases, and generating eco-friendly energy carriers for a cleaner environment

- Treatment of greenhouse gases and environment polluting substances (SO<sub>x</sub>/NO<sub>x</sub>, dust, etc.)
- Refined fuels with sewage sludge and catalytic gasification of sludge-oil-coal agglomerates
- Solar-driven photo/biocatalytic hydrogen production and indoor air purification
- Autothermal reformation of methane into syngas

## :: Clean Coal Technology Research

R&D on upgrading low-rank coal and the development of bio-catalysis for an efficient recovery of global warming gases: R&D on abatement technologies for particulate matters, and multi-pollutant control for emissions from coal combustion facilities

- Preparation of ash-free coal and upgrading of low rank coal
- Multi-pollutant control technology including hazardous air pollutants (HAPs)
- Submicron particle reduction and hot gas cleanup technology
- Nano structure control technology
- Oxidation of volatile organic compounds and waste heat recovery

## :: Gasification Research

R&D on the development of environmentally friendly thermochemical conversion processes for low quality hydrocarbon fuel to produce hydrogen and combined heat and power

- IGCC (Integrated Gasification Combined Cycle) development
- Process development for manufacturing syngas and recycling raw materials from combustible waste gasification
- Development of gasification processes from refinery residues, pet coke, or natural bitumen and syngas utilization systems
- Development of thermochemical conversion processes for biomass
- Development of new-concept gasifiers and related processes
- Process development of gas separation, storage and transportation using gas hydrates

## :: Alternative Fuels Research

R&D on core technologies to produce alternative fuels from various kinds of wastes, and non-conventional petroleum-based fuels through environment-friendly treatment

- Technologies for the practical use of production process, through which high-quality fuel oils are produced from polymer wastes
- Core technologies for pyrolysis and dechlorination of polymer wastes
- Technologies for the production of synthetic crude oils from non-conventional petroleum-based fuels
- Technologies for the preparation and combustion of RDF (Refuse-Derived Fuel)
- Technologies for the submerged quench incineration of toxic liquid wastes

## :: Chemical Process Research

R&D on separation, reaction, and reactive separation technologies including novel catalysts and adsorbents aiming at energy conservation in a wide range of industries covering oil refinement, petrochemical, fine chemical, and bio-related processes: R&D on chemical processes based on technologies for building a hydrogen economy

- Separation process and separating agents
- New catalyst and reaction process
- Enhancement of energy efficiency in oil refinery and petrochemical process
- Separation and purification technologies relevant to the environment preservation including clean fuel production
- Purification process for hydrogen and biogas



## New and Renewable Energy Technology

### :: Fuel Cell Research

R&D on core technologies for polymer electrolyte membrane fuel cells for improving performance and durability, and for reducing cost through optimization of materials, components, and systems: residential, transportational, and mobile fuel cell systems

- R&D on materials, components, and systems of PEFCs (Polymer Electrolyte Fuel Cells) for residential cogeneration systems, electric vehicles, and portable electronic devices
- Development of core technologies of electrodes, membranes, and membrane-electrode assemblies to improve performance and durability
- Development of an optimal design and operational schemes of PEFC stacks and systems
- Training, education, and performance evaluations of PEFCs

### :: Solar Cells Research

R&D on materials and devices based on silicon and chemical compounds (I-III-VI, II-VI, CuInGaSe<sub>2</sub>, CdTe, etc.) of solar cells

- R&D on solar cell materials and devices
- Development of amorphous-Si/|microcrystalline-Si tandem solar cells and amorphous-Si/crystalline-Si heterojunction solar cells
- Development of CIGS thin film solar cells by physical vapor deposition and chemical processes
- Test and performance evaluation of solar cell materials and devices

### :: Advanced Fuel Cell Research

R&D on DAFCs (Direct Alcohol Fuel Cells), SOFCs (Solid Oxide Fuel Cells), PAFCs (Phosphoric Acid Fuel Cells) for distributed generation, military power sources and portable electronic devices

- DAFC systems and key components for portable, military, mobile and electronic applications
- SOFC stack, balance of plant and systems
- DMFCs (Direct Methanol Fuel Cells)
- Education and training programs on fuel cell core technologies for universities and industries
- Development of energy production and storage technologies by using electrochemical energy conversion systems

### :: Photovoltaic Research

R&D on silicon solar cells, PV modules, PV PCS, PV systems, as well as certification and performance evaluations of PV components and a PV manpower training program

- R&D on silicon solar cells and PV manpower training curriculum and programs
- R&D on PV modules and BIPV modules
- R&D on PV power conditioning system (PCS)
- Certification and performance diagnosis of PV systems and components
- Self-controlled distributed power system technologies for ECO (Electricity Cluster Oriented) networks and future-oriented micro-grid network technologies

### :: Wind Energy Research

R&D on wind resource assessment, wind turbine system and elements development, wind turbine system performance test, wind farm design and maintenance and especially offshore wind power generation demonstration

- Assessment and forecasts of wind energy resources and wind farm design
- Construction and operation of a wind turbine test site
- Basic design and analysis of grid-connected wind turbines
- Installation and operation of demonstration offshore wind farms
- Development of low wind speed wind turbine blade

### :: Solar Thermal Research

R&D on solar thermal systems:

- R&D on solar thermal energy collecting, storage, and utilizing technologies
- R&D on solar heating system technologies for building and industrial heat processes
- Performance test of solar collectors and hot water heater for national certification
- R&D on hydropower systems and assessment of hydropower potential
- R&D on freezing show-cases using ice-slurry technology, heat pump application using off-peak electricity

### :: Advanced Solar Thermal Research

Research on concentrating technology of solar energy and the applications of making electricity and solar fuel production and development of a renewable energy resources data center

- Concentrated solar thermal power generation
- Solar thermochemistry and solar fuel production
- Solar energy resource assessment and applications
- Atlas of renewable energy resources and construction of national renewable energy data center

### :: Geothermal Energy Research

R&D on the design of high-efficiency cooling and heating systems using geothermal technology, unutilized energy, development of related parts, system evaluation, and demonstrations

- Geothermal hybrid heating and cooling system design, analysis and commissioning technologies
- Thermal and power system technologies using unutilized energy resource including waste energy
- Waste heat (ground water, river, sea) source heat pump system design and technology development
- Renewable energy system feasibility study with RETScreen
- Renewable energy system performance prediction and verification with IPMVP

### :: Hydrogen System Research

R&D on hydrogen systems including catalysts and reactors for hydrogen production as a future clean-energy source

- Compact natural gas reformers for stationary PEFCs (Polymer Electrolyte Fuel Cells)
- Natural gas steam reformers and hydrogen supply systems for hydrogen stations
- Reformers & Catalytic oxidizers for SOFC and MCFC
- Gas to liquids (GTL)
- Catalysts for hydrogen and syngas production

### :: Hydrogen Energy Research

R&D on new technologies for the production and storage of hydrogen as well as on an optimized process design for mass hydrogen production

- Thermochemical water-splitting for hydrogen production (SI, hybrid sulfur, solar thermochemical, thermochemical methane reforming, and other processes.)
- High performance electrolysis system for hydrogen production (PEM electrolysis, high temperature electrolysis of steam, alkaline electrolysis)
- Hydrogen storage evaluation system
- Advanced CO<sub>2</sub>-free hydrogen production system (hybrid water-splitting process)

### :: Bioenergy Research

R&D on production and utilization of various energies (methane, biodiesel, bioethanol, hydrogen and synthetic gas) from biomass, including organic wastes and lignocellulosic biomass, using thermochemical and/or biological technologies

- Biodiesel production technologies
- Biological production of hydrogen using solar energies
- Ethanol production from lignocellulosic biomass
- Biogas utilization using anaerobic co-digestion
- Gasification, pyrolysis, and combustion of biomass



## Future Fundamental Technology

### :: Convergence Materials Research

R&D on ionic-conducting ceramic materials, SOFC materials, and high-temperature structural materials for high efficiency/pollution-free energy facilities, multi-functional ceramic nano-coating technology, fiber reinforced ceramic composites by converging of energy, and environment and nano technologies

- Ionic-conducting ceramic membranes for gas separation and reaction
- Novel solid electrolytes and electrodes for IT-SOFC or HT-steam electrolysis
- Ceramic candle filter for CTL and IGCC plants
- Fiber reinforced ceramic composites and Si-based energy materials
- Carbon fiber composite materials for wind turbine blades
- Multi-functional ceramic nano-coating technology

### :: Photo-Electric Materials Research

R&D on electrochemical energy storage, photo-electrochemical conversion of solar energy, photo-catalysts, advanced electrochemical and photo-electrochemical materials, high-performance hydrogen sensor materials and devices, and electrical and electronic materials for future energy

- Dye-sensitized and organic solar cell
- Electrolyte and electrode for electrochemical energy storage (super-capacitor, li-polymer battery, and others.)
- Photo-catalyst
- Photo-electric energy conversion and storage materials
- Photo-luminescent materials & devices for energy efficiency
- Gas sensor and MEMS technologies for energy efficiency control
- Organic/inorganic hybrid EL(Electroluminescence) materials/devices
- Color/transparency-changeable smart window

### :: Nano Materials Research

R&D on functional materials for the green environment and energy resources, including inorganic membranes, adsorbent/sorbent, inorganic aerogels/hollow spheres, environment-friendly biocomposite and thermo-/photo-electric materials and catalyst

- Inorganic membranes for CO<sub>2</sub>, H<sub>2</sub> recovery and bioethanol purification
- Honeycomb made of inorganic sheet having nanoporous adsorbents for VOC abatement or dehumidification
- Inorganic aerogel and hollow sphere for thermal insulation
- Environment-friendly biocomposites
- Nano and photo-luminescent phosphors for white LED
- Catalyst and microreactor materials

### :: Advanced Process Research

R&D on advanced chemical reaction and separation technologies for realizing a new energy & environmental system, followed by the commercialization of lab-scale manufacturing processes on specialized materials and components

- Simultaneous chemical reaction and separation process
- Hybrid metal and ceramic membrane processes
- Optimization of manufacturing process
- Hydrogen storage system
- Microwave energy process

## Energy Policy Research

### :: Energy R&D Policy

The Energy R&D Policy Team's mission is to establish KIER's management goal and strategies including long-term development strategies: exploring and selecting top-priority R&D areas and future promising R&D projects: as well as an overall R&D plan and detailed plans of action

### :: Energy Technology Analysis

The Energy Technology Analysis Team has been conducting research on technological strategies such as GHG-reduction potential in its technical aspect, and so on. The team is also performing research on the establishment of an energy technology database and the effects of developed and transferred energy technologies, as well as an energy demand-side management policy

### :: International Cooperation

To enhance the international research capacity of KIER, the International Cooperation Team carries out the following activities: First, it supports research activities and networking with international organizations and overseas energy-related research organizations: second, it develops and fosters methods of utilization of research facilities and manpower between KIER and overseas research organizations: and third, it builds and supports the operation of overseas centers for cooperation

### Russian Korean Cooperation Center for Energy and Environment Technology

The Russian Korean Cooperation Center for Energy and Environment Technology was established in Moscow in 1994. It aims at acquiring fundamental and advanced technologies that have practical aspects for research and industrial use. For that purpose, Russian scientists are invited into joint research, and the sharing of research facilities and equipment is promoted. The center, as a legal entity established in Russia, has played a pivotal role in promoting R&D in energy technologies

### :: Technology Transfer

The Technology Transfer Center aims to promote dissemination of energy technology by the transfer and commercialization of technology developed by KIER, also by the business incubation for energy technology companies and the provision of training and education programs as well as the distribution of energy technology information

### :: Testing and Evaluation for Energy Technology

The Testing and Evaluation Center for Energy Technology was established and is currently in operation for the standardization and globalization of energy technology through the integrated management of performance testing and evaluation functions on energy equipment and technology with energy related testing and analysis (previously carried out by KIER): thus, it promotes efficiency and establishes the basis for a research center specializing in performance testing, certification and evaluation

### Technology Transfer and Testing and Evaluation for Energy Technology

### Jeju New and Renewable Energy Research Branch

The Jeju New and Renewable Energy Research Branch was built with the aim to carry out research and disseminate energy technology at the same time.

- Demonstration of energy technology in the field of new and renewable energy, and through the demonstration, improvement in research results is expected
- Experts trained at the branch
- First-hand experience offered
- Awareness program offered

<http://jeju.kier.re.kr>