

**GLOBAL ENERGY INNOVATOR** 

Toward a content and prosperous society, led by KIER energy technology



152 Gajeong-ro, Yuseong-gu, Daejeon 34129 TEL:+82-42-860-3114 FAX:+82-42-861-6224

R&D Project Management T:+82-42-860-3035 Public Relations T:+82-42-860-3244

Procurement T:+82-42-860-3422 Employment T:+82-42-860-3251

Technology Support T:+82-42-860-3546 Visit T:+82-42-860-3361









- 25 FEP Convergence Research Center

333

 $\sim$ 

- R&D Center for Reduction of Non-CO2 Greenhouse Gases
- Center for Environmentally Friendly Vehicle

## <sup>66</sup> We commit to continue our researches in various fields with energy and environmental issues as a top priority. 99

Human history can be seen as a history of power, that is, a history of energy.

Depending on the availability of energy, international politics has changed and the national economy has been affected. This energy is not only a part of the economy but also an important security issue directly linked to the survival of the people.

The energy revolution has expanded capitalism, globalization, energy production and consumption, but has caused the environmental destruction. We should consider the rapid change of climate due to global warming, one of the main problems we have.

Established in 1977 to contribute to creation of national growth engines and the development of the national economy, the Korea Institute of Energy Research (KIER) is working to develop various solutions for national energy and climate problems.

For this, KIER is making the best research for energy selfsustaining technologies including the energy efficiency/ materials technologies to improve the energy use efficiency and maximize the industrial efficiency, new and renewable energy technologies that would lead the 4th industrial revolution, greenhouse gas reduction technologies to reduce the main cause of climate change, and the marine energy and system convergence technologies.

KIER, which has assumed the burden for national energy technologies over 40 years, promises to continue multidirectional researches for the next generation in order to prevent global warming and realize the environment-friendly future.

President, Korea Institute of Energy Research Dr. Byong-Sung Kwak, Ph.D

Creation of energy new industry for solving national energy and climate problems

> research productivity and large sized R&D

obening same goal of becoming **Enable Happier World** using KIER Energy **Technologies KIER** 

> Improvement of through innovative performance based on market needs

"Toward a content and prosperous society, led by KIER energy technology."



## VISION

Creation of native organizational culture based on cooperation and safety consciousness

Enhancement of investment efficiency through establishing detailed R&D management system

a world-top energy research institution











## Gwangju Bioenergy Research Center

Location : Gwangju City Main Research Areas : Energy storage, bioenergy, industry-university-institute R&D collaboration and technical support in new and renewable energy

\* Others 2.2%

## Korea Institute of Energy Research (headquarter)

Location : Daejeon City Main Research Areas : New and renewable energy, greenhouse gas emission reduction, energy efficiency and materials process, etc.

#### Hydrogen and Fuel Cell Center for dustry, Academy and Laboratories

Location : Buan City Main Research Areas : Demonstration of hydrogen and fuel cell

#### **KIER-UNIST Advanced Center for** Energy

Location : Ulsan City Main Research Areas : Next generation battery, electrical industrialization system and electrical convergence technology demonstration, etc.

### Jeju Global Research Center

Location : Jeju Island Main Research Areas : On/off shore technology convergence, system convergence, and wind energy, etc.

Passionately dreaming same goal of becoming a world-top energy research institution

# Main Research Areas



### KOREA INSTITUTE OF ENERGY RESEARCH

KOREA **INSTITUTE OF** ENERG RESEARCH

### **Energy Efficiency and Materials Technology**

• KIER aims at contributing achievement of the national energy saving goal through energy

demands/supply management and energy saving technology development in the fields of building,

**Main Research Areas** 

### Energy Saving Research

### transportation and industry. Major Research Fields

- Smart green building, smart window and door system/integument technology
- High efficiency complex drying system and heat recovery system
- Alkali metal thermal to electric conversion technology
- Ultra-fine particles electro-spray wet process electric precipitation high efficiency source technology
- Source technology of high temperature steam production using the overheat exchanger device
- Sewage sludge fuel manufacturing and processing technology using green carbon
- Nano-fluid cooling and reliability technology
- Vehicle/engine feel efficiency/environment improving technology
- High efficiency eco-friendly vehicles and future alternative fuel application technology
- High efficient heating technology and battery pack thermal management technologies for electric vehicles



Energy **ICT** · **ESS** 

5kW slim-type

vanadium redox flow batterv stack

KIER intends to improve an energy supply/demand/transfer efficiency based on ICT convergence technology and conduct a research on energy integration management and operation for improving energy reliability; and

To contribute on stable energy demand/supply with an energy saving technology for improving energy efficiency and realizing the reduction of greenhouse gas emissions.



#### Major Research Fields

 ICT convergence energy optimization management and energy saving technologies

Green building

monia fueled

ehicle AmVeh

- Key technologies of distributed power, micro-grid and smart-grid intelligent energy harvesting future technoloav
- · High efficiency technology of electric power guzzling devices
- Energy storage technology
- · Energy storage integration system and demonstration technologies
- Energy storage test certification and standardization technology

800 kVA real-time computer simulation system for microgrid

### Thermal Energy System

Energy

Network

- Major Research Fields
- Future power generation technology
- Oxy-fuel combustion technology
- Heat pump application technology
- Excess enthalpy combustion application technology
- Thermal energy system convergence and cross-cutting technology



High temperature production hybrid heat pump system

Major Research Fields

Smart energy network

- Energy network optimization based on the interactive energy virtual trading
- · Smart composites energy storage and utilization system
- Thermal energy network smart meters

Development and performance evaluation of the cogeneration plant



Pellet boiler



#### • KIER researches on efficient energy conversion technologies of heat-to-heat/heat-to-electricity/ electricity-to-heat for efficient use of low and high temperature heat energy and researches on heat energy system including fossil fuel and synthetic fuel combustion.









Supercritical CO<sub>2</sub> power generation



The world's first axial-type supercritical CO<sub>2</sub> turbine

• KIER endeavors to reduce the greenhouse gas emissions and rationalize the energy efficiency through improving energy device efficiency for efficient energy production and rational distribution/consumption including cogeneration system, boiler, etc.; and • To improve an energy utilization efficiency and reduce the greenhouse gas emission by realizing the optimal energy management system in physical/virtual energy network unit.

KOREA **INSTITUTE OF** 

RESEARCH

### **Energy Efficiency and Materials Technology**

**Main Research Areas** 

**INSTITUTE OF** ENERGY RESEARCH

New and Renewable Energy Technology

Main Research Areas

KOREA



① SOEC stack for hydrogen mass production ② 300 CPSI C-SiC composite honeycomb for CSP ③ Gas separation using metal organic frameworks

12 | 13

#### • KIER is engaging in advanced R&D on value chain system technology on solar cells; and • To involve in various policies related with the certification system and dissemination actively; and • To perform a role as a R&D hub in solar cell covering industry-university-institute, and lead the national solar cell power industry growth and contribute to ensure the sustainable core

- Next generation solar cell development such as chemical materials/silicon thin film, dye induction and
- PV performance test/evaluation technology and international standardization





CIGS thin film solar cells



Ultra-thin crystalline si solar cell

### KIER is studying on hot water, heating/cooling, thermal supply/storage, fresh water, power generation, zero-energy building/town and hydrogen production with solar

#### To guide new/renewable thermal energy resources and develop evaluation



#### Major Research Fields

Dish type solar concentrator (10kWe)

- Non-tracking solar collector and solar hot water system
- Tracking type high concentrating system and high temperature solar cell receiver Heat/cold storage system with a sensible and latent heat/chemical reaction • Zero-energy building and eco-friendly energy community base on solar cell • Distributed mid/large-sized solar cell power plant
- Seawater desalination and cooling system with solar heat
  - New/renewable thermal energy convergence utilization technology
  - Compound regeneration thermal system and cold storage system base on heat storage
  - Solar chemical reaction technologies for hydrogen production



KOREA **INSTITUTE OF** RESEARCH

### New and Renewable Energy Technology

**Main Research Areas** 

DMFC mini ca

INSTITUTE OF Climate Change Technology RESEARCH

Main Research Areas

KOREA

Fuel Cell • KIER researches on core materials technology development for improving performances and durability of fuel cells and electrochemical devices; and

• To design the fuel cell and electrochemical system and research the comprehensivization-related technologies for building fuel cells, distributed power generation, fuel cell vehicles, IT/portable power and APU (auxiliary power unit).

Major Research Fields

- Core element technology and system of PEFC, SOFC and DMFC
- Positive/negative ion exchange membrane and high durability MEA design technologies based on low cost and high performance polymers
- Cylindrical/plate SOFC cells/stack/system design and manufacturing technology
- Fuel cell system design for military, logistics processing and airplane



1kW polymer electrolyte fuel cell system for residential power generation

PEMFC MEA manufacturing technology

Hydrogen

KIER researches on hydrogen production and storage such as core element technology, integrated system development, etc. with hydrocarbon reforming and water splitting.

#### Major Research Fields

- SI thermo-chemical water splitting hydrogen production process
- High pressure/purity hydrogen production system for hydrogen storage stations
- Design and control of high efficiency compact-sized fuel processor
- Structure catalyst design for fuel processor
- Hydrogen production process by chemical looping
- Water electrolysis and renewable energy connection technology
- Photochemical hydrogen production





Photoelectrochemical hydrogen production SI thermochemical water splitting process

## Greenhouse

- change mitigation; and

#### Major Research Fields

- Low carbon energy/environment process technologies
- CO2 capture and conversion technology by absorption, adhesion, membrane separation and dry particle
- Solid raw materials energy technology with a fluidized bed
- Pollutants removal technology with combustion flue gases
- Low-water stream/non-aqueous/phrase separation CO2 absorbent with low renewable energies
- CO<sub>2</sub> capture and mineralization technologies using carbonic anhydrase and mimetic catalysts
- Catalyst and electrochemical conversion technology for useful compound or clean fuel production from carbon dioxide • Application technologies with hydrate crystallization (CO<sub>2</sub> separation, bio product concentration, desalination
- and natural gas hydrate production technologies)

Different reaction calorimeter for analyzing heat of absorption



Gas

#### • KIER is developing the greenhouse gas capture/utilization (conversion) technologies for climate

#### • To develop clean energy (as an alternative of fossil fuels) utilization/dissemination technologies.



10 tpd coal drver



CO2 recovery process using promoted K2CO3 aqueous solution

## **Climate Change Technology**

production, treatment, and utilization technologies.

Development of distributed gasification power plant for export/domestic use

**Main Research Areas** 

Clean Fuel

KIER CTL plant

Photobioreactor system

using sunlight and coal-

firing flue gas

resources: and

Major Research Fields

Low-grade fuel upgrading technology

Low-grade fuel gasification technologies

KORFA **INSTITUTE OF** RESEARCH

## Jeju Global Research Center

Main Research Areas

Marine Energy

### Major Research Fields

- Marine energy convergence platform technologies
- pressure retarded osmosis (PRO) and capmixing) Seawater desalination and water treatment technologies
- Useful resource recovery technologies
- Marine energy and environmental core materials and components technology
- Marine bio energy technology
- Marine energy storage technology
- Ocean thermal energies such as seawater heat source, etc.
- Regional specialization energy technology

### System Convergence

sufficiency technology with a distributed energy network system.

#### Major Research Fields

- System convergence design tool and operation control system development
- Development of pre-test simulator for performances and reliabilities of components and systems
- Development of battery charging condition/lifetime expectation models
- Power distribution system stability technologies and electricity quality pre-test simulator development • Integrated operation monitoring and system (total operating center)
- Failure mode and effect analysis
- Big data acquisition and operation management technology
- Test demonstration standardization process
- · Dead battery integrity test simulator

#### • KIER endeavors to have the world's best competitiveness through developing performance test inspection technologies for development and dissemination of wind power system and element component technologies.

### Major Research Fields

- Wind turbine control system
- Performance and reliability certification emulation
- Floating offshore wind turbine dynamic control
- Wind turbine plant integration operation management system
- Small/mid-sized wind turbine performance inspection
- On/off shore wind farm design and economic feasibility evaluation • Wind turbine blade structure and aerodynamic design
- Wind turbine element component reliability evaluation technologies
- Wind turbine noise characteristics evaluation technologies



• KIER has contributed to the national energy security by producing clean fuels from flow-grade

To ensure a stable supply of gas and crude oil by diversifying gas and crude oil (heavy crude oil)

Fischer-tropsch

synthesis reactor

(capacity :15bbl/day)

- synthetic natural gas
- organic waste

- Bio-oil production and utilization

polymer



### Wind Energy

- - Integrated wind turbine design system

## Convergence & Integration

#### KIER is promoting core technologies in the fields of marine energy and environment, and developing the commercialized technologies.

- Marine energy production technologies: salinity gradient (reverse electrodialysis

Low energy consumption pre-treatment technology and process development



MVR seawater desalination



Salinity gradient power system

## KIER endeavors to improve the energy utilization efficiency and develop the energy self-

Offshore wind power system

16 | 17

Enable happier world using KIER energy technologies

KOREA INSTITUTE OF ENERGY RESEARCH

**Technology Commercialization** 

#### KIER makes excellent R&D achievements as strong patents (power patenting), commercializes them, transfers to home and abroad and commercializes such technologies.

KOREA **INSTITUTE OF** ENERGY RESEARCH

## **Corporate Cooperation**

KIER engages in joint R&D related with energy human resource development, providing information, dispatching experts, supporting business start-ups, establishment of research institutes, incubation, and other operations business to realize mutual growth with SMEs.

KOREA **INSTITUTE OF** ENERGY RESEARCH

### **Business Incubation**

KIER is improving the start-up success rate through providing the space, management, customized technology guidance and information required for the management of the companies to ensure startups may manage the business stably using the excellent infra (research personnel, performance analysis equipment, etc.) of KIER.

coordination to SMEs. etc.

# **Research Outcomes Diffusion**



• Negotiation of domestic and overseas technology transfer and commercialization link • Technical briefings and exchanges, technology sharing fair, etc.



• Operation of "Energy doctor mentoring program" and counseling to SMEs with technical difficulties • Support of quality and production management, operation of "Energy club" and other initiatives

· Incubation of startups, support to SMEs, demand prediction, researcher start-up support, technology-link

KIER, establishing technological response strategies for energy, climate change and environmental issues

# **Future R&D Strategy**



20 | 21 KORFA **INSTITUTE OF Energy Policy Research** ENERGY RESEARCH • KIER identifies/plans the future core R&D fields of researches and establishes the technical response strategies to the energy/climate change/environmental issues using the multiple criteria decision method, energy system modeling, technical feasibility analysis model, etc. • KIER researches the policy on techno-econimic ripple effects owing to development and distribution of energy technologies. KOREA INSTITUTE OF **Climate Technology Strategy** ENERGY RESEARCH KIER analyzes the technology trend to cope with climate change issues, and provides the fundamental researches for establishing the innovative R&D strategies and related policies. KIER Contribution to Mid and Long Term National Policy Improvement of the Improvement of Supply and expansion of greenhouse gas reductions energy efficiency new and renewable energy Final energy consumption goal in Reduction goal for domestic New and renewable energy greenhouse gas in 2030: 2030: portion in 2030 of primary energy: expansion to 25.7% 11.1% 9.7% reduction reduction compared to BAU compared to existing demand (Unit: t CO2-e (CO2 equivalents) (Unit: TOE (ton of oil equivalent)) (Unit: TOE (ton of oil equivalent)) 218 million 28 million 24 million 29% 21% 22% ontributi 64 million 5 million 6.2 million 100 thousand National policy KIER R&D National policy KIER R&D National policy KIER R&D in 2030 achievement in 2030 achievement in 2030 achievement Domestic reduction goal of 37% intended The 2nd Korean national energy master The 4th basic plan for new and renewable nationally determined contributions (INDC) plan ('14) energy ('14),



### **Global R&D Strategy**

KOREA **INSTITUTE OF** 

ENERGY

RESEARCH

.:.··· ..... 33.... Europe **Central Asia** Japan Africa China Middle East India ..... South-East Asia

### Africa

• Kumi Univ. (Uganda)

#### Europe

- ECN (Netherland)
- Univ.of Twente (Netherland)
- TUBITAK MarmaraResearch Center (Turkey)
- Sakarya Univ. (Turkey)
- ENEA (Italy)
- VTT Technical ResearchCenter of Finland (Finland)
- Univ. of Oxford (England)
- Fraunhofer Institute (Germany)
- ICPF (Czech)
- DTU (Denmark)

#### Middle East

- King Abdulaziz Univ. (Saudi Arabia) • KISR (Kuwait)
- Tel-Aviv Univ. (Israel)
- Technion-Israel Institute of Technology (Israel)
- Central Asia
- Nazarbayev University (Kazakhstan)

• Bar-Ilan Univ. (Israel)

- KEE (Kazakhstan)
- OJSC KygyzNeftGas (Kyrgyzstan)
- Baga Nuur Coal Mining LLC (Mongolia)

#### India

• VIT University

#### South-East Asia

- ARDEMR (Indonesia)
- BPPT (Indonesia)
- tekMIRA (Indonesia)
- PT SUCOFINDO (Indonesia)
- PT Medco Downstream (Indonesia)
- NPIC (Cambodia)
- State Agency for Technology Innovation (Vietnam)
- Industrial Univ. of Hochimihn city (Vietnam)
- MIT (Philippines)

#### China

- Guangzhou Inst of Energy
- Conversion, (GIEC, CAS)
- Shenyang Univ. of Technology, SUT

#### Oceania

- CSIRO (Australia)
- SCION (New Zealand)
- The Univ. of Auckland (New Zealand)
- COLCIENCIAS (Colombia)
- Univ. of Aruba (Aruba)

Latin America

## •••••• 1.1 . Canada USA





KIER, building a strategic cooperation network with major international organizations, countries, institutions and, based on it, identifies, plans and carries out the joint international research projects.

• Univ. of Antioguia (Colombia)

- Univ. of Hawaii
- FAS
- Sandia Corporation
- Univ. of Pittsburgh
- UL • NETL, DOE
- Univ.of Texas at Arlington
- KSEA





