



지구를 살맛 나게 하는 1도의 기술

**Below 1° to Keep
the Earth Livable**

에너지기술로 **행복사회**를 열어가는



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KIER MTP

Core Value

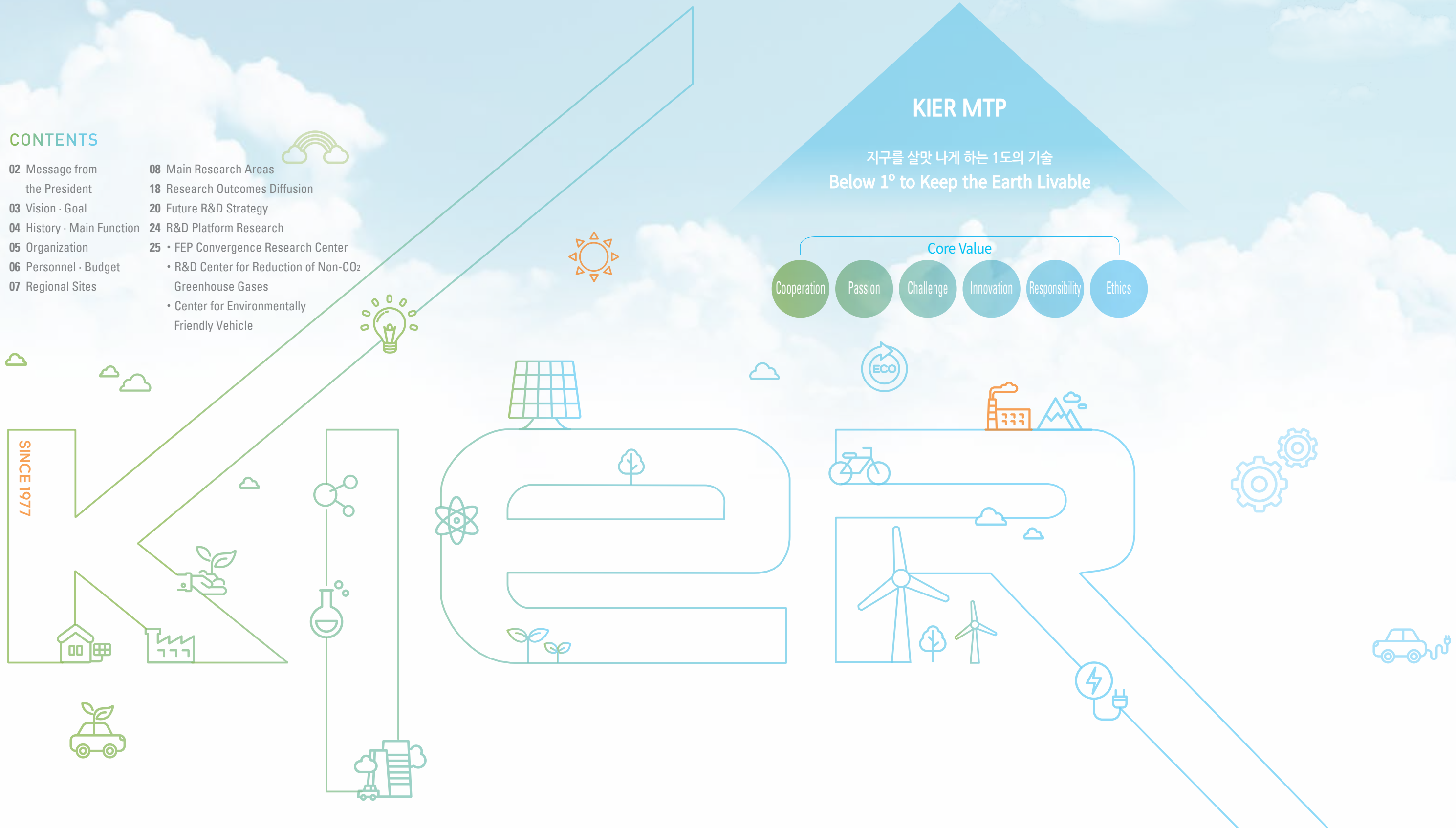
Cooperation

Passion

Challenge

Innovation

Responsibility



“We commit to continue our researches in various fields with energy and environmental issues as a top priority.”

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 self-sustaining 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.

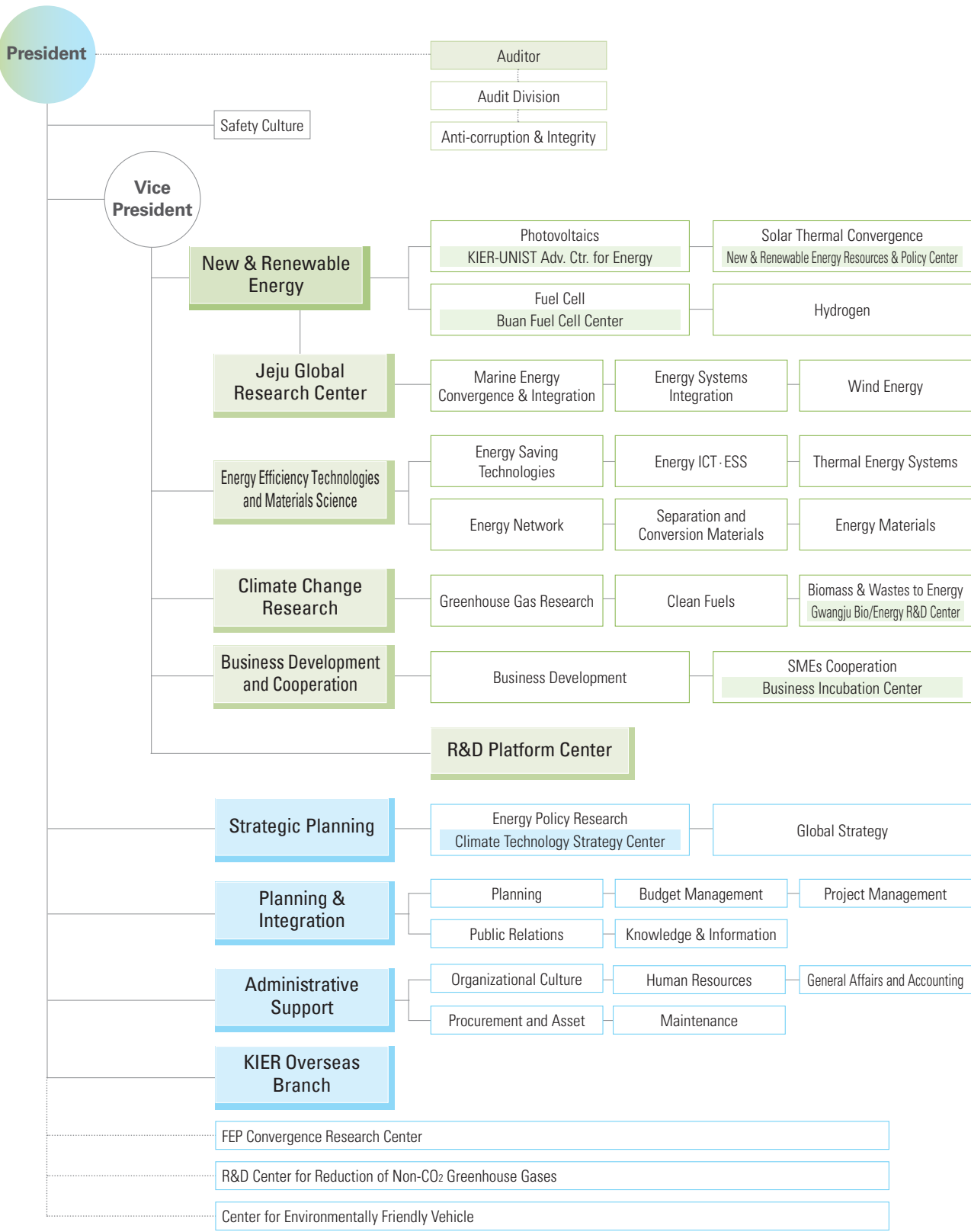
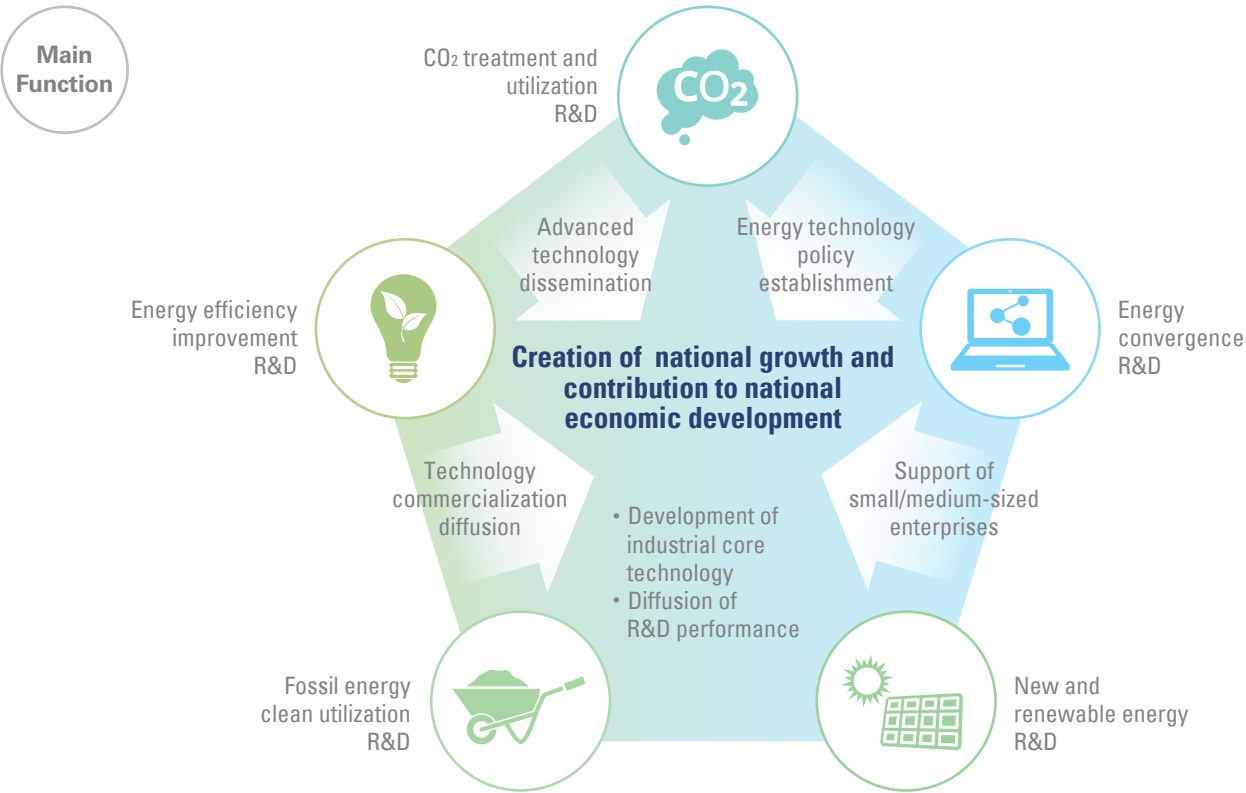
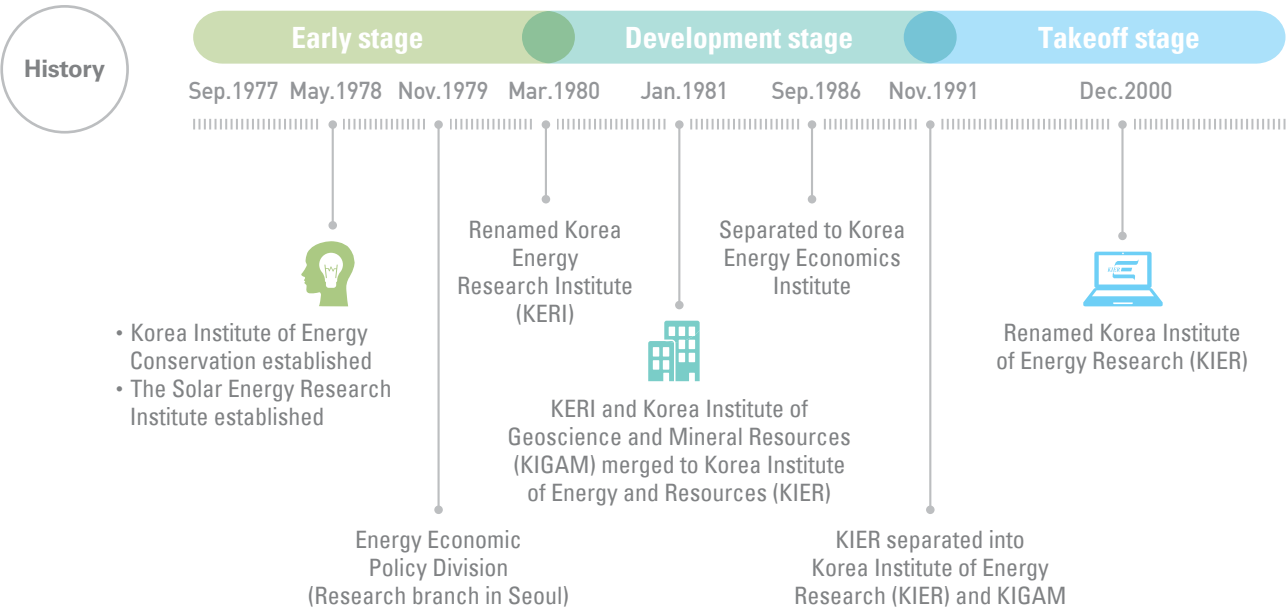
KIER, which has assumed the burden for national energy technologies over 40 years, promises to continue multidirectional researches for the next generation in order to prevent global warming and realize the environment-friendly future.

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

Byong S. Kwak

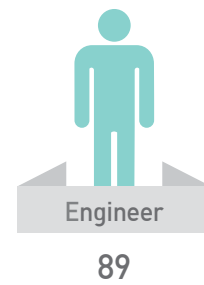
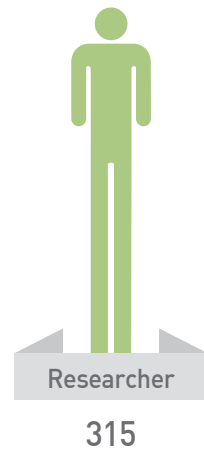


“Toward a content and prosperous society, led by KIER energy technology.”



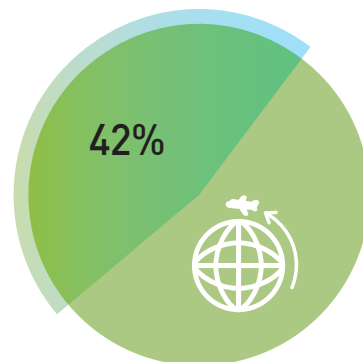
Personnel

464 persons

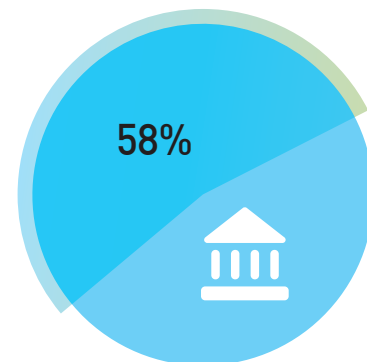


Budget

\$161M



Competitive grant
\$67.2M



Government grant
\$94M



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.

Buan Fuel Cell Center

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.

Gwangju Bio/Energy R&D Center

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

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



New and Renewable Energy Technology

Photovoltaics

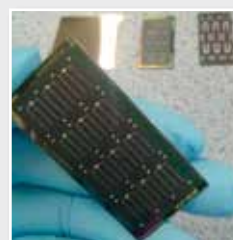
- KIER is engaging in advanced R&D on value chain system technology on solar cells; and
- To involve in various policies related with the certification system and dissemination actively; and
- To perform a role as a R&D hub in solar cell covering industry-university-institute, and lead the national solar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

Major Research Fields

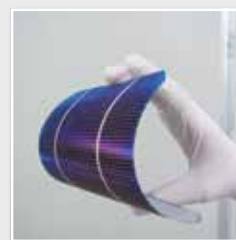
- Crystalline silicon solar cell
- Next generation solar cell development such as chemical materials/silicon thin film, dye induction and organic/inorganic composites, etc. based on CIGS, CZTS and CTS
- Photovoltaic (PV) module and building integrated photovoltaic (BIPV)
- Photovoltaic PCS (power conversion system)
- PV materials, element component device performance test/evaluation
- PV performance test/evaluation technology and international standardization
- Customized PV system design and diagnosis technologies
- Future micro-grid and energy supply network technologies
- Solar cell personnel education/training program development



Roll-to-roll vacuum coater
PECVD cluster system for si thin-
film solar



CIGS thin film solar cells



Ultra-thin crystalline si solar cell

Solar Thermal Convergence

- KIER is studying on hot water, heating/cooling, thermal supply/storage, fresh water, power generation, zero-energy building/town and hydrogen production with solar and new/renewable thermal energies; and
- To guide new/renewable thermal energy resources and develop evaluation technologies.



Dish type solar concentrator (10kWe)

Major Research Fields

- 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



Zero-energy
solar house II



Solar packaged hybrid system

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



DMFC mini car

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

New and Renewable Energy Technology

Energy Efficiency Technologies and Materials Science

Marine Energy Convergence and Integration

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

Major Research Fields

- Marine energy convergence platform technologies
- Marine energy production technologies: salinity gradient (reverse electrodialysis, pressure retarded osmosis (PRO) and capmixing)
- Seawater desalination and water treatment technologies
- Useful resource recovery technologies
- Low energy consumption pre-treatment technology and process development
- 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



MVR seawater desalination



Salinity gradient power system

Energy Systems Integration

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

Wind Energy

- 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
- Integrated wind turbine design 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



Offshore wind power system

Energy Saving Technologies

- 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, 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 fuel 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

Fluidized bed drying system



Ammonia fueled vehicle, AmVeh



Green building

Energy ICTESS

- 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
- Key technologies of distributed power, micro-grid and smart-grid intelligent energy harvesting future technology
- 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

5kW slim-type vanadium redox flow battery stack



300 kVA real-time computer simulation system for microgrid

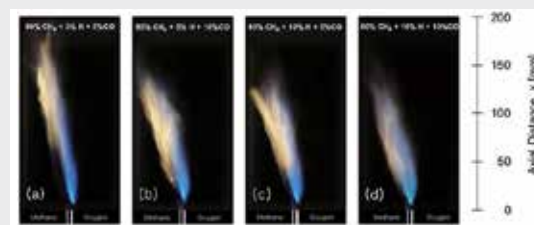
Energy Efficiency Technologies and Materials Science

Thermal Energy Systems

- 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.

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



Non-premixed turbulent oxy-fuel flame injecting from two slit nozzles



High temperature production hybrid heat pump system



Supercritical CO₂ power generation



The world's first axial-type supercritical CO₂ turbine

Energy Network

- 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.

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

- Development, optimization and performance evaluation of the cogeneration system with a prime mover (motor) such as gas engines, turbines, stirling engines, etc.

- Development of organic rankine cycle power turbine

Development and performance evaluation of high efficiency and low emission boiler system

- Wood fuel boiler system for home and industry



Pellet boiler



Organic rankine cycle power system



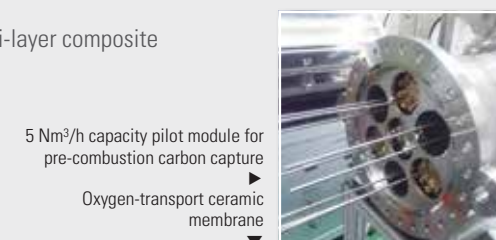
Oxygen PC boiler

Separation and Conversion Materials

- KIER is developing the nano-based materials (which overcome the limit of the next generation conversion technologies) such as solar PV, thermoelectricity and secondary battery, etc. and separation materials based on various gas membrane for maximizing the industry efficiency.

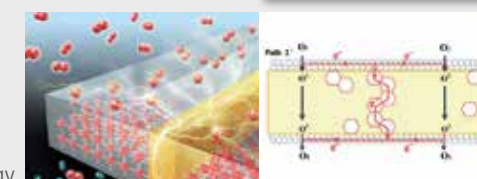
Major Research Fields

- High penetration selectivity palladium base and multi-layer composite hydrogen membrane
- Oxygen permeability ceramic membrane
- Carbon dioxide membrane capture after combustion
- High performance thermoelectricity module
- Crystalline silicon solar cell materials and module recycling
- Metal and oxides (aerogel) nano particle production and application
- Super capacitor materials
- Flow battery high performance carbon electrode technology and electrode feature analysis
- Metal-air battery core materials and element technology
- Liquid metal battery materials technology
- Cation and conductor battery materials technology



5 Nm³/h capacity pilot module for pre-combustion carbon capture

Oxygen-transport ceramic membrane



Energy Materials

- KIER is staging convergence researches on cross-cutting materials development, energy/environmental technology (ET) and nanotechnology (NT) for use as new and renewable, clean and high efficiency energy materials.

Major Research Fields

- Carbon and SiC fiber-reinforced composite materials for high-temperature applications
- Environmentally friendly bio-composites reinforced with natural fibers
- Bend-twist-coupling blade for wind turbine generator
- High-temperature alkali metal thermal to electric converter (AMTEC) elements and modules
- Materials and processing for solid oxide fuel cell (SOFC)
- Materials and stack for high performance and durable solid oxide electrolysis cell (SOEC) for hydrogen synthesis
- Metal-carbon/nano metal hybrid materials and bio carbonized chaff based catalyst materials
- Electrode materials for fuel cells and secondary batteries using carbon composites
- Adsorbent using metal organic framework (MOF) or zeolite for high CO₂ adsorption and selectivity



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

Climate Change Research Technology

Greenhouse Gas Research

- KIER is developing the greenhouse gas capture/utilization (conversion) technologies for climate change mitigation; and
- To develop clean energy (as an alternative of fossil fuels) utilization/dissemination technologies.

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/pharse separation CO₂ absorbent with low renewable energies
- CO₂ 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 (CO₂ separation, bio product concentration, desalination and natural gas hydrate production technologies)

Different reaction calorimeter for analyzing heat of absorption



10 tpd coal dryer



CO₂ recovery process using promoted K₂CO₃ aqueous solution

Clean Fuels

- KIER has contributed to the national energy security by producing clean fuels from flow-grade resources; and
- To ensure a stable supply of gas and crude oil by diversifying gas and crude oil (heavy crude oil) production, treatment, and utilization technologies.

Major Research Fields

- Low-grade fuel upgrading technology
- Low-grade fuel gasification technologies
- Development of distributed gasification power plant for export/domestic use
- CTL (coal-to-liquid) and BTL (biomass-to-liquid) technologies
- High-performance catalysts for fischer-tropsch synthesis
- Refinery and petrochemical process technologies
- Gas and liquid separation process: adsorption, distillation, absorption and crystallization
- Treatment and conversion of offshore and onshore natural gas/crude oil (FLNG, FPSO, etc.)

Fischer-tropsch synthesis reactor (capacity :15bbl/day)



KIER CTL plant



Ash-free coal production pilot plant (1 ton/day)



Biomass and Wastes to Energy

- KIER engages in and promotes researches on biomass and waste resources-energy with an aim for establishing the sustainable society without greenhouse gas emissions and ensuring the future energy/chemical resources after the oil age.

Major Research Fields

- Biofuel production from lignocellulosic biomass
- Biodiesel production from low-grade resources such as animal fat and cooking oil
- Microalgae biorefinery
- Pyrolysis of polymeric waste
- Gasification of municipal waste and production of synthetic natural gas
- Production of biofuels and chemical feedstocks from organic waste
- Catalytic conversion of N₂O gas
- Biological conversion of fossil fuels
- Heavy oil upgrading
- Bio-oil production and utilization

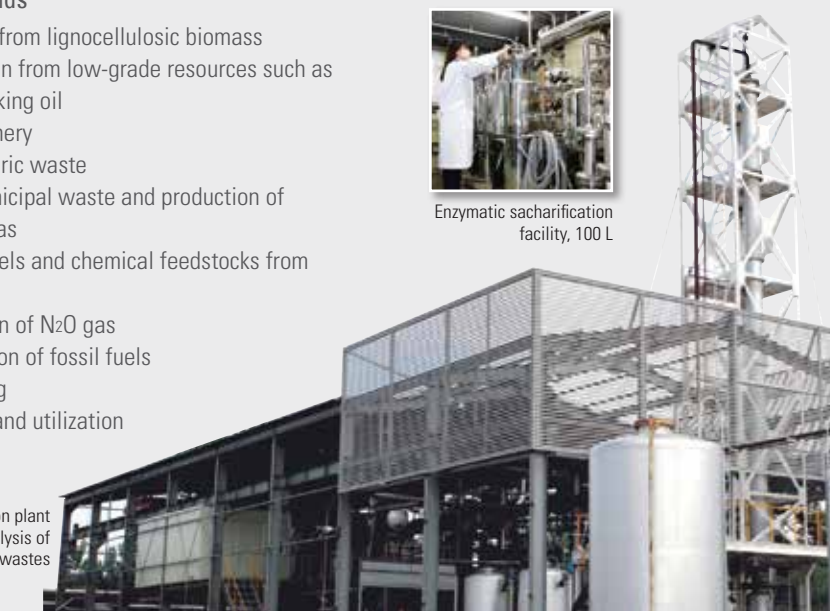


Enzymatic saccharification facility, 100 L

Photobioreactor system using sunlight and coal-firing flue gas



Demonstration plant for the pyrolysis of polymer wastes



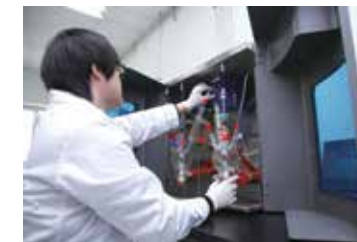
Research Outcomes Diffusion



Business Development and Cooperation

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

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



SMEs 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.

- 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

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.

- Incubation of startups, support to SMEs, demand prediction, researcher start-up support, technology-link coordination to SMEs, etc.

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

Future R&D Strategy



KOREA
INSTITUTE OF
ENERGY
RESEARCH

Energy Policy Research

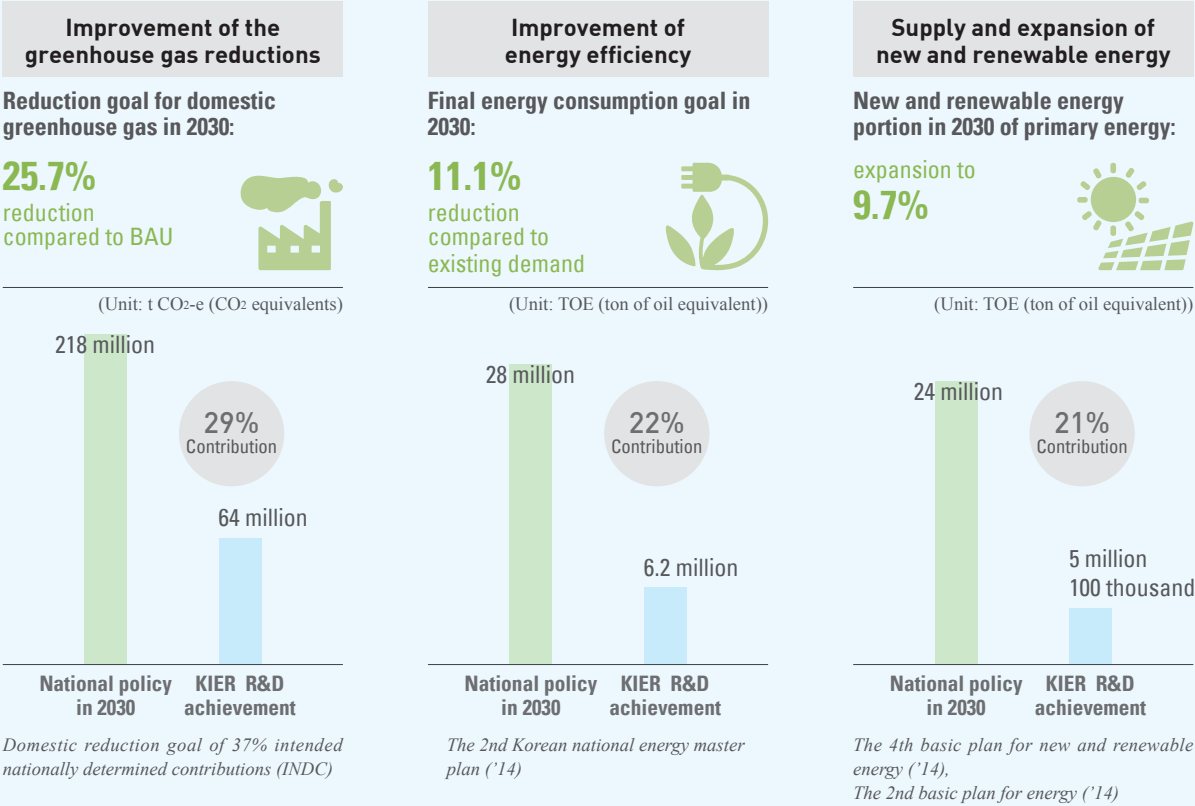
- KIER identifies/plans the future core R&D fields of researches and establishes the technical response strategies to the energy/climate change/environmental issues using the multiple criteria decision method, energy system modeling, technical feasibility analysis model, etc.
- KIER researches the policy on techno-economic ripple effects owing to development and distribution of energy technologies.

KOREA
INSTITUTE OF
ENERGY
RESEARCH

Climate Technology Strategy

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



Global Strategy



Africa

- Kumi Univ. (Uganda)

Europe

- Univ.of Twente (Netherland)
- TUBITAK MarmaraResearch Center (Turkey)
- Sakarya Univ. (Turkey)
- VTT Technical ResearchCenter of Finland (Finland)
- Univ. of Oxford (England)
- ICPF (Czech)
- DTU (Denmark)

Middle East

- King Abdulaziz Univ. (Saudi Arabia)
- Bar-Ilan Univ. (Israel)
- Tel-Aviv Univ. (Israel)
- Technion-Israel Institute of Technology (Israel)

Central Asia

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

India

- VIT University

South-East Asia

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

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.



China

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

Oceania

- CSIRO (Australia)
- SCION (New Zealand)

Japan

- National Traffic Safety and Environment Laboratory
- Niigata University

Canada

- CanmetENERGY
- Highbury Energy Inc.

Latin America

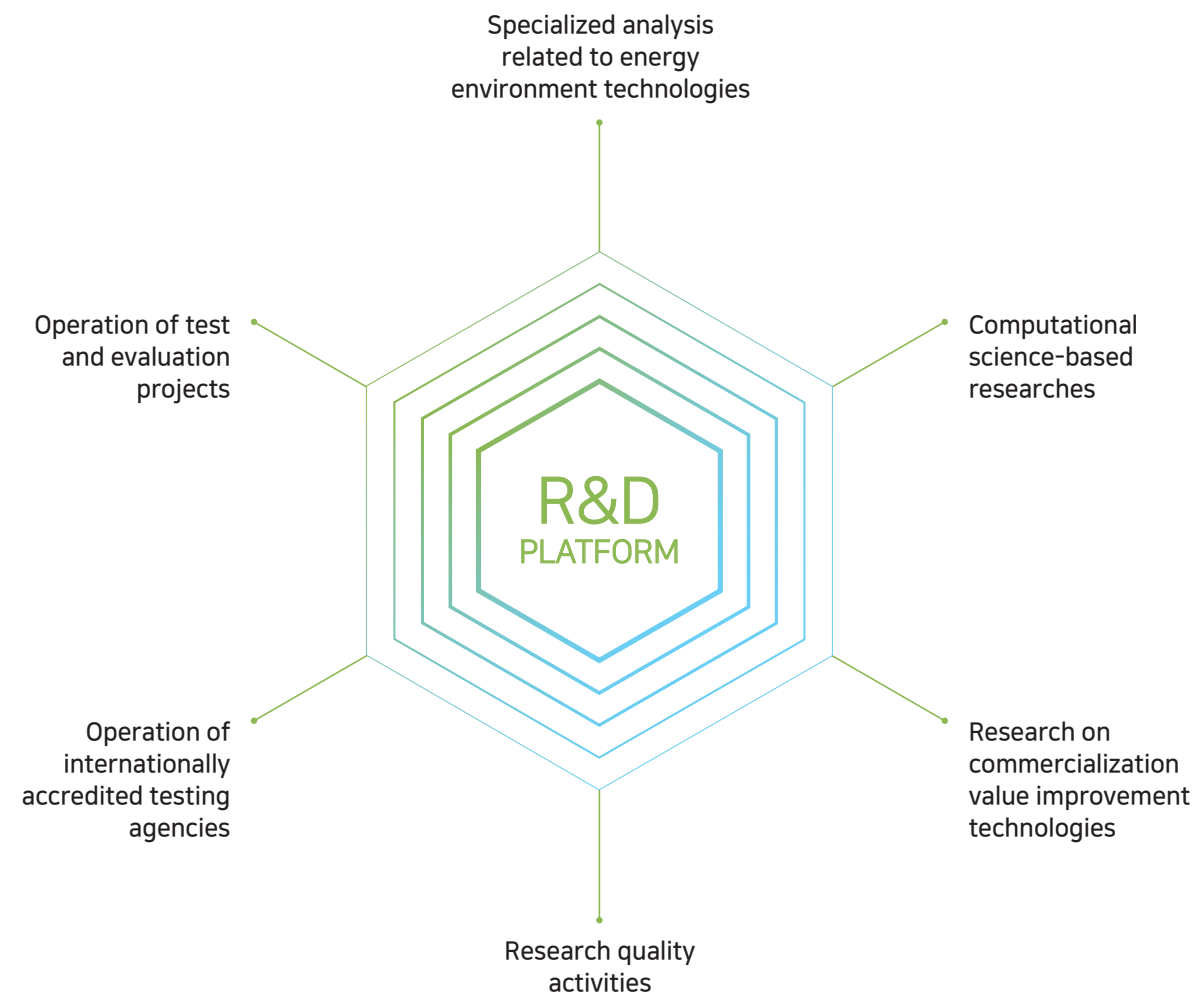
- Univ. of Antioquia (Colombia)
- COLCIENCIAS (Colombia)
- Univ. of Aruba (Aruba)

USA

- State of Montana
- NREL
- GABI
- IEC, Univ. of Delaware
- ACORE
- Univ. of Hawaii
- FAS
- UL
- NETL, DOE
- Univ.of Texas at Arlington
- Building Performance Institute, Inc. (BPI)

R&D Platform Research

KIER plays a role of studying the genetic technologies commonly available in the R&D process and innovating the R&D performance system for improving R&D quality and productivity.



FEP Convergence Research Center

www.kier.re.kr/fep

- Launched as a part of future advanced fusion research project of the National Research Institute for Science and Technology (NST)
- (※ Collaborate research institutes: Korea Institute of Industrial Technology, Korea Research Institute of Standards and Science and Korea Institute of Machinery & Materials)
- Improvement of power generation efficiency by separation of carbon dioxide sources and supercritical power generation technologies
- Solving global warming through water recovery and technology reuse



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

www.nonco2.re.kr

- Launched as a part of the ministry of environment's next-generation eco-innovation project (EI project)
- Development of the world's best non-CO₂ emission reduction technology
- Early commercialization of developed technologies and export commercialization
- Achieving GHG reduction targets through eco-friendly enterprise emissions



Center for Environmentally Friendly Vehicle

www.cefv.re.kr

- Launched as a part of ministry of environment's next-generation eco-innovation project (EI project)
- Development of low-emission and low carbon technologies focusing on automobile emission allowance standards and automobile greenhouse gas reduction technologies
- Strengthening competitiveness of the domestic automobile industry through integrated development, distribution and management of eco-friendly automobile technologies
- Leading the globalization and top 4 green car powers by advancement into the overseas advanced automobile markets

