مركز أبحاث نظم الطاقة المستدامة

INTERDISCIPLINARY RESEARCH CENTER for

Sustainable Energy Systems

2007-2024

17 Years of Research Excellence

Powering Progress with Purpose

Sustaining the Kingdom

Who We Are

PREFACE

In a rapidly growing and interconnected world, the demand for energy has seen an unprecedented rise. As modern societies become more complex and industrialized, the corresponding need for efficient, sustainable energy solutions has become crucial. The Interdisciplinary Research Center for Sustainable Energy Systems (IRC-SES), founded in 2007 by the Ministry of Education of Saudi Arabia, has been at the forefront of advocating for clean energy and promoting energy efficiency on both national and international platforms. By fostering innovation in energy technologies and engaging a wide range of stakeholders, IRC-SES aligns with the Kingdom's Vision 2030 to drive sustainable energy practices and economic diversification.

The pressing need for global energy transition—particularly within the realms of renewable energy, net-zero technologies, and climate change mitigation—requires effective advocacy and public engagement to succeed. Recognizing this, IRC-SES has spearheaded several innovative and impactful public engagement initiatives, including high-profile events such as the Saudi Arabian Renewable Energy Conference and Exhibition (SARECE). This platform brings together experts, policymakers, and key industry figures to promote awareness of sustainable energy solutions, focusing on education, research, and the deployment of cutting-edge technologies. These initiatives have reached both local and global audiences, fostering a culture of energy-consciousness within the Kingdom and abroad.

One of the primary pillars of IRC-SES's work is its commitment to delivering clear, effective messages on the importance of energy efficiency and clean energy technologies. Through digital campaigns, research publications, and international collaborations, IRC-SES has successfully elevated the conversation around energy issues. The center has also produced educational content, workshops, and training programs aimed at students, professionals, and the general public, helping bridge the knowledge gap and inspire future innovators.

The IRC-SES also stands out through its Center of Excellence in Energy Efficiency (CEEE), which focuses on intelligent energy management systems and promoting energy conservation practices across various sectors. The center’s communication strategies target both internal and external stakeholders, including government bodies, industrial partners, and educational institutions. By engaging diverse groups, IRC-SES amplifies the dialogue on sustainable practices and creates a pathway for more informed energy policies and behaviors.

One of IRC-SES's key strengths is its capacity for innovative and diverse communication strategies. Whether through social media campaigns, digital reports, or interactive webinars, IRC-SES continually seeks to refine and expand its outreach efforts. The RETI initiative, for example, has successfully educated thousands of participants on renewable energy

technologies, emphasizing the importance of energy efficiency in combating global warming and securing a sustainable future.

The center’s measurable successes include a substantial portfolio of over 300 publications, 70 patents, and numerous national and international awards, validating its role as a leader in advancing energy awareness and technological innovation. IRC-SES is committed to fostering diversity within the energy sector, ensuring that people from various backgrounds contribute to the ongoing energy transition.

In conclusion, through its impactful advocacy efforts, original messaging, and wide-reaching initiatives, IRC-SES is proud to contribute to the global dialogue on clean energy and sustainability. Our efforts reflect a deep commitment to promoting energy efficiency and clean energy technologies, making us a strong candidate for the Energy Institute's International Energy Engagement Award 2024.

IRC-SES Leadership

A Message from the Director

As global energy demands escalate, the Interdisciplinary Research Center for Sustainable Energy Systems (IRC-SES) remains committed to spearheading sustainable growth within the Kingdom. Established under the auspices of the Ministry of Education, our center is a beacon of innovation in renewable energy technologies, aligning with Saudi Vision 2030 and aiming for net-zero emissions by 2060.

At IRC-SES, we focus on developing innovative, sustainable solutions that significantly impact the economic, social, and environmental landscapes of Saudi Arabia. We facilitate cutting-edge research, enhance energy efficiency, and promote energy conservation across diverse sectors. Our efforts extend to educating future leaders in sustainable energy, ensuring that they are well-equipped to drive the nation's energy transformation.

Despite recent global challenges, including the COVID-19 pandemic, our commitment has not wavered. We continue to advance scientific research, support equitable energy transitions, and contribute to the Kingdom's status as a leader in sustainable energy.

Together, we are paving the way toward a more sustainable future, fostering innovation, and nurturing the human capital necessary to sustain and expand Saudi Arabia's energy sector.

Dr. Atif Saeed Misfer AlZahrani
Director, IRC-SES
atif@kfupm.edu.sa

About Us

IRC for Sustainable Energy Systems (IRC-SES) is committed to advancing scientific and technological progress in the realm of sustainable and renewable energy.

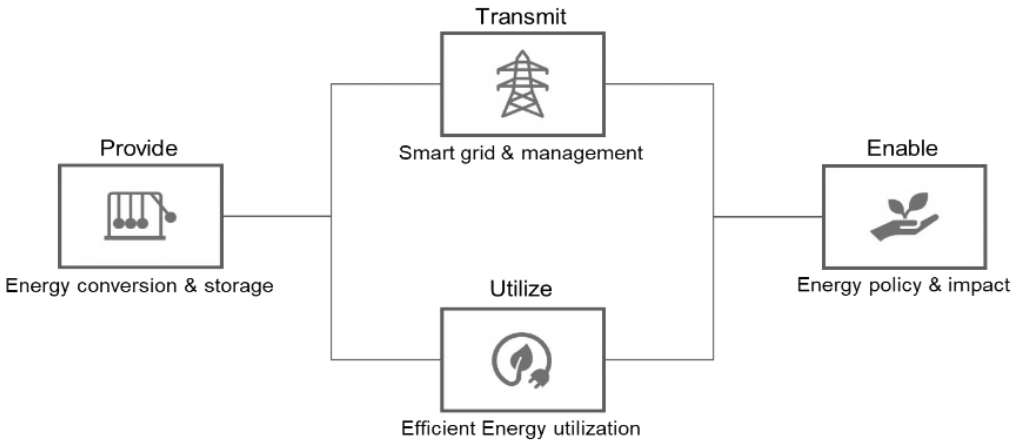
Scope of Work

IRC-SES is tackling aspects related to sustainable energy starting from providing sustainable energy, transmission, utilization and enabling through technology assessment and policy formulation.

Mission

To facilitate locally important, globally impactful sustainable energy R&D that contribute to the objectives of Saudi Vision 2030.

IRC-SES engages in pioneering projects and noteworthy initiatives aimed at enhancing the adoption and market presence of nascent sustainable and renewable energy technologies. Furthermore, the Center is dedicated to elevating public consciousness and ultimately serving the burgeoning sustainable energy sector in the Kingdom of Saudi Arabia (KSA).



Vision

Creating innovative, sustainable, and efficient energy solutions that deliver meaningful benefits socially, environmentally, and economically, meticulously aligned with the transformative aspirations of the Saudi Vision 2030.

The Interdisciplinary Research Center for Sustainable Energy Systems (IRC-SES) is at the forefront of crafting innovative, sustainable, and efficient energy solutions, each meticulously designed to offer profound social, environmental, and economic benefits. This commitment is in direct alignment with the transformative aspirations of Saudi Vision 2030, underlining the center's pivotal role in the Kingdom's energy transition. By focusing on groundbreaking research and development, IRC-SES is not just responding to today's energy challenges but is actively shaping a future where sustainable energy is a cornerstone of societal advancement, environmental stewardship, and economic prosperity in Saudi Arabia and beyond. Through its efforts, IRC-SES embodies the vision of a nation dedicated to leading the global energy transition, making significant strides towards a more sustainable, efficient, and inclusive energy landscape.

Awards

IRC-SES, is honored to have received numerous international and national accolades, recognizing us as the premier research unit in Saudi Arabia for our pioneering and unparalleled contributions to renewable and solar energy research.

Additionally, our commitment to human capital development and student training programs has earned us esteemed regional awards, further affirming our leadership in fostering educational excellence within the energy sector.

Grand Challenges

IRC -SES is diligently engaged in addressing critical national objectives, which include:

1. Elevating the contribution of renewable energy sources to approximately 50% of total electricity generation by the year 2035.
2. Ascending to become the fourth largest producer of electric vehicles (EVs) and EV batteries by 2030.
3. Achieving net-zero emissions by the year 2060.
4. Reducing the cost of clean hydrogen to less than $1 per kilogram by 2030.
5. Promoting the reuse of raw materials and products within the industrial sector.

What We Do

Focused Research and Development (R&D) Clusters

The IRC-SES is structured around the following key research areas that are essential to advancing the Kingdom's energy transition and sustainability goals. This interdisciplinary approach allows the center to play a pivotal role in driving innovative solutions and supporting the Kingdom's shift toward clean energy. The focused R&D clusters at IRC-SES include, but are not limited to:

- Energy Conversion & Storage
- Smart Grid Technologies & Management: Development of resilient energy distribution systems, Advanced communication, and automation technologies.
- Efficient Energy Utilization: Energy Management
- Energy Policy Assessments & Impact: Crafting comprehensive standards and policies, aligned with the national sustainability goals.
- Renewable Hydrogen Energy:
- Innovative Storage Solutions, Battery Technologies & EV's

Energy Solutions

IRC-SES provides a range of exclusive, customized energy solutions and client services designed to address the unique needs of each client:

- We assist clients in navigating critical challenges and implementing initiatives that enhance their strategic objectives and generate shareholder value.
- Our services cater to clients across all major alternative energy sectors, including solar energy, energy storage and conversion, renewable energy integrated systems, solar cooling systems, grid connections, and energy efficiency.
- We publish the latest research outcomes and conduct up-to-date critical analyses, enabling clients to stay informed about the rapidly evolving alternative energy technologies and market dynamics. Our insightful materials offer a blend of practical and visionary solutions.
- We offer high-quality seminars, workshops, and conferences that tackle significant issues in alternative and clean energy.
- Additionally, we provide debriefs from our practice, offering valuable insights into significant developments affecting the industry. Our advisory services help clients manage strategic, financial, operational, technological, and regulatory risks to maximize enterprise value and advance with confidence.

Planning & Delivery

Public-private partnership and collaboration with industry, government, and university partners

The evaluation of energy consumption practices and the exploration of conservation opportunities for industrial clients have historically been influenced by the cost of energy resources. Initiated by the oil embargo of the 1970s, there has been a growing interest in the efficient operation of industrial activities, correlating closely with manufacturing costs. This focus has expanded the study of resource utilization into broader domains such as waste minimization, pollution prevention, and productivity enhancement.

IRC-SES is built upon a robust foundation of public-private partnerships, collaborating with industry, government, and academic institutions to address the pressing demands for innovation in energy efficiency, business development, and the cultivation of a skilled workforce.

In collaboration with the Saudi Energy Efficiency Center (SEEC), the Saudi Energy Efficiency Program (SEEP), King Abdulaziz City for Science and Technology (KACST), and under the advisory and guidance of the United States Department of Energy (US-DOE), IRC-SES spearheads the following leading programs:

- Energy Efficiency Education, Training, and Short Courses (EETC)
- Energy Efficiency Assessments Program (EEAP)
- Energy Efficiency Standards & Policy Development (EESPD)
- Energy Efficiency Applied Research Projects (EEARP)

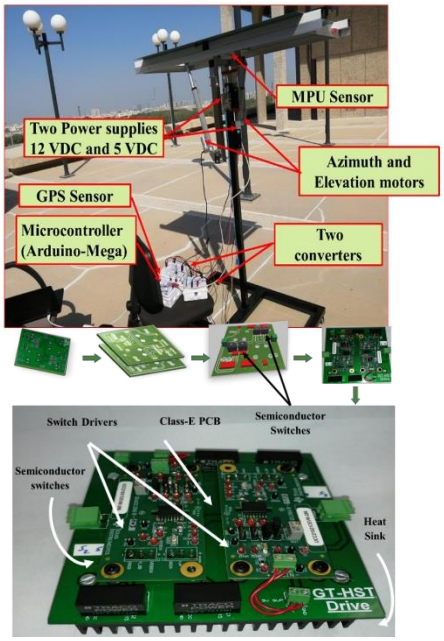
These initiatives are integral to our mission to enhance sustainable industrial practices and foster an environment conducive to continuous improvement in energy management.

IRC-SES Laboratories & Scientific Facilities

- Renewable Energy Materials Laboratory (REM)
- Solar Cells Characterization Laboratory (SCCL)
- Photovoltaic Outdoor Testing Facility
- Energy Efficiency and Management Laboratory
- Solar Air Conditioning System
- Thin Film Fabrication and Characterization Laboratory
- KFUPM Solar Beach Laboratory

Renewable Energy Materials Laboratory (REM)

The REM laboratory is equipped with state-of-the-art facilities designed to pioneer advancements in materials crucial for renewable energy technologies. It hosts a wide array of sophisticated equipment capable of synthesizing, characterizing, cell fabrication, and testing novel materials that can enhance the efficiency and durability of solar cells, batteries, and other renewable energy systems. Key capabilities include high-resolution microscopy, spectroscopy tools, and environmental testing chambers that simulate a range of operational conditions. The REM Lab is a critical resource for researchers aiming to develop the next generation of materials that lower costs and improve the performance of renewable energy technologies, thereby making sustainable solutions more accessible and effective across the globe.



Solar Cells Characterization Laboratory (SCCL)

The SCCL is a cutting-edge facility dedicated to the advancement and testing of photovoltaic materials and devices. It provides comprehensive analytical capabilities to evaluate the performance, efficiency, and durability of various solar cell technologies under different environmental conditions. This laboratory enables researchers to conduct detailed assessments of new solar cell designs, and their stability testing, from small-scale prototypes to commercial-sized panels, ensuring that viable and sustainable innovations in solar technology can be effectively translated into real-world energy solutions.

Photovoltaic Outdoor Testing Facility

The PV outdoor facilities are specifically designed to assess the performance and reliability of photovoltaic (PV) technologies in real-world environmental conditions. They feature advanced tracking systems that maximize solar exposure and a variety of monitoring equipment to rigorously evaluate the energy output, efficiency, and degradation of PV modules over time. Capable of testing under different harsh climatic conditions, this outdoor facility provides invaluable data on how solar panels perform under the heat, dust, and variable sunlight typical of real-world settings. The insights gained here are crucial for optimizing PV system designs and enhancing their adaptability and endurance, thereby promoting more robust and efficient solar energy solutions.

Energy Efficiency and Management Laboratory

This dry lab is a state-of-the-art facility dedicated to improving energy utilization across various systems and technologies. It is equipped with multiple workstations, and advanced instrumentation for analyzing energy consumption patterns and testing energy-saving technologies in simulated real-life environments. Capabilities include detailed thermal imaging, airflow analysis, and efficiency diagnostics for HVAC systems, lighting, and insulation materials. The laboratory provides a robust platform for researchers and industry professionals to develop, test, and refine strategies and innovations that enhance energy efficiency, reduce operational costs, and contribute to environmental sustainability. Through its comprehensive testing and optimization processes, the lab plays a crucial role in training students and professionals for the purpose of advancing energy conservation initiatives and promoting smarter energy management practices.

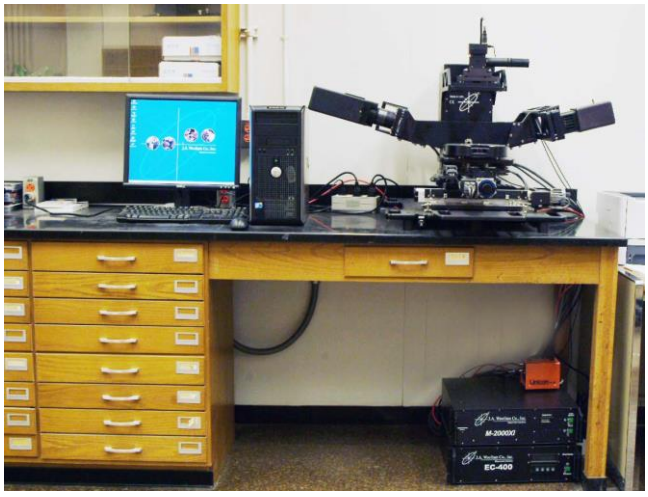
Solar Air Conditioning Systems Laboratory

This facility represents a groundbreaking integration of photovoltaic technology with modern air conditioning systems utilized in real-time at a KFUPM bus station located near its Research Institute. This innovative project harnesses solar energy directly to power a Variable Refrigerant Flow (VRF) system, providing eco-friendly, efficient cooling for the station. It is equipped with high-efficiency solar panels connected to an inverter that optimally converts solar power to run the air conditioning units, along with data loggers and smart meters to transmit data in real-time. This system not only reduces reliance on traditional energy sources but also demonstrates significant potential in reducing operational costs and carbon emissions. Its deployment at our bus station serves as a practical model of sustainable urban infrastructure,

showcasing the viability of solar-powered public utilities in enhancing urban comfort and environmental health.

Thin Film Fabrication and Characterization Laboratory

This facility is a specialized dry lab meticulously designed for the development and analysis of thin films, crucial components in various advanced technologies. This laboratory is equipped with cutting-edge facilities to fabricate thin films using techniques such as sputtering, evaporation, and chemical vapor deposition. Additionally, it houses advanced instrumentation for characterizing the optical, electrical, and electronic properties of these films. The capabilities include spectrophotometry, ellipsometry, and electrical resistivity measurement setups, enabling researchers to gain detailed insights into material behaviours and optimize their applications in photovoltaics, electronics, and energy-efficient coatings. This lab provides a comprehensive environment for pushing the boundaries of material science and enhancing the performance of energy-related technologies.

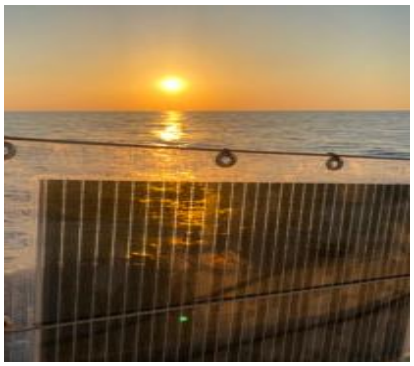


KFUPM Solar Beach Laboratory

The KFUPM Solar Beach Laboratory boasts an array of specialized equipment designed to advance research in renewable energy technologies. Key facilities include:

1. Wind Speed Profiler: This sophisticated tool provides precise wind speed data essential for evaluating and optimizing wind energy solutions.
2. Power System Studies Equipment: This includes setups for both off-grid and grid-connected scenarios, allowing comprehensive studies on power system dynamics and integration techniques.
3. Remote Power Supply Capabilities: Designed to study and implement solutions for supplying power to remote locations, which is crucial for enhancing the accessibility and reliability of renewable energy sources.
4. Solar Thermal System: Equipped for testing Indirect Direct Evaporative System Performance, this system is pivotal in optimizing solar thermal applications for cooling and heating.
5. Meteorological Measurement Instruments: These are critical for gathering data on local weather conditions, enabling precise calculations and adjustments for renewable energy applications, particularly in solar and wind energy projects.

Together, these facilities empower the beach laboratory to conduct groundbreaking research and development, positioning it as a leader in the study and the deployed application of renewable energy technologies.




Energy Efficiency & Management Division at a Glance

Establishing a framework for disseminating knowledge and training

The Center of Excellence in Energy Efficiency (CEEE), a subsidiary of IRC-SES at King Fahd University of Petroleum & Minerals (KFUPM), was inaugurated in October 2016. Supported by the Saudi Energy Efficiency Program (SEEP) and funded by King Abdulaziz City for Science and Technology (KACST), CEEE was established as part of the Saudi Energy Efficiency Center (SEEC) initiative in alignment with Saudi Arabia's Vision 2030. The center is dedicated to fostering sustainable development, enhancing energy efficiency, and advancing modern energy technologies and services across the Kingdom of Saudi Arabia (KSA).

This division offers a range of public services including knowledge dissemination, training, support for research and development, promotion of innovative technologies, and public awareness campaigns on energy efficiency. It also focuses on technology transfer and applied research within the Kingdom.

The center's Training and Capacity Building program equips stakeholders—including students, engineers, and industrial professionals—with essential skills and knowledge related to energy efficiency, its role in sustainable development, and environmental protection. CEEE regularly conducts workshops, seminars, and training sessions to enhance understanding of energy efficiency benefits, and teach energy conservation practices while emphasizing environmental stewardship.

Equipped with advanced educational and research facilities, including a Databases Server, Energy Auditing Measuring Instruments, and Energy Modeling Software, IRC-SES supports energy audits and assessments for various sectors. Additionally, within KFUPM, we have established a Student Energy Club that encourages student involvement in energy efficiency through annual competitions and projects, such as the design of sustainable and cost-effective energy materials. This initiative also trains participants to develop reliable energy management systems for buildings and industries, exploring innovations like smart buildings through distributed simulations.

Advisory & Executive Governing Board

Improving energy efficiency and resource management

The IRC-SES sub-division CEEE's governing advisory and executive board that oversee and supervises its operations include members from:

- King Abdulaziz City for Science and Technology (KACST)
- Saudi Energy Efficiency Center (SEEC), Director General
- Ministry of Energy, KSA
- Dean of Research, KFUPM
- Dean of College of Engineering, KFUPM
- Vice President of Research and Innovation, KFUPM
- Director, IRC-SES
- Association of Energy Engineers (AEE)
- Industrial Experts from Saudi Aramco
- Faculty members from Mechanical, Electrical, and other Engineering Disciplines, KFUPM.

Partner Entities & Strategic Alliances

A JOURNEY OF SPLENDID PARTNERSHIPS FOR A NOBLE CAUSE

IRC-SES is committed to enhancing energy efficiency across Saudi Arabia and the broader Middle East region. As a national university center, it was established with the backing and funding of the King Abdulaziz City for Science and Technology (KACST) under the auspices of the Saudi Energy Efficiency Center (SEEC), and with advisory support from the US Department of Energy (US-DOE). The center actively contributes to Saudi Arabia's Vision 2030 by fostering sustainable development through energy efficiency and renewable energy solutions, and by advancing modern energy technologies and methods within the nation.

The center offers a range of services aimed at improving energy efficiency and management. These include disseminating knowledge through training courses, supporting research and development, promoting innovative technologies and new ideas, and enhancing public awareness. Additionally, the center strives to facilitate technology transfer and foster applied research throughout the Kingdom.

KFUPM

King Fahd University of Petroleum & Minerals (KFUPM)

King Fahd University of Petroleum & Minerals (KFUPM) is a leading educational organization for science and technology. Since its inception in 1973, the University enrollment has grown to more than 10000 students.

Teaching and Research are the main two core functions of KFUPM. The vision is ambitiously drafted to reflect the aspired outcomes of both. Global Competitiveness of graduates requires that they are prepared with high knowledge, sharp skills, real ethics and instilled leadership. Carrying cutting-edge research in all its fields will enable KFUPM to make scholarly impact and contribute to national needs. In addition, as KFUPM is focusing in its research and technology development on energy and its related fields, it aims to achieve leadership in this challenging area. In all of these ambitious stands, KFUPM strives to be a preeminent institution worldwide.

While the mission of almost every higher education institution is centered around the three key components of teaching, research, and community service, KFUPM is committed to make a difference in all what it does. This distinct contribution is to be witnessed in the Kingdom of Saudi Arabia and beyond, keeping its focus on the fields of sciences, engineering and business. KFUPM's mission highlights the main characteristics of its graduates which should make them ahead of their peers. Research will make a difference only when it is creative and innovative. While addressing global trend and making a scholarly impact in research, KFUPM is giving essential local needs the appropriate attention. Finally, KFUPM believes that engagement with the society is an opportunity to partner with its key stakeholders, contribute to the prosperity and intellectuality of the community, and enrich the experience of KFUPM community.

جامعة الملك فهد للبترول والمعادن
King Fahd University of Petroleum & Minerals

KACST

Supporting the National Research, Development and Innovation Strategy

King Abdulaziz City for Science and Technology (KACST) is a scientific government institution that supports and enhances scientific applied research. It coordinates the activities of government institutions and scientific research centers in accordance with the requirements of the development of the Kingdom of Saudi Arabia. It also cooperates with the relevant authorities in identifying national priorities and policies to build a scientific and technological basis that serves development in various sectors. It also provides opportunities for the development of national competences and recruitment of highly qualified specialists to support development in the Kingdom. KACST is home to laboratories, facilities and resources to enable and support scientists across the country.

KACST has introduced a national plan for science, technology and innovation, the National Industrial Development and Logistics Program (NIDLP) and scientific support services for universities and research centers. Its technical support includes providing the Internet service through the Saudi Research and Innovation Network (Maeen), technical services, electronic and security archiving.

KACST has implemented research and development projects in 15 vital sectors that contribute to economic growth and sustainability. It also continues to support and develop industrial innovation centers program and enhancing the work of business incubators, accelerators and the Industry 4.0 program. KACST's vision is to be a pioneer organization in science and technology by supporting innovation and fostering scientific research to promote the industrial development in the Kingdom of Saudi Arabia. It invests in scientific research and technological advancements to serve national development in the Kingdom through the following objectives:

- Providing support for scientific research and technological development.
- Conducting applied scientific research and technological development.
- Coordinating national activities in the fields of science, technology and innovation.
- Strengthening local and international partnerships for technology transfer, localization and development.
- Providing consultations, services and innovative solutions.
- Investing in technology development and its commercial processes.

مدينة الملك عبدالعزيز
للعلوم والتقنية KACST

SEEC

Setting national programs for energy efficiency and determining their indicators, objectives, plans, and policies.

The Saudi Energy Efficiency Center (SEEC) is the key entity and unique interface responsible for the whole energy efficiency sector in the kingdom. SEEC was established in 2010 with aim to rationalize and increase the energy efficiency in production and consumption in order to preserve the KSA natural resources and enhance the economic and social welfare of KSA population.

In 2012, the national program to rationalize and increase the efficiency of energy consumption called "Saudi Energy Efficiency Program" was launched as a framework for a system coordinates energy efficiency efforts in KSA. In addition to the Center, it includes a number of specialized government authorities, some governmental institutions and companies, and the private sector.

SEEC program objectives include improving and raising the efficiency of energy consumption in three key sectors, occupying over 90% from the primary energy consumption, which are: Industry, construction and land transport, as the program contributed to launch energy efficiency initiatives, in cooperation with more than 30 government and semi-government authorities through work teams that developed more than 80 initiatives in different stages.

SEEC's major strategic objectives include:

- Improve energy efficiency consumption.
- Improve energy efficiency production.
- Ensure compliance and abidance of energy efficiency regulations and standards.
- Encourage investment and finance, business development, and local content in the energy efficiency field.
- Spread awareness of the importance of rationalizing in increasing energy efficiency.
- Qualify and develop human cadres and provide consultations in the field of energy efficiency.

المركز السعودي لكفاءة الطاقة
Saudi Energy Efficiency Center

US DOE

United States of America – Department of Energy

The United States Department of Energy (DOE) has one of the richest and most diverse histories in the federal government. It is a cabinet-level department of the United States government concerned with the United States' policies regarding energy and safety in handling nuclear material. Its responsibilities include the nation's nuclear weapons program, nuclear reactor production for the United States Navy, energy conservation, energy-related research, radioactive waste disposal, and domestic energy production.

Mission Statement

Fulfill the Department of Energy’s post-closure responsibilities and ensure the future protection of human health and the environment.

Goals

- ✓ Goal 1 - Protect human health and the environment
- ✓ Goal 2 - Preserve, protect, and share records and information
- ✓ Goal 3 - Safeguard former contractor workers’ retirement benefits
- ✓ Goal 4 - Sustainably manage and optimize the use of land and assets
- ✓ Goal 5 - Sustain management excellence
- ✓ Goal 6 - Engage the public, governments, and interested parties

U.S. DEPARTMENT OF ENERGY

AEE Saudi Chapter

Association of Energy Engineers

The Association of Energy Engineers (AEE) is a not-for-profit professional organization of 18,000 members in 100 countries. Its mission is to promote energy efficiency and sustainable development worldwide.

The Saudi AEE Chapter’s objective is to increase the level of awareness and technical knowledge within the professional community across the Kingdom in the dynamic fields of energy efficiency, energy management, renewable energy, sustainability and related areas.

AEE KSA Chapter's mission is to promote the scientific and educational interests of those engaged in the energy industry and to foster action for sustainable development in the kingdom which support Saudi Arabia's Vision 2030.

AEE has a dedicated group of over 18,500 professionals as members in more than 100 countries with over 90 local and international chapters committed to helping their firms or clients increase energy efficiency, utilize innovative energy service options, enhance environmental management programs, upgrade facility operations, and improve equipment performance -- while at the same time bolstering their organizations' bottom lines.

Association of Energy Engineers | Saudi Chapter

KACARE

Energy Research and Innovation Center (ERIC)

KACARE Energy Research and Innovation Center (ERIC) as an extended collaborative initiative of IRC-SES director oversees a Fellowship program representing K.A.CARE's universities collaborative initiative for enhancing and developing cooperation with leading educational institutes locally and globally in the fields of research, innovation, education, training, and advisory services to support scientific research in the fields of Atomic and Renewable energy and develop human capacity through utilizing the research capabilities of universities and developing them to achieve real research results within the technical fields that K.A.CARE focus on them.

ERIC at the university is a centre that supervises and monitors the work progress of programs activities of the collaboration agreement between K.A.CARE and KFUPM.

The program aims to come up with new research works, results, and technologies which serve the vision of K.A.CARE in the field of renewable energy, and hence, the Kingdom's Vision 2030. Through KFUPM, IRC-SES and ERIC we have generated an excellent number of scholarly outcomes as result from this grant.

ERIC's fellowship research streams include:

1. Renewable Energy (RE) Systems
2. RE Technologies
3. Sustainability Studies
4. Solar Thermal Applications
5. Renewable Energy in Water Management
6. Power and Grid Management
7. Geothermal Energy
8. Energy Storage
9. Green and Blue Hydrogen
10. Waste To Energy
11. Nuclear Energy

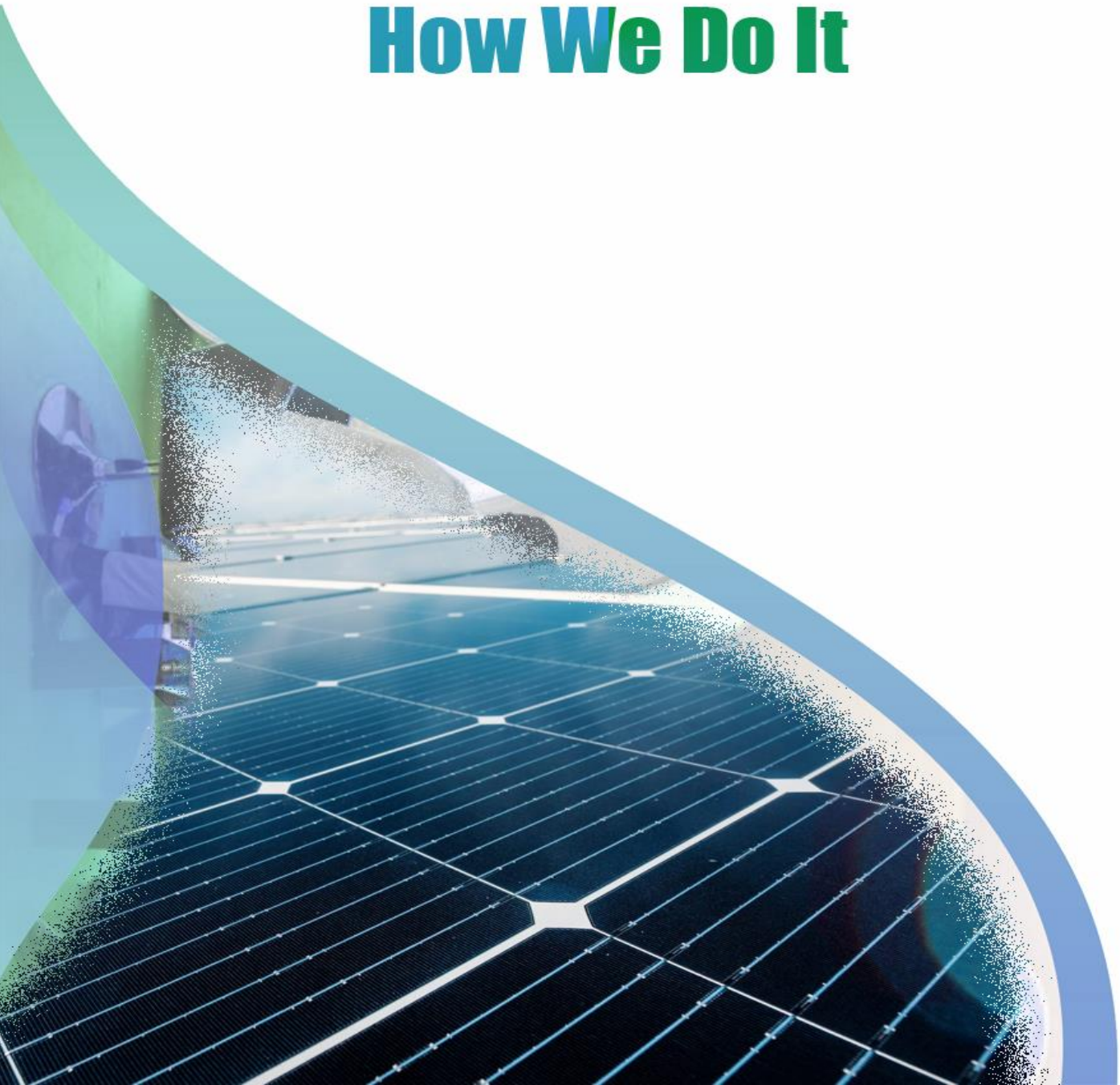
Under this program, 39 Faculty were nominated for KACARE research fellowship during the academic years from 2020 to 2022. This program also facilitated select 4 candidates to pursue postdoc at KFUPM.

مدينة الملك عبد الله للطاقة الذرية والمتجددة K·A·CARE


Nurturing
Knowledge Based
Ventures
ENERGY EFFICIENCY (CEED)
VISION
MISSION
OBJECTIVES
aee
The Association of
Energy Engineers


MAX
EFFICIENCY
EFFICIENCY
LEVEL

How We Do It

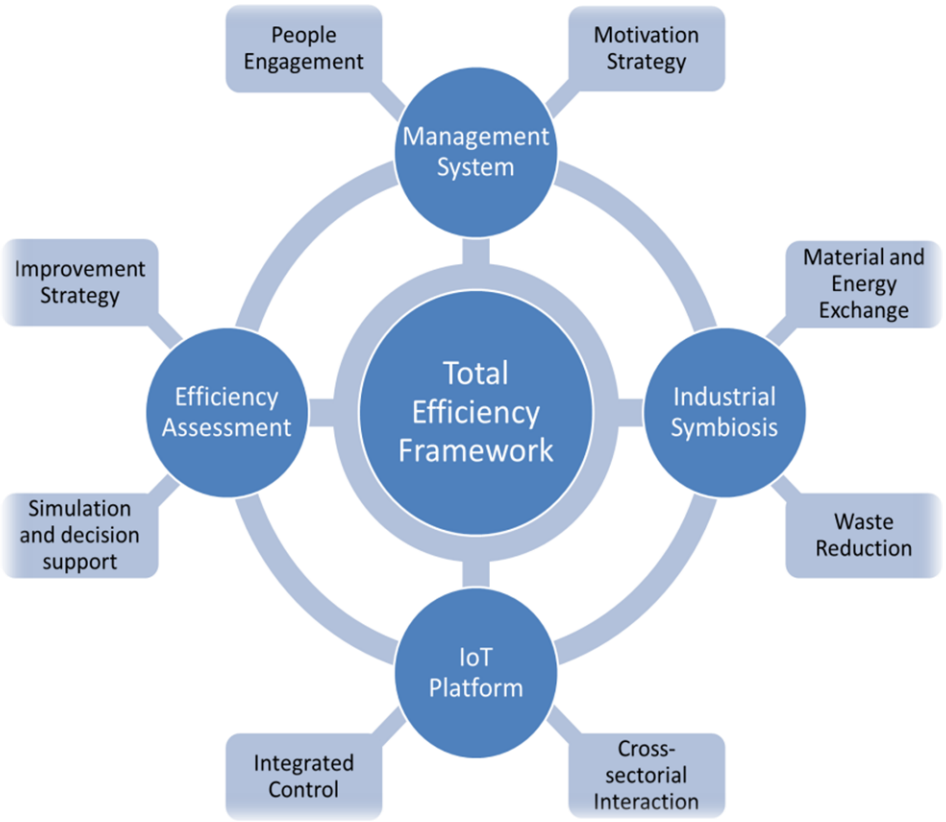


Innovation

Improving energy efficiency and resource management

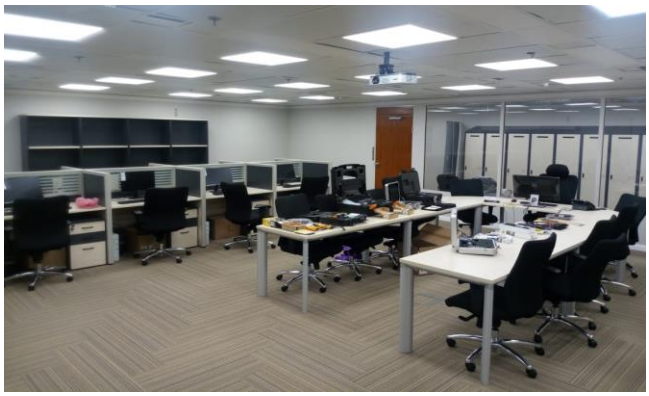
IRC-SES's various innovative activities through projects and efforts include:

- Capacity building of the IRC-SES-team's energy efficiency and management, particularly in energy audits.
- Theoretical and hands-on practices for COOP students to conduct energy audits and assessments professionally.
- Experiencing ASHRAE methodology for conducting energy auditing in buildings, especially with a tangible approach to cost effective monitoring and control of uniform indoor air-temperature.
- Developing technologies to remotely control building services and appliances via Internet
- Installing PV systems to supplement a portion of the energy needs.
- Writing and preparing detailed reports on identified possible opportunities for energy savings in KFUPM mosques.
- Submitting an application for LEED certification to certify the chosen mosque as a Nearly Zero Energy Building (nZEB).



Laboratory, Database Server & Energy Audit Equipment/Tools

IRC-SES established an Educational and Research Laboratory that promotes the theoretical and practical training, holding meetings, carrying out office-related work, and conducting research in energy efficiency. On March 05, 2020, delegates from the US consulate have visited the laboratory and were impressed by the facilities and high-tech energy audit measuring instruments, equipment and tools that we have acquired.

Picture of the Educational and Research Laboratory

The lab is well furnished with State-of-the-Art. Energy Auditing Measuring Instruments, Equipment, and Tools as well as Energy Efficiency Standards and Policies, and Energy Modeling Software tools to support energy audits and assessment for industries, buildings, and other end energy users. With such capabilities, any detailed energy audit can be conducted and performed to identify energy-saving potentials and provide assessment recommendations that benefit any building and/or industrial facility with the aim of reducing or managing energy consumption without compromising the comfort and wellbeing of building occupants.

Pictures of Measuring Instruments, Equipment, and Tools for energy auditing

Database Server

Interactive platform for record storage and access

Being inspired by and cooperating with the US -DOE, IRC-SES has provided a web-based database server to mainly store all records of its projects conducted for buildings and industries. The server has a user interface suitable for both search and browsing of all stored data and information gathered during the audit of energy projects and studies to help clients, especially industries, keep up to date on their energy savings. This also offers a very interactive platform for local industries, faculty members and students to find energy saving ideas via reading the recommendations accumulated over years through conducted energy projects and studies.

Web-based Databases Server

Energy Efficiency And Management

IRC-SES uses various pedagogical techniques – theoretical lectures and practical applied courses – as means for stakeholders (i.e., participating students, engineers and other professionals) to understand the importance of energy efficiency in buildings and industries, to create awareness on energy conservation and environmental protection, and to acquire applied strategies for improving energy efficiency management and effectiveness of smart buildings. The following is a brief description of some of the training courses offered by us

Theoretical Aspects of Training, include:

- Safety and Precautions to prioritize health and safety considerations when conducting an energy audit.
- Energy Audit and its Levels to highlight to the stakeholders the meaning of an energy audit, then the importance of conducting it to assess energy consumption and measures of energy savings.
- Energy Conservation and Environmental Protection to teach stakeholders – via organized workshops and interactive sessions – about promoting energy conservation and cultivating good energy use habits and to take steps to encourage the use of renewable energy sources.
- Sustainability to train stakeholders on sustainability to enable them to improve energy efficiency while taking the necessary actions in reducing risks and increasing competitive awareness.
- Energy and Comfort Management to teach stakeholders (or participants) about the importance of environmental protection and challenges that affect us all today.

Practical Aspects of Training, where stakeholders are provided with hands-on learning experience on the use of measuring instruments and tools while conducting energy audits and measurements in buildings and industrial facilities, such as:

- **Preliminary Energy-Use Analysis** to teach the stakeholders (or participating students) about the practice of analyzing and evaluating the monthly bills of electricity, gas, and water.
- **Technical Manipulation of Measuring Instruments, Equipment and Tools to equip the stakeholders** (or participating students) with sufficient knowledge and skills of how to use or manipulate energy audit measuring instruments, equipment and tools to perform the accurate measurement.

- **Conducting Energy Audits and Analysis** to train the stakeholders on how to conduct a detailed energy audit and visually analyze all systems that a building or industry facility has, and then provide them with the operations and maintenance (O&M) best practices guide, developed by the U.S. DoE, to achieve operational efficiency within that building or industry facility.

- **Implementation of Energy Efficiency Measures** to train the stakeholders (or participating students) how to implement energy efficiency measures in the form of awareness programs by using, for example, stickers and signs to remind occupants to "Turn-Off the artificial lighting" and/or "Shut the sash" when leaving the premises inside the University.

Pictures of student volunteers placing stickers/signs for energy saving at KFUPM premises

- **Implementation of Renewable Energy projects** to enlighten the path of stakeholders and move towards clean and renewable energy. For instance, IRC-SES equipped a Bus-Stop – located inside the KFUPM campus – with solar photovoltaic (PV) panels on the roof to fully power its Air-Conditioning (AC) system through climate control to ensure occupants' thermal comfort and to export the surplus energy back to the grid when production is higher than consumption. 7,109 kWh – from which 92 kWh was an excess power sent back to the grid – and saved the equivalent of more than 1.5 tons of carbon dioxide.

Solar PV roof top air conditioned Bus-Stop in the KFUPM campus (left) aided with smart meter (left)

- **COOP students,** thus the center developed a training program of 28-weeks for graduating KFUPM students under cooperative learning (so-called COOP students) either to recruit and train them with theoretical and practical knowledge in Energy Efficiency and Management or to support ongoing students' strength in that field during their work experience in industry.

Announcement of COOP training and picture of recruited students taken during their work experience

Pictures of COOP training students - with our members - taken during their work experience in industry

- **Students Exchange Program**, where the center encourages KFUPM students to participate in the international exchange program for one academic semester or year to gain global perspective in Energy Efficiency and Management, and thus far the Center permitted 11 undergraduate students to study aboard: 2 at Arizona State University and 9 at the University of Florida.

Specialized, Custom and Certified Training Programs

The following is the list of training programs offered:

Specialized Training

- Training in conducting energy audits and assessment in buildings and industries
- Training in using measuring instruments and learning the instruction for taking measurements
- Training in basic, state of the art and advanced building performance simulation
- Training in indoor climate control fundamentals: lighting, HVAC and energy built environment
- Training in analysis and design of control systems for building performance applications

Custom Training

- Training in developing requirements for energy-efficient buildings design
- Training in using specific software tools for simulation of environmental systems performance
- Training in using distributed simulations for Building Energy Management Systems (BEMS) or Building Automation System (BAS) technology (or architecture)

Certified Training

- Training in certified “Energy Auditing and Assessment of Buildings and Industries”
- Training in certified “Simulation Based Design Tools for Energy Efficient Buildings”
- Training in certified “Measurement and Verification (M&V) certification”
- Training in certified “Energy Management Certification” (ongoing)
- Training in certified “ISO 50001 certification” (ongoing)
- Training in certified “LEED certification” (ongoing)
-



Professional Development Programs

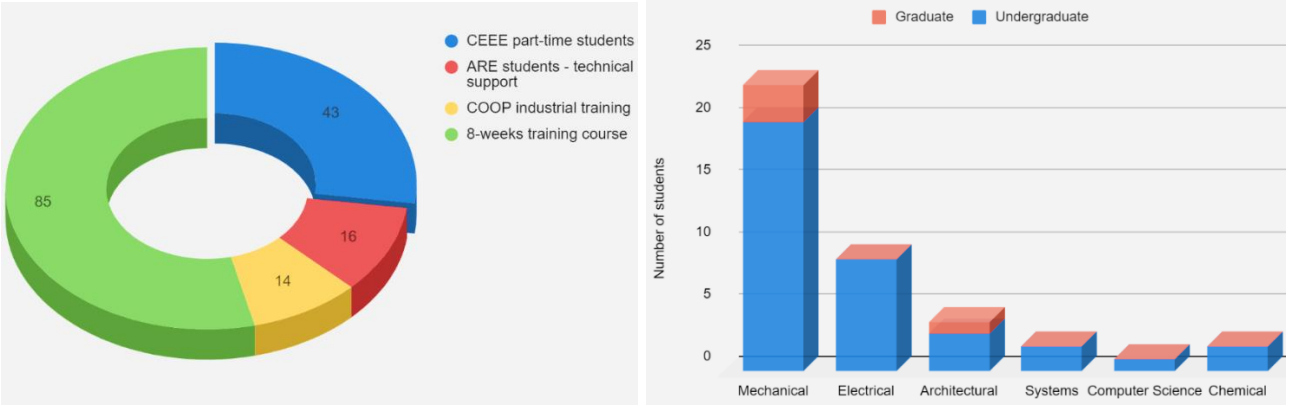
IRC-SES attaches' great importance to the training and development of students as well as of its employees, and thus its employees are generally regarded as the most valuable asset in achieving long-term success for the Center. Therefore, in-house and external (or outsourcing) training programs are part of our main goals.

In-House Training

- Theoretical and practical training is offered on Energy Efficiency and Management to all KFUPM students joining the Center, thus resulting overall in 160 students. The center has also initiated an online 8-weeks certified training program on "*Simulation based Design Tools for Energy Efficient Buildings*" since summer 2020; and so far, 35 received the certificate among 82 students attended the training.
- IRC-SES currently provides 28-weeks COOP training, as a full-time internship, to 6 students in "*Energy Auditing and Net-Zero Building Design*". Furthermore, the center continuously assures training and development to its employees and students whenever it procures new measuring equipment and tools.
- SURE (Summer Undergraduate Research Experiences) training to 2 undergraduate students on "Design Controls for Lighting and Daylighting in an Office Building" and "Camera-based Worshippers Number Detection in the Mosques".

External Training

- Certified Energy Manager (CEM) training was offered to 6 affiliates who have completed the training by Association of Energy Engineers (AEE).
- Certified Energy Auditor (CEA) training was offered to 4 affiliates who have completed the training by Association of Energy Engineers (AEE).
- The center also sponsored 2 of our affiliates for 2-months energy audit training in different U.S universities, which planned to be in summer 2021, but postponed to a later date due to the *COVID-19 pandemic*.



Number of students trained by CEEE vs. Number of graduate and undergraduate students from different engineering

Distributed Dynamic Simulation Platform

IRC-SES energy efficiency and management team has developed and has been improving a distributed dynamic simulation platform with a high capability of representing Building Energy Management System (BEMS) or Building Automation System (BAS) architecture in simulation by run-time coupling two or more different software tools over a network. The objective of this development is to enable stakeholders (or participating students) to create, model, and simulate building control applications that have been unfeasible yet. With such development, it becomes possible to:

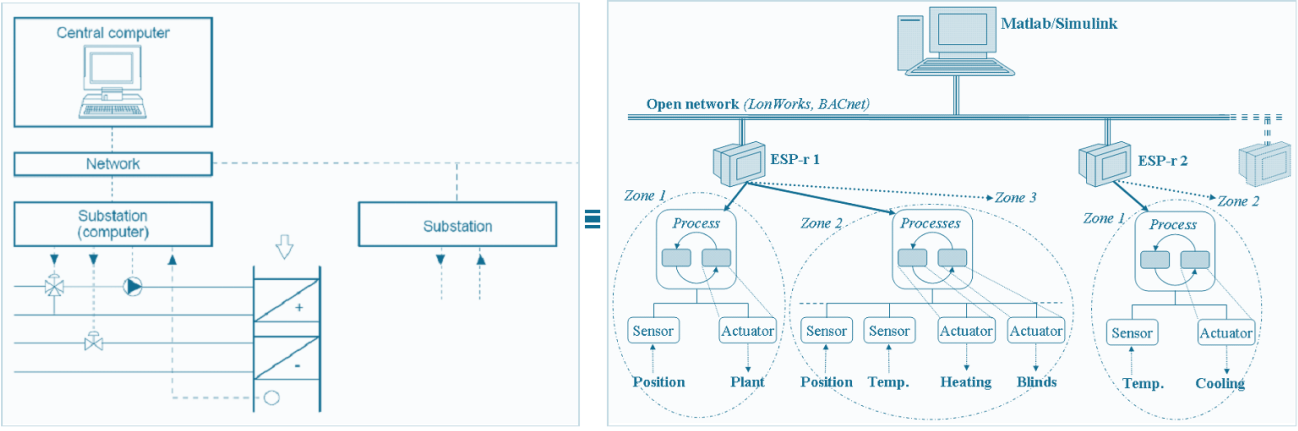
- Integrate advanced control systems (including modern control systems and artificial intelligence) in building environments to provide its occupants with consistent thermal, visual, and indoor air quality comfort at the lowest energy use possible.

- Analyze energy efficiency improvements in smart buildings while optimizing its design and operation, particularly in hot climate conditions.

- Use coordinated and interconnected control systems (or actions) to better operate and regulate building HVAC equipment and lighting components in smart buildings while minimizing energy consumption.

- Integrate self-adapting control systems to meet ever-changing requirements in building such as changes occurring within buildings or to growing interest in both reducing energy consumption and improving occupants' comfort and well-being; and

- Operating self-upgrading control systems to meet occupant needs when damping effects or changes are critical factors in the functioning of building energy systems.



BAS architecture (left) vs. its equivalence using a developed distributed simulation platform (right)

Initiatives to Introduce Energy Courses and Programs

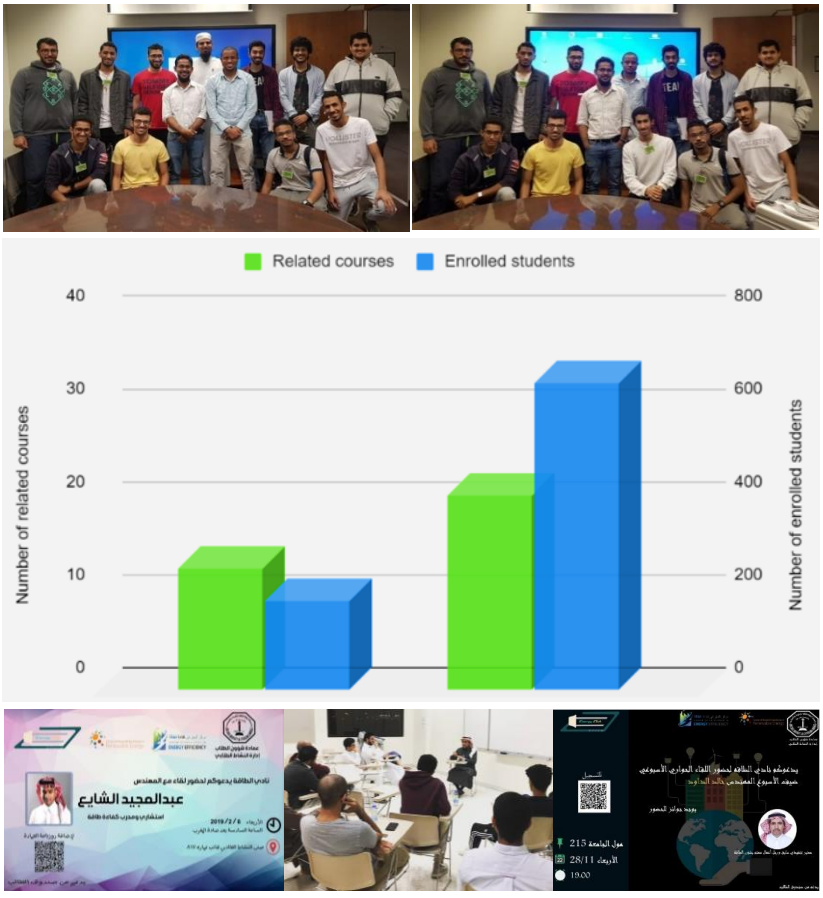
Through IRC-SES efforts and initiatives, a number of courses and programs related to energy efficiency and sustainability have been introduced into the KFUPM curriculum; as for both programs:

Undergraduate Programs

1. Energy Efficiency (CX)
2. Renewable Energy and Storage (CX)
3. Internet of Things (CX)
4. Smart and Sustainable Buildings (CX)
5. Intelligent Energy Systems Management (CX)

Graduate Programs

1. Master of Sustainable and Renewable Energy (MX)
2. Master of Smart and Sustainable Cities (New MX)
3. Master of IoT and Embedded Systems (New MX)
4. Master of Intelligent Process Control (New MX)



Number of energy efficiency related courses and enrolled students in KFUPM

Impactful Projects

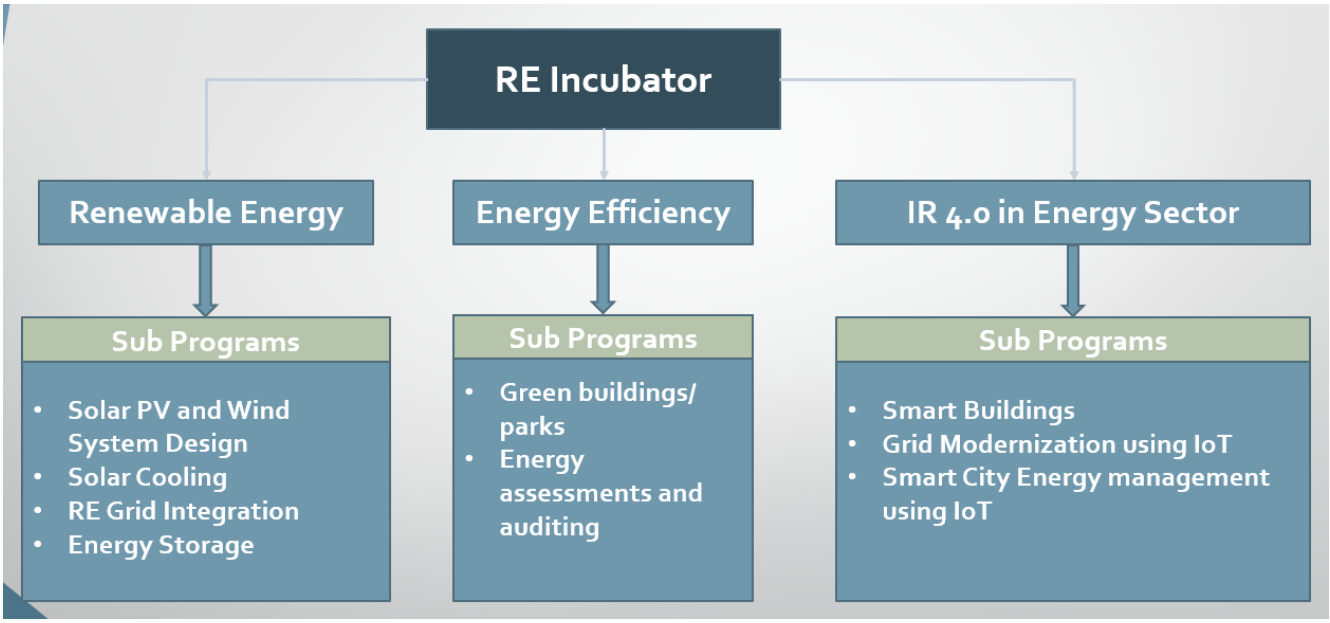
Renewable Energy Technology Incubator (RETI)

"National Industrial Development and Logistics Program" (NIDLP)

IRC-SES continues to steer its RETI programs and projects successfully. In partnership with The National Industrial Development and Logistics Program (NIDLP) RETI was established a a state-of-the-art RE technical incubator (A Comprehensive Program) at KFUPM in 2021, to inspire students, engineers, researchers, and local communities to realize the full potential of renewable energy, energy efficiency, and Industry 4.0 for relevant technology development in the kingdom. RETI is a SAR. 23 million 4 year program funded by NIDLP aimed at being a leading national technical incubator collective diversified intelligence in the Kingdom of Saudi Arabia that serves the researchers, students, and local content developers to boost their RDI capabilities in renewable energy. As of 2024, RETI has entered its 3rd year of operations.

Program Vision: To be a leading national technical incubator in the Kingdom of Saudi Arabia that serves the researchers, students, and local content developers to boost their RDI capabilities in renewable energy, energy efficiency, and Industry 4.0 in the energy sector.

Program Mission: Establishing a state-of-the-art incubator to inspire students, engineers, researchers, and local communities to realize the full potential of renewable energy, energy efficiency, and Industry 4.0 for relevant technology development in the kingdom.



VISION رؤية 2030
المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA

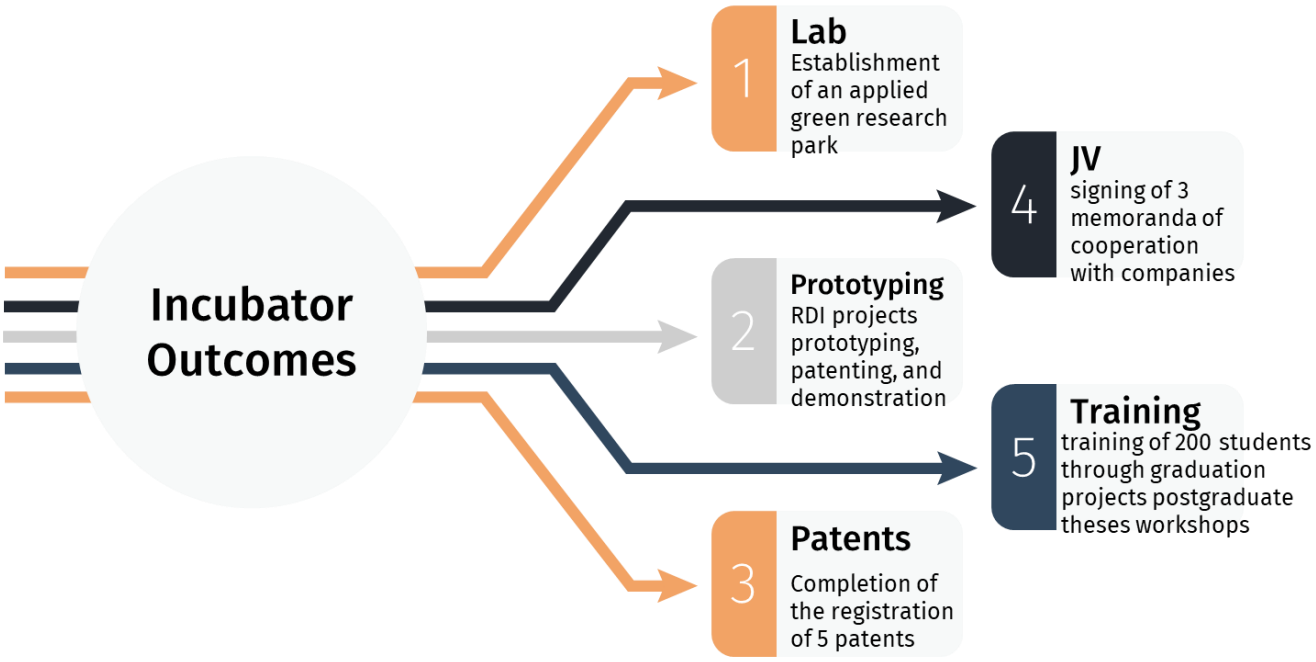
National Industrial Development and Logistics Program

01
Proof of Concept

02
Technical support for Start up

03
50K Competition

04
Student Grants

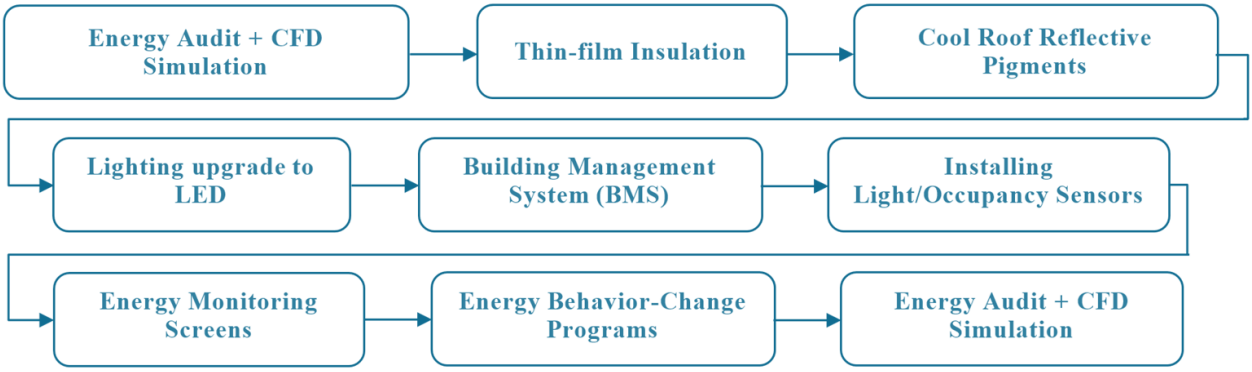


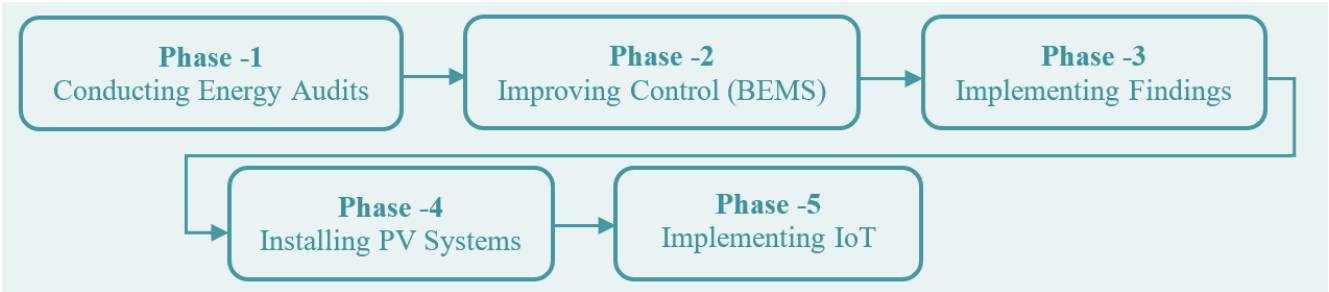
Energy Efficiency Projects And Programs

Student-Dorm Project

This project aims to study the improvement of energy efficiency potentials in two (2) identical student dorms buildings to compare these potentials between non-retrofitted and retrofitted students' dorms. IRC-SES energy efficiency division has completed the energy audit and assessment for two (2) KFUPM students' dorms buildings. In the process of completing this energy audit, we trained our COOP students' on the theoretical know-how and practical skills on improving energy efficiency in multiple occupancy buildings such as students' dorms, hotels, etc.

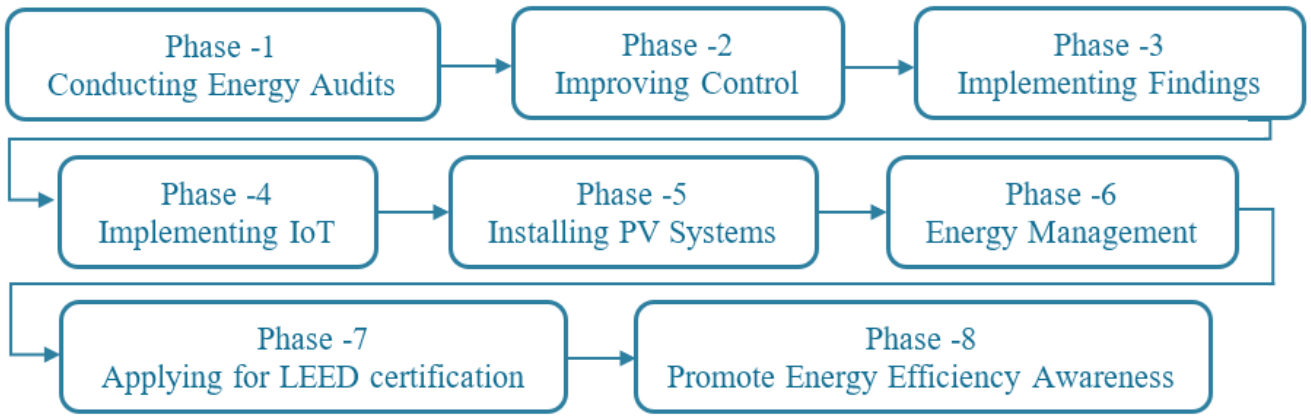
We are now conducting Computational Fluid Dynamics (CFD) simulation to improve air-conditioning efficiency in some student's dorm rooms and implementing an Energy Monitoring System (EMS) in one of the students' dorms. IRC-SES is also working on an approach to changing the behavior of occupants in buildings. The different phases of this project are shown below:





Mosque Project

The focus of the current project is on improving the energy efficiency and management in a KFUPM mosque and to transform the mosque to net-zero energy mosque by installing solar PV with IoT. We have completed some phases of this project and recorded significant progress in other phases of the project. The completed phases are 1 (conducting energy audits), 2 (improving control), 3 (implementing findings), and 4 (implementing IoT). Ongoing phases are 5 (installing PV systems), and 6 (energy management). The energy efficiency division is currently preparing for the smooth execution of phases 7 and 8. The conceptual framework of this project is illustrated below:



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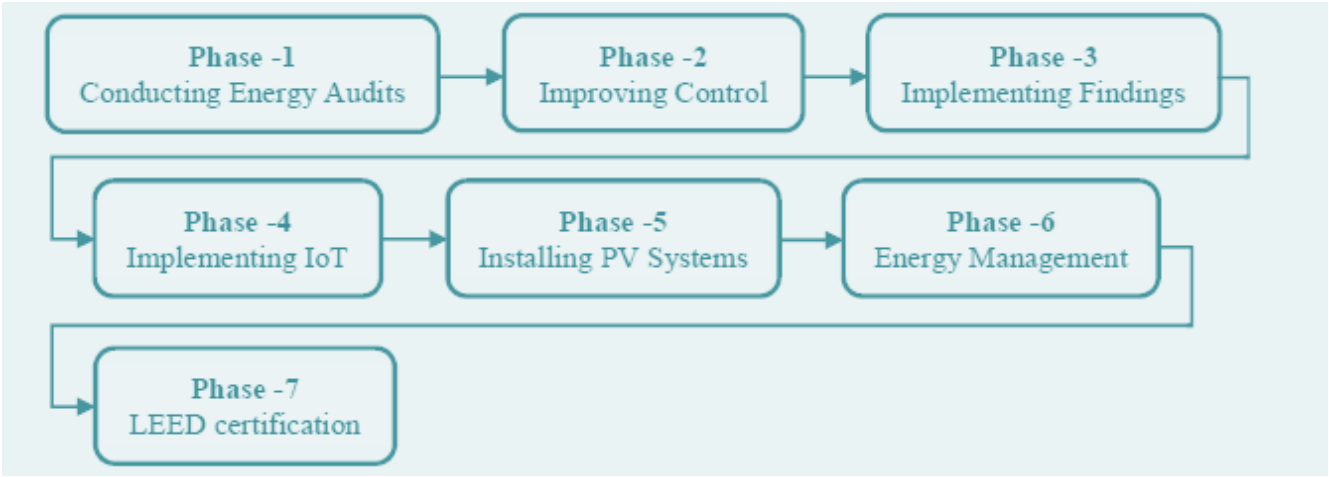


Reverse Osmosis (RO) Water Desalination Plants

The energy efficiency division has completed this ASHRAE Level-II energy auditing for three (3) KFUPM Reverse Osmosis (RO) water desalination plants. We offered comprehensive training sessions to 46 KFUPM undergraduate students and 3 Saudi KFUPM faculty members, who conducted the energy auditing alongside other center team members. Overall, we recorded an estimated annual savings of about 11% (105,800 kWh), 7.2% (108,500 kWh), and 6.3% (74,500 kWh) in energy consumption in DTV, students' housing, and eastern RO plants respectively.

KFUPM Chiller Plants

We are also conducting the energy audit of 3 KFUPM chiller plants. The outcomes of the energy audit of the newly constructed chiller plants will be used as a reference in assessing the energy performance of the old chiller plants. The main objective of this project is to assess and improve the energy efficiency of existing compression chiller plants at KFUPM.

In this regard, we invited 8 students taking the Energy Efficiency and Auditing course for the first audit on a newly installed chiller and provided intensive theoretical and practical training to them. The team supervised these students in conducting measurements in the newly constructed KFUM chiller plant, on analyzing the measured data, and in writing the detailed energy audit report.

IRC-SES intends to train and guide future students in the same way in conducting the energy assessments of other KFUPM chiller plants and identifying opportunities for energy savings and recommending possible assessment recommendations.

Training and Awareness Campaigns

Energy Efficiency Education, Training, and Short Courses

IRC-SES energy efficiency division has developed a strategy for providing awareness education to many students in KSA from different educational backgrounds (Mechanical Engineering, Electrical Engineering, Chemical Engineering, Architectural Engineering). Some of the sessions include:

1. Awareness related to Energy Efficiency
2. Hands-on training in using Energy audit Tools
3. Simulations-based operational Training.
4. Energy efficiency in buildings & Sustainable energy in smart cities.

Pictures taken during Energy Efficiency and Management Awareness Campaign

Training And Awareness Campaigns

Energy Efficiency Education, Training, and Short Courses

External Training: Consultancy and workforce development for other universities and clients

IRC-SES has made immense efforts to create awareness and training related to energy efficiency for the community both inside and ouside the organisation. We delivered the training for KFUPM high school students, Asala College and Dammam university.

Behavioral-Based Energy Program

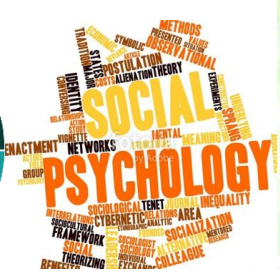
Sustainable Energy Savings through Behavioral-Based Interventions

IRC-SES's Behavioral-Based Energy Program focuses on energy savings resulting from changes in individual or organizational behavior and decision-making. Behavior-based energy efficiency strategies rely on non-financial influences and incentives that influence people's energy consumption. We use a energy-utilization feedback mechanism to show the end-user how much energy they have used compared to another point in time. The program mainly focuses on energy savings resulting from changes in individual or organizational behavior and decision-making.

Behavioral efficiency strategies are a cost-effective way to reduce energy consumption. Behavioral insights from academic research in behavioral science, economics and psychology can also help improve the performance of traditional efficiency programs.

Why Behavioral-Based?

Learn it from the Industry	Learn it from the Social Phycology
• "Energy use is not determined just by the equipment we purchase, but how we use it" • Smart Metering, Social Media, IOT, and ICTs enable effective psychological interventions & change behaviors. • BBEE establishes important links between positive aspects of Savings Energy & Motivations. • Human Factor recognized to be critical success factor for any sustainable EE Program.	• Behavior is hard enough to change when self-interest/comfort is at play, or benefits accrue largely to others • Behavioral economics complements conventional economics : ✓ People don't always behave rationally (same losses & gains are not equal) ✓ People prefer rewards today (time-discounts are not consistent) ✓ People follow their friends and peers ✓ The use of Multiple Behavior ✓ Interventions are much more effective than using single Intervention .



Students Energy Club Activities

Learning & Development, and Human Capacity Building

IRC-SES's continuous effort in managing and assisting the Students' Energy Club during the academic years 2020-2024 have yielded positive outcomes. The center continues to coordinate all the activities of the club by: regularly conducting meetings with its officials; conducting energy-related projects; organizing seminars; providing its members with hands-on training on how to use peformance measuring instruments and conduct energy audit and assessment projects; organizing poster competitions; coordinating students visitations; and providing its members with technical guidance on running the club.

An example highlighted project:

Renovating & Transformation of Wooden Houses to Smart Homes
Hands-on training at Desalination PV RO Plants

We assisted the Students' Energy Club in obtaining the necessary permissions to renovate and use existing (abandoned) wooden houses for the purpose of L&D and hands-on training. Our experts in the field of buildings automation and control systems, are assisting the club members in managing the existing wooden houses and installing all the necessary devices and tools such as sensors, actuators and controllers in order to exploit it as a technical learning initiative towards the establishment of a smart home. This initiative will motivate KFUPM students to learn more about innovative housing (smart homes) and promote energy efficiency, conservation technologies as well as practices that exploit natural resources (such as solar and wind). As a future objective, the center plans to make it a net-zero energy home to generate its required energy from solar PV systems to be installed on its roof.

Summer Undergraduate Research Experience Program

(SURE203)

During summers, IRC-SES members contribute towards supervising students for the Summer Undergraduate Research Experience program (SURE203-213), in the following topics:

- Design Controls for Lighting and Daylighting in an Office Building
- Community Micro-grid Energy Scheduling
- Design of Fuzzy-logic based Converters for DC Micro-grid
- Fault Diagnosis in Active Distribution Grid/Micro-grid
- Power Quality Disturbance Mitigation in Micro-grid
- CFD analysis of a Thermoelectric Air Funnel Cooler System
- Integrated Ammonia Production System with Carbon Capture
- Development of polymer-templated smart thin film
- Optimal Sizing of Hybrid Microgrids Employing Metaheuristic Algorithm
- Microgrid Energy Management with Integration of Hybrid Storage Systems
- Wind generation prediction with machine learning models for Microgrid
- Lithium and Copper co-doped Nickel Oxide Hole Transport Layer (HTL) based Perovskite solar cell
- Spectral control of solar radiation through windows and heat harvesting for energy conservation and utilization
- Benefits of Advanced Control Systems for Energy Efficiency Improvement in Buildings

Undergraduate Student Research Grant

(UXplore)

IRC-SES director and faculty are also major contributors to the Undergraduate Student Research Grant (UXplore) in collaboration with the KFUPM deanship of student affairs and Vice deanship of excellence & success to promote undergraduate research and scholarly achievements. The objectives of UXplore are to:

- Enrich students' research skills and experience
- Attract students to graduate education
- Provide effective career preparation
- Develop critical thinking, creativity, problem-solving, intellectual independence, and leadership skills

Student winning UXplore are supported for conducting research under his advisor's mentorship for one semester (Fall or Spring). The program also offers conditional extension (with no additional cost) for one more semester based on the decision made by the Undergraduate Research Office (URO).
The UXplore program offers incentives as monthly stipend, certificates of grant completion, accomplishments are Included in the student's non-academic transcript and priority in conference participation.

DEANSHIP OF STUDENT AFFAIRS
Vice Deanship for Excellence & Success

IRC-SES success Metrics & Results

Brief Highlights

- **We have worked alongside and in partnership with many industrial reputable private companies and with many governmental entities** as such Saudi Aramco, Ministry of Energy, Ministry of Education, KACST, SEEC, SEEP, K.A.CARE, SABIC, Saudi Wildlife Center, Saudi Electricity Company, Saudi Steel Pipes, Sipchem, Zamil Industrial, ARASCO, Gulf Renewable Lab etc.

- **In pursuit of the center's grand challenge, the center currently has 35+ active projects, in collaboration with different industrial and academic partners with an estimated funding of approx. SAR 28 million,** for the achievement of our nearly Net-zero energy building targets.

- **Successfully published over 1250+ articles in ISI-indexed journals in 17 years,** excluding conferences, books and book chapters. Many of these include publications with high impact factor exceeding beyond 10.

- **Successfully contributed to international and national clean-tech and renewable energy related conferences worldwide** and published over 300 conference papers.

- **IRC-SES has 7 dedicated fully established state-of-the-art laboratories** for its own research and in the process of developing multiple others.

- **IRC-SES has over 70 scientific patented inventions,** many of which are under consideration for commercialization assessments.

- **IRC-SES has published over 10 scientific books authored and edited by our researchers** and numerous book chapters.

- **IRC-SES continues to successfully manage and support a division that operates independently in Energy Efficiency i.e. Center of Excellence in Energy Efficiency (CEEE),** with aims to disseminate knowledge of energy efficiency, and to exert concentrated efforts in developing, transferring, and popularizing technologies, and to promote impactful practices in the field of energy efficiency.

- **Organized over 80 events** inclusive of seminars, workshops, technical meetings, conferences, public forums, school visits etc.

- **Center organized and conducted KSA's 1st Saudi Arabian Renewable Energy Conference and Exhibition" (SARECE)** under the Royal decree from the late Custodian of the Two Holy Mosques, "His Majesty" King Abdullah Bin Abdulaziz Al Saud in 2012. We're currently planning the 2nd Edition of the SARECE 2 for December 2025.

- **IRC-SES offers a range of business start-up and incubation opportunities for technology companies**, in partnership with the King Fahd University of Petroleum & Minerals (KFUPM). Efforts also include education and outreach programs for energy professionals, educators, citizen groups, and industry.

- **The center offers an atmosphere of innovation, creativity, and opportunity.** It is primed for innovation and fueled by an effective governmental and educational partnership that aims at assisting to position local industrial sector for success. IRC-SES at KFUPM host a variety of services for high-tech endeavors and are linked with internationally acclaimed entities.

- **We also offer debriefs, from our practice, offering valuable insight into important developments affecting the businesses.** Advisory helps clients manage strategic, financial, operational, technological, and regulatory risk to maximize enterprise value, helping them move forward with confidence.

- **Our recent activities to aid the Kingdom's vision 2030 include various technology initiatives include:** 2nd Edition of the Saudi Arabian Renewable Energy Conference & Exhibition planned for December 2025, scientific research, laboratories, docking for research vessels, collaborative studies, exerting concentrated efforts in developing, transferring, and popularizing sustainable technologies, and to promote impactful practices in the field of renewable energy generation, energy storage, energy efficiency and conversion.

Energy Training and Projects

Brief Highlights

B. Ongoing projects

- Energy Efficiency Improvement in KFUPM Mosques Project
- Energy Auditing of Reverse Osmosis (RO) Water Desalination Plants
- Retrofitting of one of the KFUPM Students' Dormitory
- Energy Auditing of KFUPM Chiller plants
- Performance and Efficiency Optimization of Photo-thermoelectric Air Conditioner System: Net Zero Air Cooling

C. Coordination of Students' Energy Club Activities

- Smart Building Project
- Solar energy generation model
- KFUPM FABLAB building
- Hands-on Training and Conducting Energy Audit
- Organizing Seminars (5 Seminars and 2 technical meetings)
- Home Energy Efficiency Guide
- Sustainable Future Fuels
- Grid Modernization and the Smart Grid
- Poster Competition
- Students Visitations
    - Saudi Standards, Metrology and Quality Organization (SASO)
    - King Salman Energy Park (SPARK)
    - Jeddah South Thermal Power Plant

D. Competition

- 50K Energy Efficiency Competition

E. ***Awards and Recognition Won by our Energy Efficiency Division:***

- Association of Energy Engineer's (AEE's) Award
- Emirates Energy Award-2020
- Wilo The Energy Award 2022 (Highly Commended)

F. Teaching and Training Program

- CEEE's COOP Training Program
- CEEE's Contribution in the SURE-203 Program
- Simulation-Based Design Tools for Energy Efficient Buildings
- Energy Efficiency and Management Training
- Energy Efficiency Training to KFUPM Faculty Members
- Energy Efficiency Training and Awareness Campaign
- Energy Efficiency Training for Dammam University Students
- Energy Efficiency Awareness Training for High SchoolQUEED's Training of CEEE Students

G. Organizing and Participating in Seminars/Workshops

- The Impact of Industrial Revolution 4.0 (4IR) on the Energy Efficiency and Electricity Market
- Energy Efficiency Week
- CX Program: Intelligent Energy Systems Management
- Education and Career Opportunities for Energy Efficiency Professionals in Saudi Arabia
- Energy Efficiency in Buildings
- Solar PV in Buildings: Enabling Zero-Carbon Future For KSA
- Seminar on Advanced Energy Auditing Instruments
- ABB Al-Khobar Energy Efficiency Symposium

H. Other activities Conducted

- Participated in developing Undergraduate Concentration (CX) Programs
- Provide details of students enrolled in ENERGY EFFICIENCY-related courses at KFUPM
- Working on Collaboration with Vinci ENERGIES
- Completed CEEE Database Workstation Project
- Created and continuously updating CEEE's Webpage on LinkedIn
- Promoting Energy Behavior-Change Program among KFUPM community
- Developed CEEE's New Business Model
- Working on 2 JOURNAL PAPERS for School and Mosques
- Purchased more EQUIPMENT / INSTRUMENTS for energy auditing

Our Impact

Success and Results

Brief Success/Result Highlights

IRC-SES provided both theoretical and hands-on practical training to over **six hundred (600)** students in energy efficiency and management, and other research-related work.

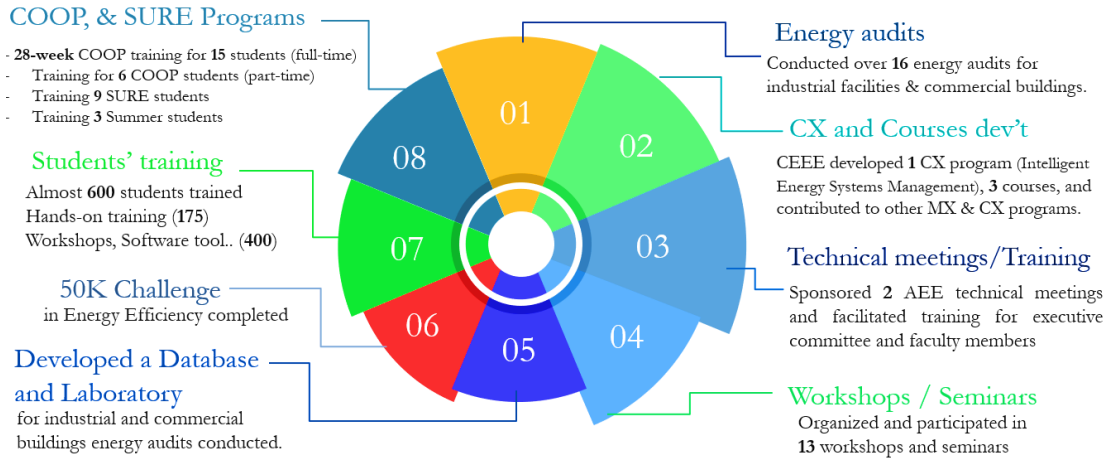
- Provided hands-on practical training to **one hundred seventy five** (**175)** students in energy efficiency and management:
- Provided Energy Efficiency and Management training and awareness campaign to over **seventy (70)** engineering students in the nearby universities and colleges.
- More than **four hundred (400)** students were provided training through short courses and workshops on energy efficiency and management.
- Awareness campaign to more than **thirty (30)** high-school students.

➢ Provided 8-weeks online short-training course on "Simulation-Based Design Tools for Energy Efficient Buildings" to **two hundred and thirty (230)** undergraduate students.

1. **The center team members have supervised seventeen (17)** students for Summer Undergraduate Research Experience program.

2. **IRC-SES energy efficiency division has conducted sixteen** (**16)** energy audits and assessments of industrial facilities and buildings.

3. **Other statistics:**
   - **Seven (7)** staff/affiliate members attended Certified Energy Manager (CEM) / Certified Energy Auditor (CEA) training and certification courses.
   - **Eleven (11)** Public Lectures, Workshops, and Seminars were organized.
   - So far, **seventy-four (74)** students have participated in the energy auditing of industries and buildings with the energy efficiency division.



Outcomes

Brief Highlighted Outcomes from numerous Projects

The main outcomes include:

- Capacity building of the CEEE-team's energy efficiency and management, particularly in energy audits.
- Theory and hands-on practice for COOP students to conduct energy audits and assessments professionally.
- Using ASHRAE methodology for conducting energy auditing in buildings, especially with a tangible approach for cost effective monitoring and control of uniform indoor air-temperature.
- Developing technologies to remotely control building services and appliances via Internet
- Installing PV systems to supplement a portion of the energy needs.
- Writing a detailed report on identified possible opportunities for energy savings in KFUPM mosques.
- Submitting an application for LEED certification to certify the chosen mosque as a Nearly Zero Energy Building (nZEB).

	Name of Facility	Co2 Savings	SAR Savings	kWh Savings
1	Bldg 63, KFUPM	Confidential	Confidential	Confidential
2	SSP	814,392	195,454	1,085,856
3	Bldg 76, KFUPM	552,000	235,520	736,000
4	ARASCO	745,600	359,505	997,300
5	Zamil	Confidential	Confidential	Confidential
6	AFICO	Confidential	Confidential	Confidential
1	KFUPM School	53,700	50,900	71,600
8	Siddiq (RI)	19,363	9,294	25,819
9	Ali bin Abutalib	14,756	6,296	19,675
10	Abubakr siddiq	28,832	12,301	38,442
11	Zubair	9,086	3,877	12,115
12	Dhahran	Confidential	Confidential	Confidential
13	Farooq	Confidential	Confidential	Confidential
14	Al Rabeea	Confidential	Confidential	Confidential
15	RO plant	81,355	34,711	108,473
	Total	**3,119,000**	**1,507,000**	**5,095,000**

The above values are including numbers from the entities for which we've conducted assessments and implemented energy efficiency measures. (Their data is kept confidential based on the client's request)





10ton




Events & Workshops 2024

Lectures and Hands-on Training Events (A few examples from 2024 only)

JAN 2024 – SEPTEMBER 2024

The endeavours IRC-SES undertake are aligned with and contribute to the advancement of these specified SDG(s):

- Goal 2: Zero hunger (No hunger)
- Goal 3: Good health and well-being
- Goal 4: Quality education
- Goal 6: Clean water and sanitation
- Goal 7: Affordable and clean energy
- Goal 8: Decent work and economic growth
- Goal 9: Industry, Innovation and Infrastructure
- Goal 10: Reduced inequality
- Goal 11: Sustainable cities and communities
- Goal 12: Responsible consumption and production
- Goal 13: Climate action
- Goal 14: Life below water
- Goal 15: Life on land
- Goal 16: Peace, justice and strong institutions
- Goal 17: Partnership for the goals

The list of events and initiatives provided below exclusively demonstrate our efforts to contribute to the United Nations SDG(s).

Geothermal Energy & Its Role In The Global Energy Transition

January 2024

This certified three-day course equipped students with the essential knowledge required to contribute to global energy transition efforts and the goal of ensuring clean and affordable energy for all. The course offered a comprehensive overview of geothermal energy, covering its advantages, disadvantages, and various aspects from subsurface exploration to surface energy conversion technologies. The content provided varying levels of detail to cater to different knowledge bases. Additionally, the course featured a field visit to geothermal energy laboratories, offering students practical insights into the technologies and processes involved in geothermal energy systems.

The below collage of images represents a few of our on-going events and activities with many more already conducted in the past years.

Renewable Energy Technical Incubator (RETI) Laboratory Kick-off Event
January 2024

In January 2024, the Renewable Energy Technical Incubator (RETI) Laboratory was officially unveiled, marking a significant step forward in fostering innovation in clean energy. To celebrate this milestone, IRC-SES organized a kick-off event, bringing together faculty, researchers, engineers, technical staff, and students from KFUPM, alongside RETI program participants. This event served as an introduction to the cutting-edge facilities and resources

of the RETI Laboratory, highlighting its pivotal role in advancing research and development in the field of renewable energy and sustainability. The lab's goal is to drive impactful solutions and breakthroughs in clean energy technologies.

RETI 50K Challenge

March-June 2024

Renewable Energy Technical Incubator (RETI) organized and conducted the 50K Challenge for Students on the 6th of June 2024. The competition encouraged university students to transform innovative ideas related to clean and renewable energy, energy efficiency, and industry 4.0 in energy systems into viable prototypes.

High-profile judges from academia, KFUPM, and industrial entities like Saudi Aramco evaluated and selected the winners from amongst 7 teams. Prizes totalling SAR 50,000 were awarded to the top three teams, with the first, second, and third places receiving SAR 25,000, SAR 15,000, and SAR 10,000, respectively.

Landmark inaugural RETI and National Industrial Development and Logistics Program (NIDLP) Joint Event at Dhahran Techno Valley

June 2024

On Thursday, June 6, 2024, the Interdisciplinary Research Center for Sustainable Energy Systems (IRC-SES) at King Fahd University of Petroleum and Minerals (KFUPM) organized a significant event, titled "Renewable Energy Technical Incubator (RETI) and National Industrial Development and Logistics Program (NIDLP) Joint Forum," held at the Dhahran Techno Valley (DTVC). This initiative, which came into existence through a generous funding of SAR 23 million from the NIDLP, aims to expedite research, development, and innovation (RDI) projects in renewable energy, energy efficiency, and Industry 4.0 applications.

The RETI-NIDLP Joint Forum successfully concluded, marking yet another significant milestone in KFUPM’s storied history of delivering on its research and excellence commitments. This event continues to build upon KFUPM's legacy of supporting and advancing the Kingdom of Saudi Arabia's goals in renewable energy and technological innovation.

Undergraduate & Graduate Research Programs supported under the RETI Initiative

2023- 2024

As part of IRC-SES's ongoing efforts to promote clean energy technologies, the Renewable Energy Technical Incubator (RETI) Initiative supports both undergraduate and graduate research programs. In 2024, multiple research grants were awarded to students, providing them with the necessary resources to explore innovative solutions in renewable energy. These grants aim to assist students in transforming their ideas and research into viable commercial technologies, fostering a new generation of leaders in clean energy development and deployment. The RETI Initiative is dedicated to advancing impactful research that contributes to a sustainable future. Grants were awarded to 7 UG and 13 G students.

Proof of Concept (POC)
2023- 2024

The POC Grants under the RETI initiative marked yet another significant milestone in KFUPM’s storied history of delivering on its research and excellence commitments. POC Grants help continue building upon KFUPM's legacy of supporting and advancing the Kingdom of Saudi Arabia's goals in renewable energy and technological innovation.

A total of 9 POC projects were funded which are all expected to complete by December 2024.


KFUPM Research
Forum 2024


UPM Research
Forum 2024

Online Energy Efficiency Certified Training Workshop
May 2024

Online Energy Efficiency Certified training workshop provided to over 150* Students. Experts from world renowned industrial leader Saudi Aramco, and SADAIA, and IRC-SES shared extensive knowledge and practical experiences with the attendees on the subjects of Energy management and utilization, efficiency, conservation, retrofitting and smart energy consumption and minimizing energy losses in buildings an facilities.

Research Enrichment Program

June-July 2024

The Mawhiba Enrichment Research Program is designed to introduce students to the fundamentals of scientific research, including research ethics, intellectual property, and essential skills such as laboratory use, safety protocols, data analysis, and scientific report writing. The program emphasizes hands-on experience in labs and collaboration with scientific experts, helping students develop both technical and personal skills. It targets students from the third intermediate to secondary school levels and is typically offered as a summer program lasting 3-4 weeks. Distinguished participants may receive continued mentorship for up to six months to further support their research development.

Ibdaa and ISEF competition

June-July 2024

The IRC-SES actively supports student development through initiatives aligned with Saudi Arabia’s Vision 2030, particularly focusing on innovation in advanced technologies and entrepreneurship. As part of this commitment, IRC-SES encourages students to participate in competitive scientific environments, such as the National Olympiad for Scientific Creativity "Ibdaa", which stimulates young minds to engage in scientific research and creativity. This program prepares pre-college students to contribute to global knowledge systems and achieve sustainable national development. Organized by the Ministry of Education and Mawhiba, it aims to foster a spirit of scientific thinking and innovation, supporting Saudi Arabia's goal of becoming a leader in global scientific achievements.

Cooperative Training
June-July 2024

The IRC-SES supports students through its Cooperative Training Program, offering them the opportunity to gain professional experience in real-world work environments. The program facilitates collaboration between the student, faculty members, and employment supervisors, ensuring that learning outcomes are met. This structured training is guided by a Cooperative Training Form and Training Agreement, detailing the tasks and skills to be developed. Regular on-site meetings with supervisors ensure consistent progress. At the end of the program, students submit a report outlining the tasks they completed and the learning outcomes achieved, providing a comprehensive reflection on their experience.

Supervising the Undergraduate Students Graduate Research
August-Ongoing 2024

The IRC-SES actively supervises undergraduate and graduate students during their Graduate Research Projects with a focus on clean energy technologies. By offering specialized mentorship and access to cutting-edge research in renewable energy, energy efficiency, and sustainability, IRC-SES helps students apply academic knowledge to real-world challenges. This guidance ensures that students not only develop strong research methodologies but also contribute to advancements in clean energy solutions. By aligning student research with the center's mission, IRC-SES prepares the next generation of innovators in the renewable energy sector.

Energy Efficiency and Management Training for Faculty members from KFUPM and Imam Abdulrahman Bin Faisal University

August 2024

As part of the Center of Excellence in Energy Efficiency (CEEE) initiative, we successfully delivered Energy Efficiency and Management Training to four faculty members from KFUPM and Imam Abdulrahman Bin Faisal University. The training focused on equipping participants with advanced knowledge in energy management strategies, practical approaches to energy conservation, and tools to enhance energy performance in their respective institutions. This initiative aimed to foster collaboration and improve energy efficiency practices across academic settings.

Battery Technologies, Energy Storage Deep Dive, and E-Mobility

September 2024

The 3 day certified course, tailored with a focus on batteries, endeavours to forge a link between scientific understanding and societal application. It catered to science students by elucidating the societal and industrial requisites. This program was meticulously designed for those with a keen interest in battery technology, aspiring to advance their career in this innovative field.

- Battery energy storage technology.
- Emerging battery technologies and their strengths and weaknesses.
- Performance and Reliability.
- How energy storage can be used as an asset to maintain or improve grid reliability and operations.
- Lithium-Ion Batteries: "Ideal" versus "real" conditions
- Recycling Batteries and 2nd Life Usage.
- E-Mobility

Multiple Lab Training Sessions: Energy Auditing, Assessments & Auditing Tools

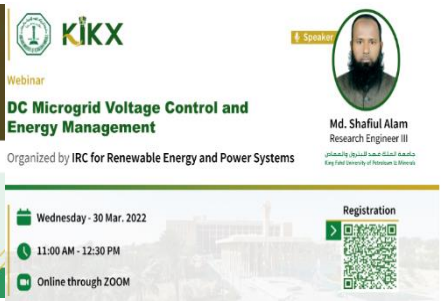
September 2024

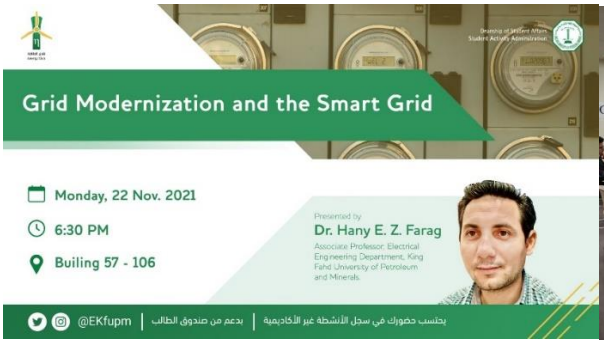
As part of the Center of Excellence in Energy Efficiency (CEEE) initiative, we conducted a training session for students focused on Energy Auditing Tools and Equipment. This hands-on program provided participants with in-depth knowledge of key auditing instruments, enabling them to effectively assess energy consumption and identify opportunities for optimization in various settings. The training emphasized practical applications and fostered a deeper understanding of how to drive energy efficiency improvements.

Industrial Visits to Power Plants & Facilities
2024

These field trainings provide students with valuable insights into large-scale power generation processes, energy efficiency practices, and real-world applications of the concepts learned in their coursework, fostering a deeper understanding of energy management within industrial settings.

The following collage of images represents a few of our on-going events and activities with many more already conducted in the past years.





Events & Workshops

Competitions and 50k Challenge

Awards & Recognition (IRC-SES)

Al-Qassim Award for Excellence and Creativity 2023 and 2024

IRC-SES has been awarded the prestigious Al-Qassim Award for Excellence and Creativity for two years continuously for 2023 and 2024. This remarkable achievement is a testament to the hard work, dedication, and innovative spirit of our entire team, including faculty, affiliates, researchers, engineers, and supporting staff. This award is won by and for our team, KFUPM, and the Kingdom of Saudi Arabia. It reflects our humble efforts to help the Kingdom achieve its sustainable energy milestones, vision, and grand challenges.

Together, we continue to strive towards excellence and contribute to the noble objectives of sustainable energy development in our nation.

National Award by AlMarai

The AlMarai Awards for Scientific Innovation were initiated in 2001 in cooperation with the King Abdulaziz City for Science and Technology. The Awards are intended to sponsor scientific innovation as well as research units, scientists, researchers, and science itself in basic, applied, and development sciences within the Kingdom of Saudi Arabia.

On November 9th, 2020, AlMarai Company announced names of the winners of the 19th AlMarai Scientific Innovation awards. Interdisciplinary Research Center for Sustainable Energy Systems (IRC-SES) at the Research Institute of KFUPM received the AlMarai award for the best research unit in the Kingdom. Earlier two of its individual researchers were honored with AlMarai Prize 2017 for their exhaustive contribution in applied research in renewable energy in particular and engineering in general.

Awards & Recognition (Energy Efficiency Division)

Regional awards for Institutional Energy Management, Professional Development, and Human Capital Development

IRC-SESCEEE division has been acknowledged both nationally and internationally for its far stretching energy resource efficient activities on the global energy efficiency map.

ASSOCIATION OF ENERGY ENGINEER'S (AEE'S) AWARD

The center has also won the Association of Energy Engineer's (AEE's) Middle East Region Institutional Energy Management Award for 2021. The center won this award for its successful and outstanding work in energy efficiency such as the promotion of energy audits and energy efficiency savings, the integration of energy monitoring systems in buildings and industries, energy-efficiency capacity building, etc. The ceremony for the Middle East Region Institutional Energy Management Award was held on October 19, 2021 in New Orleans, USA.

The previous IRC-SESDirector, Dr. Fahad Al-Sulaiman had also secured the International AEE Energy Professional Development Award 2021.

EMIRATES ENERGY AWARD-2019

The center also participated in the Fourth Cycle of the Emirates Energy Award-2019, and won the award under the "Education & Capacity Building" category of the Energy Efficiency and Management Program. The Dubai Supreme Council of Energy, United Arab Emirates, organizes this global energy award competition on a yearly basis.

جـائـزة الإمـــارات للـطـاقـة
EMIRATES ENERGY AWARD

Awards & Recognition (Students)

Masdar- Future Sustainability Leaders Program (international)

Mr. Ziyad Alaskar, a student trained by the IRC-SES energy efficiency division participated in the Future Sustainability Leaders Program under the initiative of MASDAR that connects university students and young professionals with global business leaders, policymakers, and technology pioneers, to help them learn the latest sustainability best practices. Mr. Ziyads Team were awarded a First Place Winner in Ecothon innovation challenge for developing an application "**TADs APP**" that promotes a sense of responsibility in energy consumption through advance electricity tool system, rewards for energy saving and direct marketing.

50k Students Competition 2023

Clean-Tech competition to support Viable Prototypes & Products

50k Students Competition 2024

Clean-Tech competition to support Viable Prototypes & Products

50K THE CHALLENGE

VISION 2030 رؤية المملكة العربية السعودية KINGDOM OF SAUDI ARABIA

National Industrial Development and Logistics Program

مركز أبحاث نظم الطاقة المستدامة
INTERDISCIPLINARY RESEARCH CENTER for
Sustainable Energy Systems

1 PLACE — SAR 25K

2 PLACE — SAR 15K

3 PLACE — SAR 10K

The Renewable Energy Technical Incubator (RETI) under the Interdisciplinary Research Center for Sustainable Energy Systems (IRC-SES) has launched the RETI 50K Challenge for the KFUPM students. The competition encourages university students to transform innovative ideas related to Renewable Energy, Energy Efficiency, and Industry 4.0 in Energy Systems into viable prototypes.

Hi, have a quick look at the following questions!

- Do you have any creative ideas or innovative concepts related to the mentioned topics?
- Do you want to transform your projects into viable prototypes or products?
- Are you looking forward to financial and technical support to realize your long-cherished dreams?
- Are you looking for stakeholders to invest in your ideas?
- Do you want to win prizes (monetary and certificates) for developing your prototype or product?

If yes, RETI 50K Challenge is the perfect platform for you!

Phases

Phase I: Call for Ideas - submit your project proposal online (**4 February 2024**).
Phase II: Shortlisting - acceptance notifications for promising and competitive ideas (**11 February 2024**).
Phase III: Final Presentation - prototype demonstrations to a jury comprised of industry leaders, investors, and academic scholars (**17 March 2024**).

Benefits

- Up to SAR 60,000 support for prototype development.
- Access to RETI and KFUPM state-of-the-art- research facilities.
- Close supervision by the subject matter experts.
- Platform for showcasing and demonstrating your ideas to the right stakeholders.
- Opportunity to get funds for business startups and joint ventures.

The first-place winner will receive SAR 25,000, the second-place SAR 15,000, and the third-place winner SAR 10,000.
The fourth to tenth teams that participate will receive a cash incentive of SAR 2,000 each.

Deliverables

- ✓ Interim and final reports.
- ✓ Participation in RETI and KFUPM exhibitions and expos.
- ✓ Prototypes for demonstration.

Registration

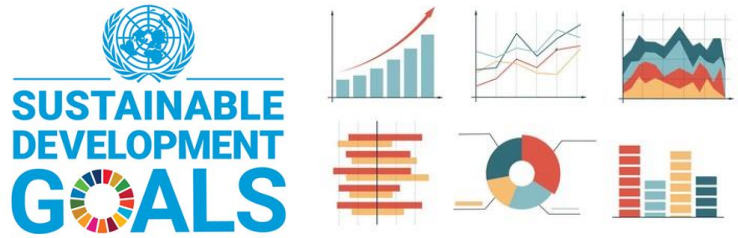
Don't miss this opportunity to turn your dream into reality and make a positive impact on the world! Participants can address questions anytime by e-mail at: reti@kfupm.edu.sa

For more information and registration, please kindly scan the QR code below:

REGISTER HERE

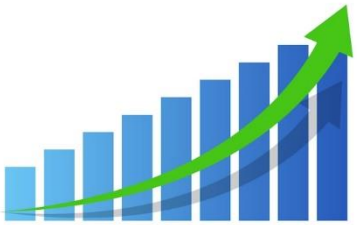
Research Output & United Nations Sustainable Development Goals Contribution (2024)

In 2015, UN member states agreed to 17 global Sustainable Development Goals (SDGs) to end poverty, protect the planet and ensure prosperity for all. Our work contributes towards the above SDG(s).



Research Outlook 16 Years (2007-2024)

17 of Pioneering Discovery: A Retrospective of Research Excellence (2007-2024):



Publications	Conference Proceedings	Issued Patents	Books
1250*	300*	80*	12

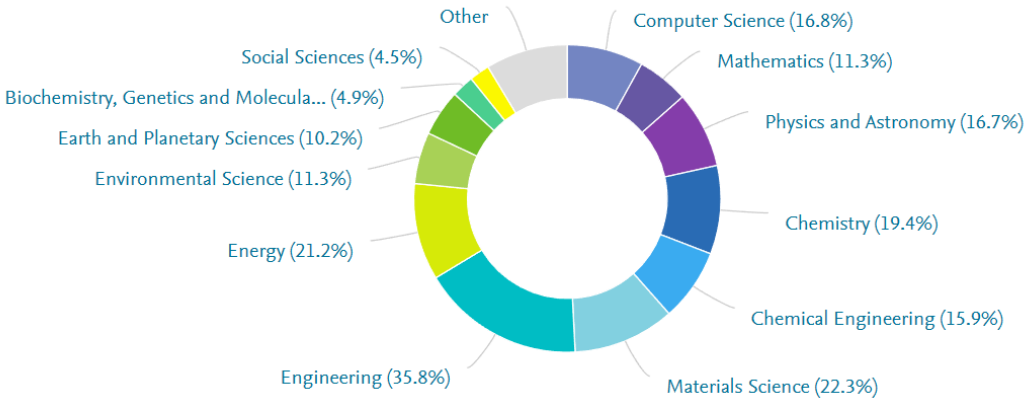
Projects	Students Trained	National Awards	International Awards
100*	1000*	3 National Awards	2 International and Regional Awards

World's Top 2% Scientists List of 2023-2024 by Stanford University

IRC-REPS is proud of our 7 Research Scientists and 30 Affiliated Faculty members of KFUPM that have been featured in the 2023 and 2024 top 2% list of Scientists by Stanford.

KFUPM Energy Sustainability Research: Most Contributed Topics (2018-2024)

Between 2018 to 2023, With regards to Energy related research, the KFUPM Publications rank in top 10% most cited worldwide.



Energy	Field-Weighted Citation Impact
3052 Published Documents	1.76

Energy Engineering & Power Technology	Field-Weighted Citation Impact
2037 Published Documents	1.73

Renewable Energy, Sustainability and the	Field-Weighted Citation Impact
1548 Published Documents	1.63

Solar Energy; Photovoltaic Cells;	Field-Weighted Citation Impact
229 Published Documents	1.79

Nuclear Energy & Engineering	Field-Weighted Citation Impact
179 Published Documents	1.42

Photocatalysis; Photocatalysts; Solar Cells	Field-Weighted Citation Impact
490 Published Documents	1.83

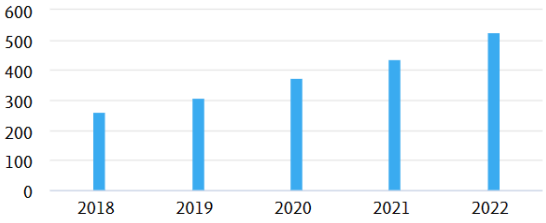
Secondary Batteries; Electric Batteries;	Field-Weighted Citation Impact
332 Published Documents	2.16

Research Strength (2018-2024)

Share of publications at the King Fahd University of Petroleum and Minerals that are among the most cited publications worldwide:

649 (21.3%)
Number of publications in the top 10% most cited publications worldwide.

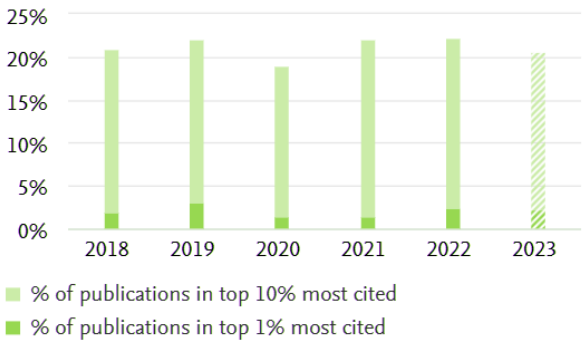
THE World University Rankings
Research Excellence Score



1,906 (18.01%)

number of publications in Top 10% Citation percentile by Global Field-Weighted Citation Impact (5 Year) at the King Fahd University of Petroleum and Minerals considered for the Research Excellence (THE) indicator

Scholarly Output in Top Citation Percentiles



201-250
World University Rankings

7,304
Scholarly Output (THE)

Research Productivity (THE)

International Co-authorship (THE)

Citation Impact (THE)

Research Strength (THE)

Research Excellence (THE)

Research Influence (THE)

Patents (THE)

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