

King Fahd University of Petroleum & Minerals

RESEARCH & INNOVATION 2023 Annual Report





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Letter from the Vice President of Research & Innovation

The third year of the research transformation at KFUPM witnessed the start of reaping the benefits and further climb on the research ladder. In the year 2023, we achieved significant milestones, marking a paradigm shift in our research landscape. The development of the Innovation-based Research Strategy (2024-2030) sets the stage for our research and innovation pathway in the coming years, guiding us towards groundbreaking endeavors and impactful contributions to the global research community.

A key highlight has been the enhancement of our research environment, creating a conducive space that attracts the finest of minds. This, coupled with world-class infrastructure, catalyzes igniting breakthrough discoveries through diverse perspectives. Potential partnerships that the University establishes with industry and government agencies will ensure that the generated knowledge translates seamlessly into the real world, reinforcing our position as a hub for practical and impactful research.

In addition to the existing 13 interdisciplinary research centers (IRCs), KFUPM established two new research centers in 2023, IRC for Biosystems & Machines and IRC for Industrial Nuclear Engineering. This demonstrates our dedication to pioneering advancements, particularly in biotechnology and civil nuclear engineering. Furthermore, KFUPM established the Petroleum Conversion Research Center (PCRC) to reinforce our commitment to scaling up of our research findings to a higher technology readiness level (TRL) in crucial areas such as hydrogen, refining, and chemicals.

KFUPM achieved the 4th position globally in terms of registered US patents. Additionally, it secured the top spot in the Arab world according to the QS Arab Regional Ranking and Times Higher Education



Dr. Ali Al-Shaikhi Vice President of Research & Innovation

World University Rankings. Moreover, KFUPM QS subject ranking continues to improve where all our engineering subjects are within the top 60 worldwide.

At the core of our pursuits is the emphasis on research that not only meets but also surpasses critical challenges, yielding tangible economic and societal impact, ultimately improving lives. Unwavering commitment of KFUPM to fostering a diverse, equitable, and inclusive research environment remains steadfast, recognizing that true excellence can only be achieved when each and every voice is empowered.

As we celebrate our university's 60 years of history and legacy, I am sincerely excited about the immense potential that lies ahead. Together, with the collective dedication of our community, we will demarcate the future and leave an indelible mark on the world through our transformative research and innovative endeavors.

Vision

To be a globally recognized innovation-based research-intensive institution that solves grand challenges for the betterment of society and diversification of economy.

Mission

To conduct interdisciplinary research in national and global priority areas in a conducive environment that attracts the best talents and provides world-class infrastructure.

Values

- > Interdisciplinarity
- Collaboration
- > Diversity, Equity, and Inclusion
- > Openness and Transparency
- > Resilience

At the core of our pursuits is the emphasis on research that not only meets but surpasses critical challenges, yielding tangible economic and societal impact, ultimately improving lives.



> Research Outcomes

35K+ 544K+ **27K ISI** Publications Citations Number of Journal Articles A Decade of Quality Research Overview Number of Publications 2014 2015 2018 2019 2016 2017 2020

2023: KFUPM researchers target top journals. 83% of total publications are in Q1 and Q2.





*Source: Scopus Database







(Articles & Reviews)



1,137 Publications in Top Journal Percentiles



1,983 Publications in Top Quartile Q1



674 Publications in Top Citation Percentiles

> Ambitious and Responsible Research: **KFUPM Contributes to UN SDGs**

In pursuit of the ambitious Saudi Vision 2030 objectives, alongside international counterparts, has embraced the 17 Sustainable Development Goals (SDGs) specified by the United Nations for a sustainable planet. Universities stand at the forefront of this endeavor, propelling research and nurturing the next generation of changemakers. At KFUPM, we collectively endeavor to pave the way for future generations to flourish in a more sustainable world. To secure

a brighter future for those to come, we must foster sustainable growth and development through knowledge dissemination, community engagement, and a clear understanding of our individual roles within this shared

vision, ever mindful of our nation's future aspirations. More information on KFUPM efforts regarding SDGs is available at https://sustainability.kfupm.edu.sa/



Distribution of publications over the Top 10 research areas at KFUPM (2018-2023)



SUSTAINABLE GALS



54th





57th

86th SDG17: Partnerships for the Goals

> Research Funding and Support









Agreements 40% with Government Agencies



Visits to Campus



Interdisciplinary **Research Projects**

19

Graduate Students attended conferences

International Conferences



Conferences

RESEARCH AND INDUSTRIAL PARTNERSHIPS



SEED Sponsorships



Chair Professors

> Research and Innovation Organization

	Vice President of Research and Innovation
 Interdisciplinary Research Center	 Advanced Materials Aviation and Space Exploration Bio Systems and Machines Communication Systems and Sensing Construction and Building Materials Finance and Digital Economy Hydrogen Technologies and Carbon Management Industrial Nuclear Energy Intelligent Manufacturing and Robotics Intelligent Secure Systems Integrative Petroleum Research Membranes and Water Security Refining and Advanced Chemicals Smart Mobility and Logistics Sustainable Energy Systems
 Applied Research Center	 Center of Excellence in Development of Nonprofit Organizations Environment and Marine Studies Metrology, Standards, and Testing Petroleum Conversion Research Center Strategic Studies and Planning
 Joint Research Center	 KACARE for Energy Research KACST for Energy Efficiency SDAIA for Artificial Intelligence
Research Support	 Core Research Facilities Deanship of Research Oversight and Coordination Industrial and Research Partnerships Office Innovation and Technology Transfer KFUPM Institute for Knowledge Exchange Research Excellence Office Research Support Department

Innovation-based Research Strategy

The research and innovation strategy at KFUPM is carefully aligned with its all-encompassing strategic plan. KFUPM is dedicated to achieving research excellence across a diverse array of disciplines.

KFUPM's Innovation-based Research Strategy

(2024-2030) is focused on addressing the national priorities identified by the Research, Development, and Innovation Authority (RDIA) of Saudi Arabia. Furthermore, the strategic objectives will contribute to achieving the United Nations' Sustainable Development Goals. In doing so, KFUPM reaffirms its commitment to exerting a meaningful impact on global challenges and promoting a sustainable and equitable future for society.

Formulation of the research strategy of KFUPM is underpinned by four pivotal factors. First, the remarkable transformation of KFUPM in recent years has redefined its strategic priorities and

Innovation-based Research Strategy





aspirations. Second, the valuable insights garnered from internal assessments of the research centers at KFUPM play a critical role in shaping the strategy. Third, the development of the strategy is influenced by national initiatives aimed at fostering research, innovation, and overall development. Fourth, the strategy is inspired by the dominant trends observed in research-intensive universities, where research strategies are structured to address grand challenges.

Collectively, these four factors coalesce to guide the creation of KFUPM's research and innovation strategy that is not only attuned to its evolving

landscape, but also positioned to contribute significantly to local and national research and development objectives.



https://ri.kfupm.edu.sa/vp-for-research-innovation/strategy



National RDI Initiatives: Fueling **Research and** Innovation



Pioneering Research **Strategies: Grand** Challenges as Inspiration

> From Challenges to Innovation Goals: in Alignment with National Priorities



Energy and Industrial Leadership

- 1. Clean, Economic Hydrogen
- 2. Renewable Energy
- 3. Crude Oil-to-Chemical Conversion
- 4. Geoenergy Leadership 5. Electric Vehicles (EVs) and EV Batteries
- 6. Nuclear Energy



Sustainable Environment and Essential Needs

1. Innovative Water Research

- 2. Net Zero Emissions
- 3. Reuse of Materials and Products in Industry
- 4. Biodiversity



Economies of the Future

- **1. Cognitive Cities**
- 2. Automation of Logistics
- 3. Industrial Robots
- 4. Net Zero Aviation
- 5. New Space Leadership
- 6. FinTech
- 7. Gaming and ESports



Health and Wellness

1. Health and Bioengineering Innovation

18



National Priorities





Research Centers

> Empowering Research

Cultivating Excellence: Empowering Research through Talent



The research centers at KFUPM boast a diverse community with 770 scientists, including 466 affiliates, 129 research scientists/engineers, and 175 postdocs. In addition to a combined total of 196 PhD and 679 MSc students. Notably, 82% of KFUPM faculty with professorial rank are affiliated with interdisciplinary research through our Interdisciplinary Research Centers. This collaboration, complemented by guest affiliates, fuels an innovative and collaborative research environment.

During 2023, KFUPM attracted 3,132 postdoc applications from 79 countries and 5 continents. Our graduate studies span 27 Masters program and 14 PhD programs, ensuring a diverse academic landscape. By embracing a global network of talent, we aim to propel research forward, fostering a rich and inclusive culture that transcends geographical and disciplinary borders.

Advancing Infrastructure for Sustainable Progress

Core Research Facilities (CRF) act as a central lab that provides "Free-of-Cost" analytical lab services to all academic departments and research centers at KFUPM on a "first-come first-served" basis.

Support Areas include Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), X-ray Diffraction (XRD), Energy Dispersive X-ray Fluorescence (ED-XRF), AFM, NMR, etc.

CRF LAB RESOURCES

- X-ray diffractometer (XRD) 02
- ED x-ray fluorescence analyzer
- WD x-ray fluorescence analyzer
- Micro x-ray fluorescence analyzer
- Scanning electron microscope (SEM) ٠
- Transmission electron microscope (TEM) 02
- Atomic force microscope (AFM) .
- Optical Microscope

CRF LAB RESOURCES – IN PROCESS

- XPS
- FIB-FESEM
- Sputtering System
- Thermal Evaporator
- E-Beam Evaporator
- Mask Aligner, Spin Coater, Developer, etc. Clean booth
- **Reactive Ion Etcher**
- Physical Property Measurement System
- Ellipsometer

Total Amount for 36 Equipments: 85.04 Million SAR

Petroleum Conversion Research Center

The Petroleum Conversion Research Center (PCRC) has been established in collaboration with Saudi Aramco to become a highly recognized applied research center for interdisciplinary and transformative research in petroleum conversion and sustainability. The Center aims to conduct research projects using dedicated pilot plants to bridge the gap between bench- and industrial-scale units. The Center will develop technologies that diversify the value-chain of petroleum. It will support the local and regional petrochemicals industry through collaborative research, innovation and training.

The Center will build infrastructure to facilitate the scale-up of process technologies from 'proof-of-concept' (TRL4) to 'pilot scale' (TRL6). Facilities at PCRC will complement research



facilities at IRCs to cover co-cracking of low-carbon streams, converting waste plastics to useful products, upgrading liquid hydrocarbons to chemicals, converting gas-to-liquids and producing renewable and alternative fuels.

The PCRC building area is 8,700 m² comprising a ground floor (2,900 m²) for pilot plant lab and five dedicated labs for reaction, catalysts synthesis, characterization, and analytical support. The pilot plant lab occupies 800 m² and comprises several state-of-the-art catalyst and process evaluation units. The first floor (1,955 m²) is dedicated for offices and meeting rooms while the basement (3,420 m²) is for parking and a mechanical workshop. The construction of the Center is expected to be completed by May 2024.

From Research to Innovation



5 IP license agreements 2023

20 Number of proof-of-concept

projects

168

Number of inventions in commercialization

6 Number of licenses to startups

Technology Classification of New Inventions

The classification of the 310 inventions, received by KFUPM's Innovation and Technology Transfer Office (ITT) during the year 2023, in different technology domains:

67 Advanced Materials Coatings	60 Basic Electrical Components, Control Systems, Scientific Instruments	47 Climate Sustainability, Renewable Energy. Buildings, Manufacturing, Water Conservation	28 Downstream: Petrochemicals, Catalyst Preparation, Oil Refining	25 Upstream: Drilling Technology, Geological Measurements
25 Computer-Image Data Processing, IoT, Artificial Intelligence	20 Water Treatment Technology	19 Membrane Technology	16 Nanotechnology	3 Others

ITT Knowledge Transfer Activities

Technology Licenses in 2023:

With over 15 years of experience, ITT partnered with the Saudi Authority for Intellectual Property (SAIP) to educate new executives from Saudi Arabia. ITT delivered online sessions covering basic and advanced levels of training in IP and technology transfer.

SAIP Attendees' Breakdown



æ 8 Non-profit Organizations

IP Management Services (2023)

For KFUPM's research and commercialization, ITT initiated and reviewed 23 research (collaborative, research and contractual), 11 non-disclosure, 4 material transfer, 4 memoranda of understanding, 2 joint invention administration agreement, and two licensing agreements.

23]]	04		
Research	Non-Disclosure	Material Transfer		
Collaborative, service, contract	Sharing confidential information	Sharing of material and data		

During the year 2023, ITT explored, negotiated, and signed licenses with startups and SMEs, including traditional license agreements, upfront commercialization terms, and options in technology collaborations.

> Yokogawa Saudi Arabia Co. received rights to commercialize the outcome of collaborative work with IRC-Sustainable Energy Systems on a multi-stage

A calcium scale removal product which can increase productivity of oil wells.

The product showed superior performance against other market dissolvers. A high-performance water-based drilling fluid formulation they developed in

MiscGlobal Co. received rights to commercialize the outcome of collaborative work with IRC-Smart Mobility & Logistics for intelligence and

Saudi Vehicle Electrification Co. received rights to an exclusive license for a solution to complete vehicle electrification being developed in collaboration

> ITT was honored by SAIP for ITT's efforts in supporting their goal of capacity building for the national ecosystem for intellectual property during the first annual ceremony of the National Network for Technology and IP Support Centers (TISCs).





Innovation Support

A. Proof-of-Concept Program

It aids KFUPM researchers to more effectively commercialize their innovations and accelerate technology transfer to local and global markets. PoC funds support prototyping and validating technical viability, enhancing the readiness level for subsequent commercialization phases such as MVP development, business planning, and securing seed capital. PoC includes a pipeline for identifying potential patents, with case managers inviting inventors to submit proposals. ITT informs and invites researchers to apply for the PoC Grant. The University has two PoC Grant Programs, with one geared towards specific technology area of renewable energy systems and funded by the National Industrial Development and Logistics Program (NIDLP) under the Renewable Energy Technical

B. Market Research Activities and Services

ITT regularly screens KFUPM's patents with the potential to offer an industrial competitive solution. ITT performs research for related companies for technology validation or minimum viable product criteria, and explores Incubator (RETI). The other grant is funded by KFUPM internal grants and KFUPM Fund and is open to proposals in all technology areas.

PROJECTS IN PROGRESS FROM PREVIOUS YEAR				
Progress Reports Evaluated 13				
CURRENT YEAR PROPOSALS				
Received	23 (13 under Renewable Energy Technical Incubator			
Evaluated	18			
Approved	11			

collaboration for technology advancement and/or licensing. During the year 2023, ITT executives performed market research for below-described patented inventions.

- Influence of ethylene oxide groups on cationic poly (ethylene oxide) gemini surfactants
- Controlled covalent functionalization of ZIF-90 as a strategy for selective CO₂ capture and separation
- Method to accelerate low-temperature oxidation for consolidation of incompetent formations
- Enhancing the switching speed of the nio-based electrochromic energy storage devices
- Energy harvesting techniques for wireless geophones
- Method of fabrication of a photoresponsive membrane for water decontamination and desalination
- H₂S removal from sour natural gas using CuMgAI layered triple oxides catalyst
- A method to reduce adsorption of cationic surfactants on carbonate rocks . using formic acid
- Citric acid-based N-alkyl amides for enhanced oil recovery applications
- Automatic addition of dots to Arabic text (Rasms)

ITT also carried out pre-research patent search landscape analysis, and market research for several IRCs. This helps researchers to determine if their inventions would be novel and relevant to the industrial needs. Items such as a list of

Green hydrogen market: value chain analysis

- Polymer electrolyte membrane electrodes for hydrogen production
- Ventricular assist or heart pump device
- Development of metal hydrides materials for hydrogen storage applications
- Boosting the coulombic efficiency and cyclic stability of iron-based redox flow battery for long-duration energy storage
- Patents that are related to "hydrogen"
- Catalytic cracking and zeolite-based catalysts
- Earth observation space telescope small satellite imagery
- Fault diagnosis in active grid

Innovation Partnerships with Startups

ITT initiated several collaborative activities for startups with research centers to extend basic ideas for innovation or early stage technologies. The startups can take a royalty-based license for the jointly owned IP resulting from the



A Blood Pump assist device designed to treat Congestive Heart Failure AI based customized online education for children in different subjects

relevant patents, patent trends, top companies, market size, market dynamics, and technology segmentation were provided. The following is the list of reports completed:

collaboration. ITT reviewed their ideas and business model, and established innovation linkages with KFUPM researchers/IRCs.



App to connect and arrange logistics between businesses to sell recyclable waste by reducing the intermediaries

A mobile data-center that adjusts loads based on grid energy usage variations to minimize carbon emissions and energy cost, and power Al and batch computing with lower cost.

A chemical treating process to reuse used RO membranes in water desalination and other applications.

Generative AI based startup leveraging and training Large Language Models.

> Partnership: Bridging Minds, Igniting Innovations

Outcomes of Industry and Research Partnerships



- KFUPM and MEWA the partnership aims to establish joint cooperation between the two parties in the fields of studies of various water resources. KFUPM is to search for ways of cooperation to address challenges faced by MEWA both locally and globally. The combination of academic expertise and governmental support is likely to yield valuable insights and contribute to sustainable water resource management practices in the region.
- 2. KFUPM and MAADEN launched the first Mining Science and Engineering Bachelor's Degree in Saudi Arabia at KFUPM, a major step in developing the next generation of talent in the Kingdom's mining sector. MAADEN is to sponsor 20 undergraduate students and 10 graduate students within the program, every year, to ensure a pipeline of skilled workforce in the mining sector.
- **3. KFUPM and NTIS** are collaborating in leading Quantum Computing Technology in the region. National Company of Telecommunications and Information Security (NTIS) aims to initiate a Research Center focused on Quantum Computing and transformative technologies at KFUPM, the first step towards ensuring and leading advanced quantum technologies within the Kingdom. The sponsorship of an

academic Chair program by NTIS, that will attract and retain top notch faculty will enhance the ability of both parties to achieve research missions agreed upon.

- **4. KFUPM and Lab 7** the collaboration with Saudi Aramco LAB 7 program is the first of its kind in the Kingdom. KFUPM specifically developed an MX program that was addressed towards the precise needs of the company and the advancement of its employees. Outcomes of the senior projects of Lab 7 students are to be incubated towards future commercialization and introduction to the market.
- 5. KFUPM and KPMG fostered collaboration in recruitment and training of KFUPM students and graduates was developed with Klynveld Peat Marwick Goerdeler (KPMG). International and local internships/co-ops for students are to be offered by the consulting company as well as providing workshops and educational sessions for students on the nature of auditing and consulting work.

KFUPM is to provide KPMG with access to the technical and human capabilities available at the University, whether student, faculty or researchers. 45 Project Agreements

Partners

Governmental Partners:

- 1. Ministry of Environment, Water and Agriculture
- 2. Ministry of Energy
- 3. Ministry of Defense
- 4. General Authority for Military Industries
- 5. King Abdulaziz City for Science and Technology
- 6. National Technical Information Service
- 7. Ministry of Communications and Information Technology
- 8. Prince Sultan Defense Studies & Research Center

Industrial Partners:

- 1. YOKOGAWA
- 2. ERG
- 3. KPMG
- 4. Emerson
- 5. MISC Global
- 6. ChampionX
- 7. Vitritech
- 8. Hydeva
- 9. Digital Petroleum
- 10. DEMA Energy
- 11. Acwa Power
- 12. OQ Technology
- 13. Gold and Minerals Ltd.
- 14. NOVEL
- 15. ELM
- ARGAS
 Weatherford
- 18. LAB 7 (Saudi Aramco)



The Industrial and Research Partnership Office plays a pivotal role in fostering collaboration and synergy between KFUPM and the industry. KFUPM signed several agreements for cooperation with government agencies, international universities, and major companies in vital sectors. These agreements aim to enhance the alignment of education and research outputs with the strategic needs of the Saudi Vision 2030 to strengthen national capabilities, invest in them, and prepare them for the future in various fields. Some of these agreements include benefiting from the undergraduate concentration programs (CX), Students Early Employment and Development (SEED), professional master's programs, and professional courses held at KFUPM.

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> Advancing Frontiers: **Impactful Research Projects**

IRC for Finance & Digital Economy

An Analytical Study of the **Economic Impact of the Kafalah Program**

This study was initiated to explore the economic impact of Kafalah on financing small and medium enterprises (SMEs). The Kafalah program is a national initiative that encourages financial institutions in the Kingdom to finance SMEs, considering the program is the guarantor for the SMEs to pay back the loans to the financial institutes. This helps SMEs to access funds to fulfill their needs at a low-interest rate.

The study has two main tracks; the first track was to assess the economic impact of the Kafalah program using detailed datasets to reveal how the program affects different economic indicators such as job creation, economic growth, and lower financing loans, as well as how the program performed during the Covid-19 pandemic and overall its positive contribution to Saudi Vision 2030. The

second track aimed to conduct an analytical study to determine the contributing factors that affect the efficiency of the Kafalah program and its service to finance SMEs. This track included collecting data from various sources, including structured surveys and interviews with concerned parties.

The 6-month study has yielded the following: (i) A detailed elucidation of the impact of the program in supporting different economic initiatives; (ii) Determined the appropriate way to assess various economic indicators and their impact, but more importantly revealed the accuracy of measuring this impact; and (iii) Determined how the program impacts the Saudi Vision 2030 goals of the Kingdom for improving the ecosystem of SMEs.



IRC for Sustainable Energy Systems

Self-Cleaning Photo Thermoelectric Air Conditioner (SC-PTAC)

The Self-Cleaning Photo Thermoelectric Air Conditioner (SC-PTAC) project, launched in 2023 under the Renewable Energy Technical Incubator (RETI) with substantial backing from the National Industrial **Development and Logistics Program** (NIDLP), aims to develop an innovative, efficient, and affordable, net zero air conditioning system resilient to Saudi Arabia's challenging climate.

Featuring movable photovoltaic (PV) panels on the upper section, a smart movable rack system is incorporated into the SC-PTAC system. This addition not only ensures a compact design but also facilitates the opening and closing of the PV panels. Brushes installed on the rack system remove debris and clean the PV panels, enhancing the overall performance.

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CONSUMPTION AND PRODUCTION

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Customizable in size and the number of thermoelectric modules (TEM) based on individual cooling needs, the SC-PTAC system utilizes axial fans at the cold junction for a constant airflow velocity of 1.2 m/s. The prototype is designed to be lightweight, portable, and devoid of refrigerants, compressors, or moving parts, differentiating it from traditional air conditioners.

Utilizing the Peltier effect of thermoelectric cooler and the photoelectric effect of PV, the SC-PTAC prototype boasts silent operation, precise temperature control, and complete reliance on solar power, aligning with ASHRAE Standard 55-2020 and UNI EN ISO 10551 Standards for indoor personalized thermal conditions.

Expected to target local HVAC industries and commercial buildings in Saudi Arabia, the SC-PTAC prototype holds significant commercialization potential. The incorporation of the movable rack system not only provides a compact design but also contributes to improved performance by ensuring the cleanliness and optimal positioning of the PV panels.



IRC for Hydrogen Technologies & Carbon Management

Blue Hydrogen Production by Sorption-Enhanced Reforming using **Bi-Functional Sorbent-Catalyst Materials: Process modeling and testing** for the Technology Deployment

This project aims to achieve several objectives: firstly, to develop a computational model for CO₂ adsorption in flow fields and validate it using experimental data; secondly, to create a kinetic model for steam methane reforming and integrate it with the CO₂ adsorption model; thirdly, to assess reaction performance for CO₂ uptake and H₂ yield across various parameters; fourthly, to synthesize bifunctional CaO-Ni materials for CO₂ adsorption and fuel reforming in Sorption-Enhanced Steam Methane Reforming (SE-SMR); fifthly, to explore the impact of higher hydrocarbons as feedstock compared to conventional hydrogen production techniques. The special about this project is the development of novel bi/tri-metallic catalysts for Sorption Enhanced Reforming (SER) using methane and Arabian oil or derivate feedstock. Starting with the synthetization of promising materials. The process involves modeling and optimization followed by characterizing and testing materials in a bench-scale

reactor. Expected outcomes include about a 25% reduction in the Levelized Cost of Hydrogen, more than 50% reduction in CAPEX with similar OPEX, and about 97% CO₂ capture rates with equivalent H₂ purity along with less than 40% lower carbon footprint. Also, the project can scale up for hundreds of MW by constructing a 10 MW plant for blue hydrogen production at KFUPM.



IRC for Refining & Advanced Chemicals

Novel Catalytic Routes for 1-Octene Production

Linear alpha-olefins (LAOs) are valuable commodity chemicals used as precursors in many areas of industry, such as synthetic lubricants and linear low-density polyethylene (LLDPE). The lubricant materials prepared from LAO are designed to provide superior lubrication performance over a wider operating temperature range than petroleum oils and are typically less volatile. Moreover, LAOs are also used as co-monomers in the polymer industry to enhance the physical properties of the polymer as well as in many other applications such as surfactants, fuel additives, adhesives, and chemical intermediates. LAOs traditionally have been produced via non-selective ethylene oligomerization. Due to the high demand for pure fractions of 1-hexene or 1-octene, selective ethylene oligomerization catalysts have been targeted for use on an industrial scale. To improve the process, higher catalyst activity and 1-octene selectivity are desired. Moreover, the selectivity for polyethylene byproduct should be minimized, to reduce reactor unit fouling and separation costs. IRC-RAC's joint collaboration project with Saudi Aramco is focused on the development of novel catalysts for ethylene tetramerization reaction that will permit the on-purpose preparation of 1-octene. The team at IRC-RAC has developed a series of novel diphosphinoamine (PNP)--based ligands and evaluated them systematically for CR-catalyzed ethylene tetramerization. The selected catalysts system easily



surpassed the targeted 1-octene selectivity of >70 wt. % while promoting ethylene tetramerization at a remarkable rate. The synthesized novel ligands were patented and the findings of this study were published in a series of scientific articles and it received a high-impact paper award from KFUPM.



IRC for Intelligent Secure Systems

WristSense: A Framework to Identify and Detect Aggressive Behavior

Wearable devices, such as smartwatches and wristbands, are becoming increasingly popular for continuous monitoring of the behavior of individuals while allowing them freedom of movement. Considering the rising popularity of wrist devices, it is important to explore their implications in digital forensics. Traditionally, digital forensics focused on examining computers, smartphones, and other conventional devices. However, the emergence of wearable devices, particularly wrist wearables, presents new opportunities and challenges in this field.

One challenge is the limited scope of previous research, which often focused on specific wristband operating systems without considering the overall market share of wearables. This may result in the omission of valuable information for digital investigations. Another challenge is the underexplored utilization of health data from wristbands in digital investigations. For example, investigating health indicators such as hypoxemia, which causes symptoms such as headache, difficulty breathing, rapid heart rate, and bluish skin, remains relatively scarce in the literature. Additionally, further research is needed to better understand the behavioral patterns of wearers, which can provide valuable clues for investigating the activities of offenders or victims.

This project aims to develop a framework for identifying digital circumstantial evidence and detecting risk factors associated with aggressive behavior. To achieve this, a systematic literature review was conducted, and a novel framework named "WristSense" was developed to extract health-related data from various wrist-wear devices and connect them with possible circumstantial evidence. The framework was evaluated through exploratory and collective case studies involving different manufacturers. Additionally, a dataset was collected in collaboration with the Public Security, Ministry of Interior, involving 40 participants who answered the BPAQ Buss Perry Aggression Questionnaire to determine their level of aggression. Finally, a machine learning model will be proposed to detect risk factors associated with aggressive behavior.

IRC for Communication Systems & Sensing

Sharing and Compatibility Studies in the Sub-700 MHz UHF Band

The project was performed for the Communication, Space, and Technology Commission (CST) and was executed in collaboration with KFUPM, KAUST, and KSU. It provided the theoretical base to support one of KSA's contributions to the World Radio Conference (WRC) 2023.

This project provides a comprehensive study on the co-existence of an International Mobile Telecommunication (IMT) system with a Digital Terrestrial Television Broadcasting (DTTB) system. The study considers the co-existence of the two systems in the sub-700 MHz band and presents the results of interference analysis for locations close to the border of KSA. Furthermore, the study includes different terrain in which each of the two systems is deployed, e.g., mountains, sea, desert, etc. The locations under consideration are selected to cover the whole border of KSA. Using an advanced terrain-aware-aware simulation software named HTZ Communications, the co-existence problem is studied in all cases. This study is structured into two main phases. The first phase focuses on studying the interference induced by the IMT base station and IMT User Equipment (UE) on the DTTB receiver in the 600 MHz band (from 614 to 694 MHz), whereas the second phase considers interference

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induced by DTTB on IMT base station and IMT-UE. This study implements such techniques and performs for all cases along the border of KSA. The project was complemented by the CST administration and was partially published in a joint journal article.

IRC for Membranes & Water Security

Hydrochemical, Isotopic, and Hydrogeophysical Investigation of the Groundwater in Eastern Coastal Aquifers of Saudi Arabia

The project addressed the pressing issue of seawater intrusion into coastal aquifers in Eastern Saudi Arabia, posing a significant threat to the sustainability of freshwater resources in the arid region. Employing a comprehensive approach, the project integrated hydro-chemical analyses, isotopic measurements, and advanced hydro-geophysical methods to map and model saline water intrusion into coastal groundwater systems. This initiative significantly enhanced our understanding of seawater intrusion into the eastern coastal aquifers of Saudi Arabia. The efforts of the interdisciplinary research team and the publication of four scientific journal articles in reputable journals contributed to the advancement of knowledge on

groundwater salinization. These publications explored integrated hydrogeological assessments, the application of artificial intelligence in salinization modeling, and the development of innovative algorithms for mapping and management of groundwater quality. By introducing novel tools and approaches, these studies offer valuable insights for scientists and policymakers to effectively manage water resources in the region. The outcomes of the project have far-reaching implications for water security, particularly in arid climates facing challenges of overuse and environmental changes that threaten water resources.



9 INDUSTRY, INNOVATION AND INFRASTRUCTURE





IRC for Construction & Building Materials

Development of NEOM UHPC Mixes for 120 Years of Service Life

Saudi Arabia's \$500 billion giga-project, NEOM, is a state-of-the-art new city in Saudi Arabia being developed with the ambition of making it a new vibrant destination as a leading futuristic global hub offering its inhabitants exceptional livability, thriving businesses, and reinventing conservation in line with the Saudi Vision 2030. The NEOM runs along the coastline of the Gulf of Agabah and the Red Sea with beaches, coral reefs, and mountains, including business hub Oxagon, luxury yachting arena Sindalah, the mountain resort of Trojena, and a smart linear city "The Line." "The Line," an engineering marvel, is a linear zero-carbon city spanning over 170 km with twin parallel skyscrapers 500 m above sea level separated by 200 m designed to accommodate a million residents in carbon-positive urban developments powered entirely by renewable and clean energy, setting a new standard for sustainable cities, created as a resilient. Therefore, NEOM awarded a major research project to KFUPM in September 2023, involving the development of ultrahigh performance concrete (UHPC) mixes with ultrahigh compressive strengths of more than 150 MPa and providing a service life of 120 years to be implemented in the construction of the Line project. Five UHPC mixes need to be developed using the raw materials sourced from NEOM and Western Region and cementitious materials, including ordinary Portland

cement, and natural and waste products as supplementary cementitious materials, including waste materials such as silica fume, granulated blast furnace slag and fly ash and Saudi natural pozzolan for sustainable construction. The project is a part of the innovation goal of the IRC-CBM, in which waste materials and CO2 are used extensively for this project. The research aims to establish the requirements for durability of super concrete mixes required to achieve a design life of 120 years for the project-wide harsh conditions, including marine exposure, ensuring corrosion protection of reinforcement using probabilistic service life modeling software for service life design. UHPC mixes with optimized embodied carbon, providing an ultrahigh strength and a service life of 120 years, and will be developed for the NEOM Line Project.



IRC for Biosystems & Machines

Pulse VAD First Biotechnology (Medical Device) for Diastolic Heart Failure/HFpEF Treatment

3 GOOD HEALTH AND WELL-BEING





The aim of applying the PulseVAD concept is to develop the first lifesaving heart pump to fulfill the vast unmet technological requirement of identifying 50% of heart failure patients (Diastolic Heart Failure with preserved Ejection Fraction), where lung congestion is the main pathological cause. This is the first pulsatile heart device that mimics heart physiology. In contrast to the common use of VADs in conventional heart failure cases (with reduced ejection fraction), atrial cannulation is desirable to directly reduce lung congestion. Atrial unloading must be performed during cardiac systole so as not to interfere with the opening of the mitral valve. In systole, the mitral valve is closed. In diastole, the mitral valve is open, and lowering pressure can cause premature closing of the valve. Uncontrolled unloading of the heart

especially the left ventricle can cause suction, arrhythmias, and thrombi. The pump must be accelerated and decelerated in the appropriate time-frame to regain pulse. We want to use the electrocardiogram (ECG) and an accelerometer to determine the appropriate time to increase and decrease RPM suitably for each patient using an individualized speed control algorithm. Currently, we are developing a control system with a focus on sensors, leads, and algorithms. The algorithms in the project aim to develop a smart system, which includes a compact control system weighing about 1.6 kg. The project also has the potential to develop smart batteries with a long lifespan of about 11 hours (the lifespan of currently available batteries is 6 hours) that can be used for several medical applications.



JRC for Artificial Intelligence-SDAIA

Al Application to Detect Skin Cancer

Cancer ranks among the leading causes of mortality in the current century, with skin cancer standing as the sixth most lethal form. Melanoma, although rare, constitutes the deadliest variant of skin cancer, comprising a mere 5% of cases in the US. Yet, it is responsible for a staggering 75% of skin cancer-related deaths, claiming approximately 10,000 lives annually. Healthcare professionals emphasize early detection as crucial for saving lives. To address this, at the JRC-SDAIA, we launched a project related to the development of a computer-aided diagnostic system for skin lesions to create a web and mobile-based diagnostic system. Open-source datasets have been collected, prepared, and analyzed to develop deep-learning computer vision models. Binary classification models have achieved an impressive 85% accuracy in distinguishing



cancerous from noncancerous lesions. To tailor these models for implementation in Saudi Arabia, a web-based data curation platform has been established in collaboration with senior dermatologists at the National Guard Hospital in Riyadh. This platform, hosted at the SDAIA-KFUPM Joint Research Center for Artificial Intelligence, enables dermatologists to upload images of skin lesions and clinical data over a year. The amassed dataset is expected to enhance the applicability of AI models tailored for diagnosing skin lesions within Saudi hospitals. The successful development of this platform not only serves its immediate purpose but also holds the potential for expansion into a biodata bank at King Fahd University of Petroleum & Minerals. This expansion could support broader initiatives in medical AI and personalized healthcare research.

Development of an Effective Corrosion Inhibitor Formulation for High Temperature Sweet **Gas Wells**

develop a corrosion inhibitor formulation to effectively control corrosion in Pre-Khuff sweet sandstone gas wells at high temperatures. There are only a few commercially available corrosion inhibitor formulations for high-temperature applications to serve the enormous demand, and most of them start to fail above 100 °C. Therefore, corrosion inhibitors capable of maintaining their efficacy above 100 °C are in high demand for most deep oil and gas wells with high temperatures, high pressures, and high total dissolved solids (TDS) encountered in global operations. The Interdisciplinary Research Center for Advanced Materials (IRC-AM) at KFUPM proposed in 2018 the development of high-temperature corrosion inhibitor formulations (CI) for the protection of tubing in these gas wells using local expertise at IRC-AM at KFUPM.

The main objective of this study was to

This project was conducted in two phases. Phase I conducted from October 2018 to November 2020, the IRC-AM team designed, synthesized, and characterized up to 15 novel molecules and evaluated them as high-temperature corrosion inhibitors. The performance of two of these molecules as high-temperature corrosion inhibitors under conditions prevailing in sweet gas wells was promising. Phase II, which commenced in November 2021 and was completed in December 2023, involved the formulation of the corrosion inhibitors and the evaluation of their performance and secondary properties. IRC-AM team successfully developed a novel corrosion inhibitor technology for Pre-Khuff sweet sandstone gas wells at high temperatures from 120-170 °C. The outcome of this project resulted in the granting of joint US patents and several journal and conference publications.



Autoclave System for Evaluation of Corrosion Inhibitor at High Temperature



Upconverting Common Visible Light Sources into Ultraviolet-C **Radiation Sources**

Ultraviolet-C (UVC) radiation (200-280 nm) are widely used in disinfection and sterilization of water, air and objects in municipal water plants, healthcare facilities, food industry, public transportation facilities, public and residential spaces, home appliances and last but not least the upstream oil and gas sector. Currently, the dominant UVC radiation sources are low-pressure mercury discharge lamps, which are bulky and fragile and contain toxic mercury. With the implementation of the Minamata Convention on Mercury in 2017, the future uses of mercury-based UVC radiation sources will be strictly limited.

A research team at CIPR have developed a series of visible-to-UVC upconversion phosphors that can efficiently upconvert commonly accessible, low-intensity, and low-energy visible light sources, such as normal natural sunlight and commercial visible-light LEDs, into high-energy, germicidal UVC radiation. The ability of the UVC phosphors to be excited by natural sunlight would offer a sustainable approach to upgrade water that is produced along with oil and gas in remote and arid locations to water that can be reinjected. Moreover, the technology will have ubiquitous use in waste water disinfection and treatment, outdoor surface sterilization and cleaning, solar photocatalysis, solar hydrogen production, and solar conversion of CO₂ to fuels. The





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Center for Integrative Petroleum Research

ability to be excited by visible-light LEDs would provide an easy and economical way to make mercury-free UVC lamps by simply placing a phosphor thin film onto the LED chips of visible-light LED lamps, such as the house-use white LED lamps. An invention disclosure describing the compositions and fabrication methods of the UVC phosphors (KFUPM Reference #: 2023-316) has been filed to KFUPM Innovation & Technology Transfer Office.



IRC for Smart Mobility and Logistics

Advanced Air Logistics: The Development of Medium Altitude Long Endurance Cargo Drone



The research center for Smart Mobility and Logistics is committed to developing advanced air logistics cargo drones. This goal is the result of a comprehensive study conducted by the center to assess both the Kingdom's needs and the global trend in cargo shipments. To achieve this goal, the research center has collaborated with Woot Tech Aerospace to design, manufacture, and operate long-distance middle-mile shipments using autonomous drones. The EssBee525 is a medium-altitude long-endurance aircraft with a high payload capacity, extended range, flight speed, endurance, and operational efficiency. It is a 100 kg fixed-wing VTOL, which does not require a

runway to fly. It can take off and land vertically using electric motors. The class-leading 16kW two-stroke engine powers forward flight. The cargo drone was initially designed to handle inter-city logistics. In addition to transferring knowledge and technology locally, the team went one step further by innovating and developing intellectual property. Indeed, the team has filed a patent application for an innovation that has the potential to disrupt the market for last-mile logistic drone solutions. This year sees the introduction of the first full-size mock up iron bird. This will be followed by prototype production in a dedicated facility at KFUPM.



IRC for Aviation and Space Exploration

Experiment for Cloud Seeding in Microgravity

The cloud seeding experiment in microgravity which is groundbreaking research, conducted aboard the International Space Station, represents a significant milestone in space technology and environmental science. It was sponsored by the Saudi Space Agency and developed in collaboration with a private in-space services company, the project aimed to test the formation of rain under microgravity conditions by condensing water vapor on Agl crystals.

This experiment has garnered international recognition for its innovative approach to addressing challenges related to water scarcity on Earth and advancing capabilities for future space

17 PARTNERSHIPS FOR THE GOALS

8



exploration, particularly in human settlements on celestial bodies like the Moon and Mars. The project underscores KFUPM's dedication to pioneering research and positions the university at the forefront of space science and sustainability initiatives.

The Interdisciplinary Research Center for Aviation and Space Exploration played a significant role in this project, contributing not only to advancing the understanding of weather phenomena but also paving the way for new possibilities in artificial rain generation. This could revolutionize environmental management strategies on Earth and for future human settlements on the Moon and Mars.

ARC for Environment and Marine Studies

Assessment and Characterization of Coastal and Inland Sabkhas in NEOM

9 ADUSTRY, INNOVATION AND INFRASTRUCTURE





This project commenced in September 2022 and ended in December 2023 with a budget of more than 2 million SAR. The study was executed using two major surveying methods: (i) Reconnaissance Survey and (ii) Detailed Survey. In the reconnaissance survey, ARCEMS studied 16 potential sabkha sites (with areas ranging from 0.6 to 12.7 square kilometers) to identify the confirmed sabkhas. Based on the results of the reconnaissance survey, the following 4 sabkhas were identified for detailed surveys: (i) Inland Gayal Sabkha, (ii) Coastal Gayal Sabkha, (iii) NEOM Bay Sabkha, and (iv) Um-Al-Hussaini Sabkha. The detailed survey is composed of the

following: (i) A landform study, (ii) Geological characterization, (iii) Physicochemical characterization of soil, (iv) Determination of the water chemistry of Sabkhas, and (v) Environmental DNA (eDNA) metabarcoding of soil microbes.

The importance of the project is that it is the first time a systematic study on various aspects of Sabkhas in NEOM was conducted. Besides, KFUPM conducted an eDNA study for the first time, and the knowledge, experience, and lessons learned from this study are valuable and will be useful for similar studies in other parts of Saudi Arabia.



ARC for Center for Metrology, Standards & Testing

Utilization of Brine Sludge in Developing Value-Added Construction Materials

In the study, brine sludge (BS), a byproduct generated during the electrolysis of brine in chlor-alkali manufacturing plants for the production of chlorine and caustic soda, was utilized to create value-added construction materials. Disposing of BS poses a significant challenge to local petrochemical industries, especially in light of stringent environmental regulations. Several types of concrete were prepared using BS and then evaluated to assess their mechanical properties and durability. The experimental findings from this study demonstrated that BS can serve multiple purposes: (i) contributing to the

INDUSTRY, INNOV AND INFRASTRUC

13 CLIMATE ACTION



development of binary cementitious materials, (ii) acting as an activator in the production of alkali-activated binder, (iii) enabling the creation of controlled low-strength materials, and (iv) facilitating the manufacturing of blocks and tiles. Optimal compositions of BS were recommended for each of these value-added structural components. Incorporating BS into the production of structural elements offers environmental benefits (addressing the challenge of BS disposal and reducing cement consumption), economic advantages (lowering production costs), and technical enhancements (improved properties).

IRC for Intelligent Manufacturing and Robotics

Innovative Strides: Advancing Collaborative Robotics

Collaborative Robots, or cobots, are no longer confined to the realm of science fiction. At the IRC-IMR center at KUPM, we have embarked on an ambitious quest to integrate collaborative robots into shared workspaces, where they operate alongside human counterparts to enhance efficiency, precision, and safety. These advanced machines are designed and programmed to adapt to a variety of operations, ranging from simple assembly to complex manufacturing processes, thereby improving industrial tasks in alignment with our research objectives.

A notable objective of our research is the creation of a scalable closed-loop control platform for collaborative robots. Furthermore, we are pioneering the integration of Al-based algorithms into our collaborative robot system. These innovative algorithms equip the robots with the capability to autonomously learn



and execute new tasks, significantly improving their adaptability and success rate in industrial settings. The effectiveness of these algorithms is being rigorously tested and validated using IRC-IMR's state-of-the-art Meca500 arms.

We are also developing a library of functions from which any robot can select and assign to start collaboration, further demonstrating our commitment to advancing the frontiers of collaborative robotics.

Inspection Robot System

The IRC-IMR center, in collaboration with a leading robotic company in KSA, has developed an inspection robot system for hydrocarbon industrial tanks to detect corrosion and cracks. This marks the first joint venture at KFUPM. The robot builds upon previous versions and is designed to operate effectively under harsh conditions.

The robot is based on an integrated eight UT transducers for large surface coverage. It includes cartesian dynamic location history to help to position accurately the defects and helps to issue the results to be analyzed in a post-process method. The robot can clear its front space to allow measurement and it is equipped with a sonar that allows the robot to maneuver between obstacles and avoid collisions.



The inspection reports include tank geometry, inspection paths, and identified defects. The robot has successfully conducted inspections on water and diesel tanks, with plans to trial crude oil tanks next to assess its readiness for this task. The robot is certified to operate in zone zero by TUVSUD in compliance with inerting of gas API 505.

Research Journals: Nurturing > **Excellence and Global Impact**

Arabian Journal for Science and Engineering (AJSE)

Since its establishment in 1975, the AJSE has grown into a highly respected publication, a collaborative effort between KFUPM and Springer. This journal plays a crucial role in disseminating research not only from Saudi Arabia but also from the wider MENA region and beyond.

In terms of global reach, AJSE experienced a record-breaking year in 2023, receiving 12,600 manuscripts from contributors in 90 different

countries. This underscores the journal's status as a truly international platform within the Springer-Nature portfolio, with submissions spanning a diverse range of disciplines and originating from a wide geographic spread. Out of the total submissions, AJSE published 1,055 papers in 2023, reflecting an acceptance rate of approximately 8.40%. AJSE achieved Scopus CiteScore of 5.2 and a Clarivate Impact Factor of 2.9, placing it in the second quartile (Q2).

Arabian Journal of Mathematics (AJM)

AJM reflects on a decade of growth and achievement, asserting its position as a premier publication in the field. Published by Springer and owned by KFUPM, AJM maintains its commitment to high-quality research.

Indexed by MathSciNet, zbMath, Clarivate, and Scopus, AJM boasts a Clarivate Impact Factor of 1.2 and a Scopus CiteScore of 2.0, ranking 83rd and 110th in their respective categories. In 2023, the journal achieved 73,730 downloads, attesting to its global readership and impact.

Authored Books: A Showcase of Scholarly Contributions

22 books have been published in 2023 which were authored and edited by KFUPM researcher and KFUPM faculty.











AJM actively seeks contributions globally, with over 700 submissions in 2023, accepting 40 papers at an approximate 6% acceptance rate. This stringent process ensures the inclusion of impactful and groundbreaking research.







Arabian Journal of Mathematics

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> Transformative Impact: Bridging **Research to Society's Advancement**

KFUPM social programs aim to empower and train educators, students, and community members to become effective leaders and agents of change.

The volunteering unit aims to instill a culture of volunteering among the academy's community and to foster a spirit of social responsibility and civic engagement.

There is a lot to celebrate and be proud of in the nonprofit sector at KFUPM. These achievements are only possible thanks to the dedication, passion, and collaboration of all the players involved. KFUPM cooperated with the National Center of Nonprofit Organizations, private-sector donors, Indiana University, and others to make significant achievements in recent years

11th Nonprofit Development **Sector Forum**

Nonprofit Development Sector Forum, which was held in 2023, attracted 504 participants from various fields and backgrounds. This forum is an annual event that started in 2011 which provides a platform for contact and interaction between international practitioners and local experts in the nonprofit sector. The forum showcases best practices, trends, challenges, and opportunities in the field and facilitates networking and collaboration among stakeholders, international practitioners, academics, and local nonprofit executives. This forum paves the way for potential adoption of international best practices to suit the Saudi context.

Introducing the Master in **Nonprofit Management Program**

KFUPM, in partnership with Indiana University has established the Master in Nonprofit Management program at KFUPM. Nonprofit workers can now pursue this prestigious degree while still engaged in their work through this fully-funded executive program that includes travel to USA for a semester at Indiana University.

Four Social Development Programs Receive National Accreditation



KFUPM has achieved remarkable milestones in the field of community development and social responsibility by obtaining national accreditation for four of its programs:

EDAMA, RAED, RASHEED, and the new MOEEN for organizing volunteering in private sector. These accreditations were by the National Center for Non-Profit Sector, the Ministry of Education, and the National Institute for Educational Career Development. These programs aim to empower and train educators, students, and community members to become effective leaders and agents of change.

315 Total Voluntary Work Units have been Established with the Help of KFUPM!

OOD!

Edama, is the program that aims to establish 6.000 voluntary work units in non-profit organizations and

government agencies by 2027. These units follow the Saudi National Standard of Voluntary work units which were built by KFUPM and accredited by the Ministry of Human Resource and Social Development and provide a variety of opportunities for volunteers to serve their communities. So far, 315 units have been established, with the support of the Ministry of Human Resources and Social Development and other foundations. These units have created more than 30,000 volunteering opportunities, attracting more than 160,000 volunteers who have dedicated more than 1.8 million hours of their time. The economic value of these hours is estimated at more than SAR 100 million.



25,000 Students Trained in **Volunteering and Social** Responsibility

Raed program trains students from higher education institutions in leader ship, entrepreneurship and innovation skills. This program has reached almost 25,000 students since 2019, with nearly 20,000 trainees in 2023 alone. The goal is to reach more than 1.6 million trainees by 2027, preparing them for the future challenges and opportunities in the labor market and society.



Rasheed trains the following: secondary school students, teachers, and education and school leaders in volunteer administration, social

responsibility and citizenship education. This program has trained 221 educators so far and plans to reach more than 6 million trainees by 2027. The program aims to foster a culture of social responsibility and civic engagement among students and schools.

23 Partnerships Established in the **Community Development Sector**

KFUPM, through its Alfozan academy has established 23 partnerships and cooperation agreements with various stakeholders in the community development sector, including three in managements-of-education, 17 universities and colleges, and three sponsors: Saudi Aramco, the Ministry of Energy, and the National Center for Non-Profit Sector. These partnerships enable the academy to expand its reach and impact, as well as to exchange knowledge and best practices with other institutions.

Now you can volunteer through KFUPM

One of the most notable achievements of the KFUPM's **Alfozan** academy is the establishment of a volunteering unit that coordinates and supports the volunteer activities of the academy's staff and beneficiaries. The volunteering unit has recorded impressive numbers in terms of volunteer engagement and contribution. The unit has mobilized 120 volunteers from the academy, who have dedicated 5,200 volunteer hours to 37 volunteer opportunities. Moreover, the volunteering unit has facilitated the participation of more than 750 students from the Saudi Aramco **Raed** program in various volunteer opportunities provided by around 40 nonprofit and government organizations. The students have contributed more than 16,900 volunteer hours, which translates to an economic value of approximately SAR 642,200. The volunteering unit aims to instill a culture of volunteering among the academy's community and to foster a spirit of social responsibility and civic engagement.

Achievements of KFUPM's Alfozan Academy: Establishment of a Volunteering Unit



Renewable Energy Technology Incubator (RETI)

In a synergistic alliance with The National Industrial Development and Logistics Program (NIDLP), RETI was inaugurated as a cutting-edge Renewable Energy (RE) technical incubator, a comprehensive program, at KFUPM in 2021. This endeavor aims to galvanize students, engineers, researchers, and the local community, encouraging them to harness the immense possibilities presented by renewable energy, energy efficiency, and Industry 4.0 for pertinent technological advancement within the Kingdom. 23 million SAR venture with a four-year horizon, is generously funded by NIDLP. It stands as a beacon of technical incubation in the Kingdom of Saudi Arabia, amalgamating diverse intellectual resources.

Student Engagement



Powering Progress: IRC-SES Secures Qassim Award for Excellence and Creativity

The IRC for Sustainable Energy Systems (IRC-SES) proudly secured the prestigious Qassim Award for Excellence and Creativity in May 2023. This distinguished recognition stands as a testament to the remarkable strides made by the center in the field of clean and renewable energy. The award not only acknowledges the excellence of IRC-SES but also highlights the innovative contributions that have significantly advanced the landscape of sustainable energy.

The recognition is a direct result of the center's unwavering commitment to groundbreaking research and innovation, showcasing a profound dedication to fostering sustainable solutions for the global energy challenges of today and tomorrow. The Qassim Award underscores the impact of IRC-SES's efforts, reinforcing its pivotal role in shaping the future of energy systems.



IRC-SES was honoured with the prestigious Qassim Award for Excellence and Creativity

Dr. Ali Al-Sheikhi, Vice President for Research and Innovation at King Fahd University of Petroleum and Minerals, received the award on behalf of IRC-SES. The ceremony, graced by the presence of HRH Prince Dr. Faisal bin Mishaal bin Saud bin Abdulaziz, marked a significant moment in the center's journey, reflecting not only on past achievements but also setting the stage for future breakthroughs.

This Award serves as a testament to the collaborative spirit and ingenuity of IRC-SES, positioning the center as a beacon of excellence in sustainable energy research and innovation. The Qassim Award for Excellence and Creativity is a symbol of recognition for the impactful endeavors undertaken by IRC-SES, and it further solidifies the center's commitment to pushing the boundaries of clean and renewable energy technologies.

> Major Research Events

The vision of the KFUPM Institute for Knowledge Exchange (KIKX) is to be a leading global hub for knowledge exchange, fostering impactful scientific events that connect experts, inspire collaboration, and drive advancements in research, academia, and industry.

Its mission is to provide a platform for organizing high-quality scientific events that foster knowledge exchange and collaboration between academia, industry, and other key stakeholders to facilitate the translation of scientific discoveries into real-world applications. Through meticulous planning, seamless coordination, and a commitment to excellence, we strive to create impactful experiences that contribute to the advancement of knowledge, economic growth, and societal well-being.



180

317

190

Application

73

Voluntee

2023 Events Statistics

The data reveals a shift in event formats, with virtual events decreasing and physical events increasing over time. Winter 2022 witnessed a dominance of virtual events (93%) most likely due to the post-pandemic period. However, Fall 2023 saw a significant increase in physical events (78%). This trend suggests a growing interest in physical events. Nonetheless, given the number of virtual event attendees, representing about 35% of total attendance throughout the data period, there is an opportunity to reach a wider audience by considering hybrid events when feasible.

3,470 Virtual Attendance

6,520 Physical Attendance

83% Attendant Rate

Our goal at KIKX is to be the main partner for academic departments and research centers at KFUPM that wish to organize scientific events that create impactful experience for all stakeholders. We are pleased to see a notable increase in collaborations, growing from 37% to 60% within a year. This growth demonstrates the trust and recognition we have earned as a valuable partner in organizing scientific events at KFUPM. Moving forward, we will continue to nurture and expand these partnerships, fostering knowledge exchange events for the ongoing excellence of KFUPM.



KIKX Highlights

Thanks to the invaluable collaboration of academic departments and research centers at KFUPM, we are thrilled to announce the successful curation of a diverse lineup of speakers from 30 countries last year. Their contributions added a global tapestry of perspectives, insights, and expertise to our events. This achievement showcases KFUPM's commitment to fostering a rich and inclusive environment for knowledge exchange and networking.

Our priority at KIKX is to ensure a comfortable and accommodating stay for all speakers. From arranging transportation to and from the airport/venue to providing well-appointed accommodations, we aim to create a seamless and enjoyable experience for our speakers throughout their stay. By addressing these logistical aspects, we free our speakers to focus on delivering their expertise and engaging with the audience, ultimately contributing to the overall success of the events.

To enhance the experience of our esteemed speakers, we have also organized social tours to introduce international speakers to the local culture. These tours have made a

Top Events by attendance

Event Title

Women in Data Science

Generative AI and the path to Artificial General Intelligence

Sources of knowledge (Arabic lecture)

Saudi International Conference On Nuclear Power Engineering

A Full Day Experience on the Future of Energy at KFUPM

How to write a good academic paper?

My Journey to Becoming an Astronaut Cloud Computing: Challenges and Opportunities

Design and Synthesis of Nanomaterials

Breakthrough Upstream Technologies from CPG and its Partners





significant impact by fostering cultural exchange and creating memorable experiences for our speakers. By immersing themselves in the local community, speakers gain a deeper understanding of the region and forge meaningful connections with the community. These social tours do not only enhance the overall event experience but also contribute to building long-lasting relationships and promoting cross-cultural understanding, which is what we are aiming to achieve.

Countries of Speakers Affiliation for All Events Organized in 2023

3181N	Saudi Arabia	+	Norway		Austria
	United States	<u>ê</u>	Slovenia		Bahrain
	United Kingdom		Denmark		Bangladesh
٠	Japan	\mathbf{X}	Scotland		Cyprus
	France	*	Canada	•	Malaysia
	Poland		Qatar	* *	Georgia
₩	Australia	8	Egypt	нH	Finland
C	Pakistan		Belgium		Italy
	Germany	C *	Turkey		South Korea
*)	China		Netherlands	۲	India

Total Number of Attendance Image: Conference Image: Conference Image: Conference State Montschop Sp3 Tis 0 100 150 200 250 300 350 400 450 500 550 600 650 700 Workshop 595 715 0 100 150 200 250 300 350 400 450 Workshop 595 715 0 100 150 200 250 300 350 100 100 100 715 10 10 10 10 100</





Saudi International Conference on Nuclear Power Engineering

In November 2023, King Fahd University of Petroleum & Minerals (KFUPM) achieved a significant milestone by hosting the inaugural Saudi International Conference on Nuclear Power Engineering (SCOPE). SCOPE, a first-of-its-kind technical conference in the Kingdom of Saudi Arabia, brought together world-renowned researchers and scientists from 39 countries to exchange research and ideas, fostering nuclear research and development for peaceful purposes. SCOPE provided a unique platform for professionals and students to participate and learn about the latest developments in the nuclear field for peaceful purposes.

This groundbreaking conference spanned three technical days event, featuring nine tracks covering various aspects of the nuclear field. The conference received an overwhelming response, with 238 submissions from 95 institutes representing 39 countries. The submissions underwent rigorous peer review, supported by 150 international reviewers who diligently assessed and enhanced their quality. The selected contributions were presented as part of 100 technical presentations, 42 posters, and 29 student research pitch presentations. In addition, one day preceding the three technical conference days was dedicated to 9 workshops covering various crucial topics in the nuclear field.

The SCOPE conference commenced under the patronage of KFUPM President, Dr. Muhammad Al-Saggaf. In his opening remarks, Dr. Alsaggaf announced the establishment of the Interdisciplinary Research Center for Industrial Nuclear Energy (IRC-INE) at KFUPM to foster cutting-edge scientific research and innovations in nuclear science and technology for peaceful applications. Dr. Ali Al-Shaikhi, Vice President of Research and Innovation, welcomed esteemed guests and encouraged nuclear experts to continue serving humanity.

The conference featured an essential panel iscussion on the role of education and training for a peaceful nuclear program, including distinguished panelists such as Prof. Emilio Baglietto (Professor at Massachusetts Institute of Technology, USA), Dr. Michaela Ovanes (Senior Nuclear Knowledge Management Specialist at International Atomic Energy Agency, Austria), Prof. Leon Cizeli (President of European Nuclear Society, Slovenia), Dr. Martina Adorni (Nuclear Safety Specialist at the Nuclear Energy Agency (NEA), France) and Mrs. Kim Pringle (Director of Human Capacity Building, KA-CARE, Saudi Arabia).

SCOPE became a hub of knowledge sharing and inspiration through keynote and invited talks by globally renowned nuclear experts, including Prof. Andreas Pautz (Paul Scherrer Institute (PSI), Switzerland), Prof. Michael Ojovan (Professor, Imperial College London (ICL), UK), Dr. Damien Féron (Past



Dr. Muhammad Al-Saggaf (KFUPM President)

President - World Corrosion Organisation, France), Prof. Luis E. Herranz (CIEMET, Spain), Dr. Benjamin Volmert (Nagra, Switzerland), Dr. Dr. Sanjeev Gupta (Becker Technologies, Germany), Dr. Maciej Lipka (Nuclear PL, Poland), and Yasir Arafat (Aalo Atomics, USA).

The chair of the conference steering committee, Dr. Ali Al-Shaikhi, honored panelists, keynote speakers, and invited speakers with awards at the gala dinner. The technical part of the conference concluded with an engaging awards distribution ceremony.

SCOPE received support from two Diamond Sponsors, the Nuclear and Radiological Regulatory Commission (NRRC) and King Abdullah City for Atomic and Renewable Energy (K.A.CARE), along with the Ministry of Energy (MOE) as a Strategic Partner. The day following the SCOPE conference, KFUPM organized a social tour to Al Ahsa, allowing participants to explore Saudi culture and hospitality.



General chairs of the SCOPE conference Dr. Afaque Shams (Left) and Dr Khaled Al-Athel (Right)



A group photo of panelists, keynote and invited speakers from the conference gala dinner



Conference guests during their trip to Al-Ahsa



Dr. Ali Al-Shaikhi, Vice President of Research & Innovation (left), along with Dr. Afaque Shams, Coordinator Nuclear Initiatives at KFUPM (right), giving an award to Abdullah Al-Asif

Highlights from the Research Events



RC for Membranes and Water Security

Water Sustainability and Conservation Symposium This symposium aimed to present the research activities and focus areas of the Interdisciplinary Research Centre for Membranes and Water Security (IRC-MWS). The center members, affiliates from academic departments, and their students presented 40 posters during the symposium.



SDAIA-KFUPM JRC for Artificial Intelligence 4th Annual Women in Data Science

Organized by SDAIA-KFUPM Joint Research for Artificial Intelligence and Stanford Women in Data Science, the "4th Annual Women in Data Science (WiDS@KFUPM) Workshop" surpassed all attendance expectations, drawing 715 in-person attendees and over 1000 virtual attendees. It provided an excellent opportunity for networking and initiating collaborations.

IRC for Hydrogen Technologies & Carbon Management **Circular Carbon Economy Introductory Workshop**

KFUPM, in collaboration with the University of Oxford and KAPSARC, has pioneered the inaugural Circular Carbon Economy (CCE) training course in the capital city of Riyadh. This introductory workshop has provided critical knowledge on the science of climate change, the CCE approach, and its four levers, offering valuable insights for achieving sustainable development, economic growth, and the net-zero target by 2060.



IRC for Refining & Advanced Chemicals Joint Saudi Japanese Symposium

IRC for Intelligent Secure Systems

Python for Scientific Computing, Artificial Intelligence, & Cyber Security Bootcamp

The IRC-ISS and the Saudi Aramco Cybersecurity Chair organized a successful bootcamp at KFUPM, tailored for engineering, computing, and scientific professionals interested in Python for Scientific Computing, TensorFlow for AI programming, and Al-powered cybersecurity with the support of KIKX.



IRC for Biosystems and Machines PulsVAD Project Kickoff Workshop

In a collaborative effort between KFUPM and the Northern Development Group, this workshop marked the beginning of a project focusing on advanced LVAD technology customized for Heart Failure with Preserved Ejection Fraction patients. It underlines KFUPM's commitment to enhancing healthcare through innovative solutions.



Generative AI and the Path to Artificial General Intelligence

This event showcased the most advanced human-like robot, Sophia, which personifies the dream for the future of AI. As a unique combination of science, engineering, and artistry, Sophia is simultaneously a human-crafted science fiction character depicting the future of AI, and a platform for advanced robotics and AI research.





The thoughtfully curated two-day symposium left an indelible mark with its resounding success. The event served as a vibrant hub for the exchange of knowledge and cultural immersion, garnering immense appreciation from Japanese participants and attendees alike.



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