Center Of Excellence in Energy Efficiency (CEEE)

Annual Progress Report - 7

May 2025

Annual Report Information

Duration (months)	**19**	**Start Date**	Oct. 2023	**End Date**	May 2025
Director	Dr. Atif Al-Zahrani				
Progress Report Due Date:	May 2025				

Executive summary

This report details the significant achievements of the Center of Excellence in Energy Efficiency (CEEE) at KFUPM from January 2023 to May 2025. CEEE's accomplishments include the completion of energy auditing projects at KFUPM's Chiller plants, which led to estimated annual savings of 135,414 kWh/year and a reduction in CO_2 emissions of about 78,072 kg/year. The center is also involved in a study analyzing a rooftop solar AC system for the KFUPM bus station, with an estimated carbon reduction of 29,000 kgs.

CEEE has been actively engaging with industries and other entities. They have submitted pre-proposals to GREENER by IHCC for a "Solar Chimney for Building Walls for Energy Saving" project and to TAQA for an energy audit to explore power savings and reduce emissions.

A core focus of CEEE is human capacity building. The center has trained students through internships and provided energy efficiency training sessions to KFUPM faculty members and students. CEEE also facilitated an industrial visit to the Qurayyah Independent Power Plant for KFUPM students and sponsored faculty members for Certified Energy Manager (CEM) training and certification.

CEEE has organized and participated in various awareness campaigns, workshops, and seminars. They hosted an AEE event on intelligent buildings, collaborated with the American Space in Nigeria for an energy conservation and efficiency seminar, and conducted energy efficiency training for young students.

CEEE also supports student-led initiatives, including the KFUPM male and female student energy clubs. CEEE has guided these clubs in organizing seminars, visits to industrial facilities like Siemens Energy, and energy-related competitions such as the "Engineer’s Shark Tank" and a sticker competition focused on energy conservation.

Finally, CEEE also organized the first-ever KFUPM Energy Week, a collaboration with student clubs and four other universities to celebrate the UN International Day of Clean Energy, featuring competitions, hackathons, debates, workshops, and an energy expo.

To plan for the future, CEEE has discussed its proposed business plan with five stakeholders, and the outcomes of these discussions are detailed in the report's final section.

Outlines

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I. Introduction & Overview:

Founded in October 2016, the Center of Excellence in Energy Efficiency (CEEE) at King Fahd University of Petroleum & Minerals (KFUPM) is dedicated mainly to improving the energy efficiency of buildings and industries in Saudi Arabia and the Middle East region as well. CEEE is a national center created with support from Saudi Energy Efficiency Program (SEEP) in response to Saudi Arabia's Vision 2030 to contribute towards supporting sustainable development, covering energy efficiency and renewable energy solutions, and promoting modern energy technologies and techniques within the country. CEEE offers public and nonprofit services in improving energy efficiency and management through disseminating knowledge and training courses, supporting research and development, promoting innovative technologies and new ideas, and creating public awareness. CEEE also aims to facilitate technology transfer and applied research in the realm. Its establishment was with the support of funding from the King Abdulaziz City for Science and Technology (KACST) as an initiative under the Saudi Energy Efficiency Center (SEEC).

CEEE's Vision: Striving for Educational Excellence in Energy Efficiency

CEEE's Mission: To disseminate knowledge on energy efficiency and to conduct and promote impactful practices in the field of energy efficiency.

CEEE's main objectives:

1. Training students and professionals in the field of energy efficiency and helping nucleate human capital development to cater to the energy-efficiency market.
2. Conducting energy audits of small/medium-sized industrial facilities and buildings.
3. Supporting SEEC in developing new standards and policies in the field of energy efficiency.
4. Undertaking applied research projects in the field of energy efficiency to keep the Kingdom at the cutting edge of the technologies related to energy efficiency.
5. Increasing the awareness of the local community of the benefits of energy efficiency.

II. Projects & Engagement

Projects

The KFUPM Center of Excellence in Energy Efficiency (CEEE) has undertaken various projects, including energy audits of chiller plants resulting in significant savings, the analysis of a rooftop solar AC system for the bus station, and a numerical study of ammonia production. CEEE also reviewed Saudi building codes for mosques and contributed to the field through journal publications on energy efficiency and solar-driven air conditioning.

1. Energy Auditing of KFUPM Chiller Plants

CEEE has completed the energy auditing and assessments of two chiller plants at KFUPM which measured and assessed their chiller performances and electric energy consumptions. This project also examined and assessed water leakage and thermal leakage or hot spots in both chiller plant #82 and chiller plant phase 4&5. The CEEE team supervised 22 KFUPM students in conducting the measurements, analyzing the measured data, and in writing the energy audit report in the two plants.

Earlier in the course of this project, CEEE provided an intensive theoretical and practical energy efficiency training to the students of Energy Efficiency and Auditing course (ME 429) and prepared them for the purpose of this project. The students took the lead and specific tasks were assigned to each of them at every step of the project. Overall, the estimated annual savings amount to 135, 414 kWh/year, a reduction in CO_2 emission of about 78,072 kg/year, a financial savings of about 101,560 SAR/year *(Full report is found in Appendix I)*.



Figure 1:Energy Auditing of 2 KFUPM Chiller Plants

2. Data Acquisition System in the KFUPM Bus Station With Roof-top Solar AC System

The CEEE team is presently working on the study titled “Techno-Economic Analysis of Rooftop Bifacial-Photovoltaic System for Net Zero Campus Bus Station: A Case Study for Arid Climate”, based on the system shown below.



Figure 2: Photovoltaic Direct-driven Inverter Multi VRF System (1) Actual (b) schematic

The recorded cooling consumption and PV generation for the bus station in 2021, 2022, and 2023 are illustrated independently in the graphs below.



Figure 3: Recorded cooling consumption and PV generation

The team has performed simulation modeling using PVSYST as per the existing sizing and design and a carbon reduction of 29,000 kgs is estimated. A techno-economic study will be conducted by comparing with simulation and existing real data. Specific details of this project include:

Cooling System	Direct-driven Inverter Multi Variable Refrigerant Flow (VRF) System
Cooling Capacity	~33.5 kW
Rooftop PV installed	7.7 kWp (23 PV panels, 335 Wp each)
Cooling power input	~ 8.4 kW
PV generation (~ 3.3 years)	38.58 MWh
Consumption (~ 3.3 years)	38.26 MWh
Carbon Emissions Reductions	29,000 kgs

3. Numerical Investigation of a Multistage Ammonia Production System

This study aims to numerically investigate a multi-stage ammonia production system, assessing the feasibility of low-pressure technology integration and conducting a techno-economic analysis to develop an optimized digital twin model for Yokogawa, ultimately enhancing efficiency. The research will also explore incorporating a low-pressure hydrogen supply and will analyze various operating conditions and parameters to identify optimization opportunities for improved efficiency and cost-effectiveness. One publication has been published, and more are in the process.

- Adib Adnan, Ayman Al Mukahhil, Binash Imteyaz, Mustafa Al Naser, Esmail M.A Mokheimer, Parametric Analysis of Non-Adiabatic Internal Direct Cooling Ammonia Synthesis Reactor, Canadian Society for Mechanical Engineering International Congress, 31st Annual Conference of the CFD Society of Canada, May 26-29, 20224-University of Toronto.

4. Other projects

CEEE optimized its resources by re-evaluating three projects. The KFUPM mosque and students' dorm projects were thoughtfully concluded following the initial progress and principal investigator's transition and a strategic evolution of the center's research goals. The thermoelectric cooling project secured alternative funding, resulting in a successful transition and the overall strategic reallocation of approximately 2,170,484.00 SAR to support future endeavors.

1	Energy Efficiency Improvement in KFUPM Mosques	Closed
2	Energy Efficiency Improvement in KFUPM Students' Dorms	Closed
3	Photo-thermoelectric air conditioner system: Net Zero air cooling *(results are shown in appendix II)*	Transitioned to RETI

5. Policies for Building Code Concerning Mosques in Saudi Arabia

CEEE reviewed two Saudi Building Codes and prepared a report containing comments specifically pertaining mosques. The two reviewed codes are *Saudi Green Construction Code (SBC 1001-CC)* and *Saudi Building Code General (SBC 201-CC)*.

A detailed review of the Saudi Building Codes specifically SBC 1001-CC (Green Construction Code) and SBC 201-CC (General Code) highlights the need to reevaluate how mosques are classified and regulated within national construction policy frameworks. Currently grouped under Assembly Group A-3 (Section 303.4), alongside venues such as art galleries, community halls, and bowling alleys, mosques exhibit unique architectural and operational characteristics that are not adequately addressed under this general classification. For instance, mosques lack fixed seating and require large, open, and flexible interior spaces to accommodate variable congregation sizes and specific religious practices. Moreover, emergency egress planning in mosques differs significantly from recreational or civic buildings, warranting tailored safety and exit strategies. In the context of SBC 1001-CC Section 608.4.2, which mandates exterior lighting and signage shutoff between midnight and 6:00 a.m., the current rule does not account for religious facilities like mosques, where prayer activities may occur outside conventional business hours, including early morning (Fajr) and late-night (Taraweeh or Qiyam) prayers. While the code allows jurisdictions discretion in defining "facility operations," inconsistent interpretations may limit mosques to minimal lighting usage (e.g., 6–12 hours/week), potentially impacting accessibility and safety. Therefore, it is strongly recommended that national policy recognize mosques as a distinct sub-category within Assembly Group A-3 or establish a dedicated classification under SBC. This would ensure more precise regulatory compliance, context-sensitive safety requirements, and energy use policies that

accommodate religious and cultural norms, while still aligning with the broader objectives of sustainability and fire safety. More detailed information can be found in *Appendix III*.

6. Journal Publications

CEEE collaborated with its affiliates to publish journal papers in the field of energy efficiency and solar-driven air conditioning systems in Saudi Arabia. Thus, three papers were published in this regard through the coordination of Dr. Kashif Irshad as highlighted below:

- *Analysis of photovoltaic thermoelectric air conditioning for personalized cooling in arid climate*. https://doi.org/10.1016/j.jobe.2024.108533. The authors fabricated and evaluated the PTE-AC system, which operates exclusively on solar PV power to create distinct hot and cold chambers for personalized cooling.
- *Buildings' Heating and Cooling Load Prediction for Hot Arid Climates: A Novel Intelligent Data-Driven Approach* https://doi.org/10.3390/buildings12101677. In this research, the authors offered a SSRD-SsIF-NN method to improve the predictive performance of a residential structure's cooling and heating demands.
- *Numerical analysis and design of a novel solar photovoltaic thermal system using finned cooling channel structures embedded with air/TiO2–water nano bi-fluid*. https://doi.org/10.1016/j.solener.2024.112368. In this study, the authors presented a detailed 3-D numerical investigation and comparative performance analysis on a BFPVT based on the simultaneous cooling with both natural air and water/TiO_2 nanofluid under two structures of cooling channels (finned and non-finned configurations). In the process, the authors conducted parametric analysis and an energic analysis.

Engagement:

CEEE at KFUPM is driving sustainability and energy efficiency through collaborations like the "Solar Chimney" research with Greener by IHCC and an energy audit for TAQA. Internally, CEEE is working towards a net-zero carbon footprint for KFUPM, establishing a Net-Zero Energy Test Bed House, and contributing to UN SDG 7 rankings. Additionally, CEEE supports SEEC by tracking energy efficiency education at KFUPM, where hundreds of students enroll in related courses each term.

1. Industries

a. *Solar Chimney for Building Walls for Energy Saving*

Greener by IHCC, based in Jeddah, Saudi Arabia, has initiated a collaboration with the Center of Excellence in Energy Efficiency (CEEE) and requested for a research and development in the field of Sustainability, Solar energy, and Energy Efficiency. In this respect, CEEE prepared and submitted a pre-proposal to GREENER by IHCC titled "*Solar Chimney for Building Walls for Energy Saving"* and is waiting for their response.

The primary objective of this partnership is to conduct an in-depth study on the potential application of Solar Chimney technology for cooling building walls. The research aims to assess the viability of Solar Chimneys as a sustainable cooling method, with a focus on reducing energy consumption and carbon emissions, while enhancing overall energy efficiency in buildings.

The deliverables for this project will include:

- A comprehensive final report summarizing the entire project, including objectives, methodologies, findings, conclusions, and recommendations for industry stakeholders.
- Publication of research results in relevant journals and presentations in conferences to contribute to the body of knowledge in sustainable building practices.

The duration of this proposed energy audit will be 12 working months, and the estimated cost is SAR 254,000.

b. *Energy Audit for TAQA*

TAQA, a Dammam based company in Saudi Arabia, has approached the Center of Excellence in Energy Efficiency (CEEE) and requested for an energy audit. The goal is to explore potential power savings, reduce carbon emissions, and improve the efficiency of their facility located in the second industrial city, Dammam. On May 16, 2024, a team from CEEE visited the TAQA facility for a walkthrough and preliminary discussion regarding the project requirements.

The primary objective of this energy audit is to identify opportunities for power savings, carbon emission reduction, and improved efficiency at the TAQA facility in Dammam 2nd Industrial City. Additionally, the CEEE will provide training and awareness to TAQA employees, along with recommendations and standardized methods to enhance performance.



Figure 4:CEEE team's visit to TAQA

The duration of this proposed energy audit will be 3 months and the estimated cost for the proposed project is SAR 194,000

TAQA is looking for the following:

- Reduce emissions
- Reduce energy consumption
- Assess rooftop solar PV opportunity
- Awareness in energy efficiency

2. KFUPM

a. NET-ZERO Carbon Footprint University Campus

CEEE is proposing ways for KFUPM to achieve a carbon neutral campus. This means that KFUPM's input of energy, water, food, and so forth will be equal to or less than the total output. In other words, CEEE is aiming for KFUPM to achieve a "net-zero" carbon footprint. CEEE's benchmarking identified that Monash University's Energy Institute and Climate works Centre together with the UN Sustainable Development Solutions Network of over 1,700 Universities have developed a detailed guide to support the *Net Zero Initiatives* of colleges and universities worldwide.

Globally, more than 1,000 colleges and universities have committed to reaching net zero emissions. In order to accelerate this progress on sustainable development and climate change, the *Net Zero on Campus Guide* was developed to provide these institutions with the support they need to decarbonize their campuses. The office of sustainability/net zero is also necessary in achieving smart universities. However, the goal of becoming a carbon neutral institution require about 2 decades as it requires a monumental commitment, a great deal of planning, and often a lot of money. Notable universities in this race include

MIT, Monash University, Stanford University's, University of Maryland, York University, Oxford University, and the University of Birmingham.

The three most sought after ranking and rating systems are:

- The Association for the Advancement of Sustainability in Higher Education (ASSHE)'s Sustainability, Tracking and Rating System (STARS),
- The Princeton Review's Guide to Green Colleges, and
- The Sierra Club's Cool Schools list.

b. Proposal for net zero house campus.

This proposal details the refurbishment of a KFUPM house by the Housing Department to establish a Net-Zero Energy Test Bed House Facility, aimed at creating a research center for sustainable building practices, energy efficiency, and net-zero design concepts. Having received initial approval, the project seeks to transform the house into a dynamic and flexible space that will provide a truly educational experience by supporting practical experiments and the testing of innovative materials and technologies, such as smart windows, advanced insulation, and renewable energy systems. The modifications will prioritize adaptability, allowing for easy installation and replacement of research components, and fostering an environment conducive to learning and discovery for researchers, students, and faculty.



Figure 5: Picture of the targeted house

c. UN SDG Impact Ranking 2024 Report

As previously conducted, CEEE, in collaboration with IRC-SES, assisted the KFUPM office of planning and Quality in coordinating and documenting KFUPM's annual contributions under the *Affordable and Clean Energy* category of the United Nations Sustainable Development Goals (UN SDG 7). This document covers all reports, proposals, presentations, pictures, or any other documents that can significantly contribute to KFUPM's efforts towards securing a higher score in SDG 7.

3. Saudi Energy Efficiency Center (SEEC)

CEEE continuously supports the Saudi Energy Efficiency Center (SEEC) in their effort to monitor the effort of educational entities in spreading energy-efficiency knowledge dissemination. Thus, CEEE compiled the details of students enrolled in different courses related to energy efficiency and management offered by KFUPM's Electrical Engineering department, Mechanical Engineering department, and Architectural Engineering and Construction Management departments within this period. In term 222, 792 students were enrolled in 32 courses whereas in term 231, 681 students registered in 27 courses across the three departments in KFUPM. Similarly, 468 students enrolled in 27 courses in term 232 while in term 241, 249 students enrolled in 31courses accordingly.

III. Human Capacity Building

Human capital development is a core to the CEEE's main objectives. Therefore, the Center continues to offer and prioritize the training of students, faculty members, and other professionals by developing and participating in various impactful training programs as highlighted below:

Some programs were conducted by the center itself, while others were conducted in collaboration with students' clubs.

CEEE-led activities

1. Internship

CEEE completed the training of 2 SURE (summer research program) students, 2 MX Students, 1 COOP, and 1 Mawhiba student. Dr. Binash Imteyaz and Dr. Kashif Irshad assisted in coordinating and supervising the training of these students.

Two MX students, Mr. Faisal Alsohmi and Mr. Fahad Alolayan, are collaborating on an investigation into an integrated blue ammonia production and oxy-combustion power generation plant. Additionally, COOP student Ms. Amani Ahmad is delving into the fundamentals of nuclear reactors and the emerging field of small modular reactor

technologies. Furthermore, Ms. Noor Al-Madan, a Mowhiba/Ibdaa student, is exploring an integrated system combining PEM electrolysis, an oxy-combustion cycle, and ammonia synthesis. Finally, Mr. Ahmed Albagami and Faisal Sulaiman Alneif, participating in the SURE program, are conducting CFD analysis of a thermoelectric air funnel cooler system. These diverse projects showcase the students' engagement with cutting-edge research in sustainable energy and power generation.

2. Courses

a. Assisting KFUPM Faculty Members in Teaching EE-related Courses

The Center of Excellence in Energy Efficiency (CEEE) continues to provide support to the faculty members of King Fahd University of Petroleum & Minerals (KFUPM) in the delivery of courses pertaining to energy efficiency. The CEEE collaborated with two esteemed faculty members from the Departments of Electrical and Mechanical Engineering at KFUPM to facilitate both theoretical and practical training in the field of energy efficiency and management for their students.

CEEE, through Dr. Binash Imteyaz, coordinated with the instructor of **ME 429**, Dr. Esmail Mokheimer, and offered three training sessions to three sets of students enrolled in the Energy Efficiency and Auditing (ME 429) course during term 232, 241 and 242. The students’ engagement focused on energy efficiency, as well as energy auditing and assessment methodologies. Subsequently, practical sessions were conducted on the utilization of energy audit instruments for conducting precise measurements. The two training sessions were held in the CEEE laboratory on **May 23, 2024**, **September 19, 2024**, and **March 3, 2025**, respectively.



Figure 6:Energy Efficiency Hands-on Training to ME 429 Students on May 23, 2024 (a) September 19, 2024 (b) and March 3, 2025 (c).

Furthermore, as per the request of the **EE 459** instructor (Dr. Mohamad Abido), CEEE arranged an energy efficiency training session for **23 students** taking the Electrical Energy Efficiency (EE 459) course in term 241. The training session was held in the CEEE laboratory on **September 24, 2024**, and focused on energy auditing and assessment as well as instrumentation.



Figure 7:Energy Efficiency Hands-on Training to EE 459 Students

Overall, these hands-on training sessions 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.

b. Industrial Visit to Qurayyah Independent Power Plant (QIPP)

CEEE team facilitated an industrial visit to Qurayyah Independent Power Plant (QIPP) for KFUPM students enrolled in ME 435 in term 231. This field training provided students with valuable insights into largescale 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. This training was coordinated with the instructor of the course in person of Dr. Binash Imteyaz and took place on October 26, 2023.



Figure 8:Educational Visit to Qurayyah Power Plant, October 2023

3. Energy Efficiency Certification to Saudi Faculty Members

CEEE is increasing its effort towards human capital development by providing a comprehensive in-person training to selected Saudi faculty members from Imam Abdulrahman bin Faisal University and KFUPM. Thus, this training covered different aspects of energy efficiency and conservation while focusing on comfort requirements, energy audit codes and standards, energy audit instruments, and other aspects of energy auditing and assessment. The training took place on August 22, 2024 in the CEEE laboratory, KFUPM. The beneficiaries of this training are Dr. Mussad AlZahrani (IAU), Dr. Fahad Al-Amri (IAU), Dr. Jihad Al-Sadah (KFUPM), Dr. Azzam AlFarraj (KFUPM), and Ms. Leen AlGhamdi (IAU).



Figure 9:Energy Efficiency & Conservation Training to Faculty Members

The training also focused on equipping the 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. Based on the suggestions of the Board of Directors of the CEEE in its 11th meeting, CEEE is obliged to create more initiatives that will nationalize their effort as a national energy efficiency center. As such, CEEE obtained approval from KFUPM and sponsored five faculty members for their Certified Energy Manager (CEM) Training and Certification.

This CEM training and sponsorship is the first of its kind outside the KFUPM. The training was held in Jubail, Saudi Arabia from September 01 - 05, 2024 and was sponsored at the rate of 6900 SAR for each candidate. Therefore, the total cost of the training was 34,500 SAR.

4. Awareness campaigns

a. Hosting AEE event

CEEE hosted an AEE event titled "Introducing the New Era of Intelligent Buildings," on Tuesday, April 8, 2025. The event aims to explore how cutting-edge AI, IoT, and smart automation are transforming building management. Attendees learned about the latest trends and case studies focusing on successful implementations of smart technologies to enhance occupant experience and improve equipment maintenance and optimization.

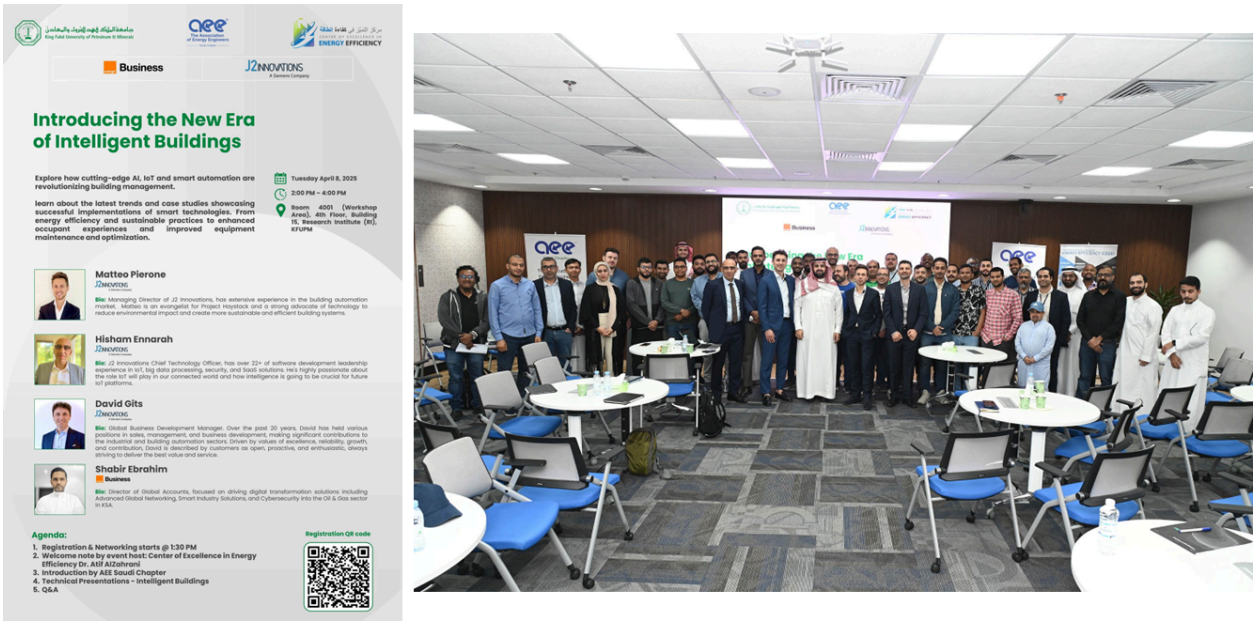


Figure 10: Flyer and a photograph of attendees to AEE event

b. CEEE and American space in Nigeria

The CEEE has gone international by collaborating with the American space to offer a seminar on *energy conservation and efficiency* to create more awareness on energy efficiency and environmental sustainability. The environmental group of the *Nigeria National Youth Service Corps* attended the seminar, which had 30 participants in attendance. This seminar was facilitated and delivered by a CEEE team member in person of Eng. Jamilu Garkuwa and was held at the state library complex Bauchi on July 25, 2024.



Figure 11:Energy Conservation and Efficiency Seminar held on July 25, 2024 in Nigeria.

c. CEEE and young generation

CEEE continued conducting its energy efficiency training and awareness campaign by offering a series of training sessions both virtually and physically. This training is an opportunity to create more energy efficiency awareness among the young generation in Saudi Arabia as a step towards the realization of Saudi Vision 2030. Eng. Jamilu Garkuwa also offered **two** seminars to Preparatory-Year – Female and Preparatory-Year – Male students, respective



Figure 12Energy Conservation Day Seminar at KFUPM Preparatory-Year.

CEEE also participated in the KFUPM university-wide events marking the Energy Conservation Day. Dr. Ahmad Samir offered **two** seminars to KFUPM high school students on 10th and 14 December 2023, respectively. Overall, **64 students** benefited by attending these seminars.



Figure 13:Energy Conservation Day Seminar at KFUPM High School

d. Workshops

The CEEE team collaborated with the IRC-SES to offer and participate in short courses aimed at creating more energy efficiency awareness and assisting in human capacity building. These training sessions were offered through the Renewable Energy Technical Incubator (RETI) and sponsored by the National Industrial Development and Logistics Program (NIDLP). The three short courses offered are:

- Energy Efficiency and Management (September 12 - 14 2023).
- Maximizing Energy Potential: Mapping The Road to Sustainability and Efficiency (May 13 – 15, 2024)
- Energy Optimization for Sustainable Development (Jan 26-28 2025)



Figure 14: Flyers for the developed courses in energy efficiency



Figure 15:Energy efficiency short courses

For the first time CEEE offered a certified and Arabic content short course in Maximizing Energy Potential: Mapping the Road to Sustainability and Efficiency in a virtual setting for over 150 Students from different universities to nationalize its efforts. CEEE invited experts

from Saudi Aramco, SADAIA, and IRC-SES who shared extensive knowledge and practical experiences with the attendees about Energy management and utilization, efficiency, conservation, retrofitting and smart energy consumption and minimizing energy losses in buildings and other facilities.

Student-led activities

The KFUPM presently has both male and, recently, female students' energy club operating independently under CEEE's technical guidance and supervision. The activities of the two clubs are summarized and highlighted below is a pictorial representation of the club's activities within this period.

The male Students Energy Club was established in August 2018 with the support of the Center for Excellence in Energy Efficiency (CEEE) and the Student Affairs Department at the King Fahd University of Petroleum & Minerals (KFUPM). The KFUPM Female Energy Club was established in 2023. Its vision is to empower students by fostering a vibrant community of energy enthusiasts, where knowledge meets opportunity.

CEEE's continuous effort in assisting and managing the Students' Energy Club to help them yield positive outcomes has been successful. CEEE guides the club in coordinating their programs, and activities. These activities include conducting energy-related projects, organizing seminars, lectures, and organizing technical meetings.

1. **Seminars & visits**

Engaging with industry professionals and specialists is crucial for building expertise in energy efficiency and the broader energy sector. To this end, the energy club has already hosted several seminars and organized a visit to Siemens Energy.



Figure 16: Collection of seminars by student clubs



Figure 17: Flyer for the visit to Siemens energy

2. Competition:

a. Engineer's Shark Tank

The CEEE collaborated with the Female Energy Club in organizing an energy competition titled *"Engineer's Shark Tank: Innovative Renewable Energy Application Pitch"* which took place on November 21, 2024, between 6:00 PM – 8:00 PM in KFUPM Building 24, Room 121.



Figure 18:Posters for the Engineer Shark Tank competition organized by the Female Energy Club.

This competition highlighted six (6) presentations from KFUPM students (both male and female) which was supervised by CEEE's experts. The CEEE also assisted financially in this competition by contributing SAR 6,000 to the total SAR 10,500 prize pool money (1st prize 5,000 SAR, 2nd prize 3,500 SAR, and 3rd prize 2,000 SAR).



Figure 19: A Glimpse from the venue of the Engineer Shark Tank competition

b. Sticker Competition

The Center of Excellence in Energy Efficiency (CEEE), in collaboration with the KFUPM Students' Energy Club, organized a university-wide sticker competition among all KFUPM students (both undergraduate and graduate including female students). This competition is intended to create awareness of Energy Conservation and Efficiency among the KFUPM community and beyond.

CEEE assisted the club in setting the rules of the competition and guided the participants in developing and improving relevant content for their sticker designs. The competition had 28 contestants. Ms. Baiq Mira Nurfatihah (MSc. Bioengineering) prize: 3,000 SAR, Ms. Maria Campos Ramirez (Geosciences) prize: 2,000 SAR, and Mr. Asipi M. Qostolani (MSc. Materials Science & Engg.) prize: 1,000 SAR emerged as 1st, 2nd, and 3rd place winners in the competition.



Figure 20: Sticker Competition on Best Practices for AC Energy Efficiency in Buildings.

c. Energy week

The Center of Excellence in Energy Efficiency at KFUPM organized the first-ever KFUPM Energy Week, celebrating the UN International Day of Clean Energy.



Figure 21: Energy week activities

The national event is a collaboration with student clubs and four other universities (IAU, PMU, KFU, and UPM) to bring together students and faculty passionate about a sustainable future. Over 80 students participated in our "Energy Rush" competition, and 30 teams from different universities tackled the "Green Campus" hackathon. Also, the center hosted the energy debate with 6 teams and 6 judges from 3 universities, and 3 parallel workshops on hydrogen, solar energy, and energy efficiency, with 25 participants in each. At the end, an energy expo featured 2 inspiring speakers, and a panel discussion was conducted.



Figure 22:A Glimpse from the venue of the Engineer Shark Tank competition

IV. Performance Indicators & Future Directions

1. CEEE Key Performance Indicators (up to May. 2025)

CEEE's Key Performance Indicators (KPI) illustrates the main activities of the center (up to May 2025) as shown in the table below.

CEEE KPI (up to Dec. 2024)	
Measures	**Comments**
1. Offer at least 4 energy efficiency training sessions to KFUPM students to create more awareness for CEEE	Completed 4 in-person training sessions.
2. Conduct 3 EE training and awareness visits to high schools and nearby universities (Outreach)	Offered 2 lectures to KFUPM high school and one to nearby university in a workshop format.
3. Complete the training of at least 5 KFUPM COOP, SURE, Uxplore, MX, Mawhiba students	Trained 2 SURE, 2 MX, 1 COOP, and 1 Mawhiba students.
4. Organize at least 2 webinars / workshops on Energy Efficiency and Management in Buildings	Completed 3 workshops
5. Organize 2 one-day students competitions in the field of energy efficiency through the students energy club	5 competitions were managed
6. Conduct EE awareness campaign through posters or stickers to improve the behavior of students and staff towards energy utilization	Completed through student's sticker competition
7. Completion of the data acquisition system in the KFUPM Bus Station with roof-top solar AC system	Managed by Dr. Kashif and his team
8. Complete the Energy Auditing of 2 KFUPM Chiller Plants	Completed and prepared the reports.
9. Discuss CEEE's new business model with at least 3 entities/companies	Discussed with SEEC, Saudi Aramco, KFUPM, and Quantum Saudi ESCO.
10. Complete the procurement of all approved energy audit instruments	Possessed all instruments needed for conducting energy audit projects at hand.
11. Continue developing policies for Building Codes regarding Mosques in Saudi Arabia	A report has been prepared for further improvement.
12. Publish 3 journal papers related to EE and solar-driven air conditioning systems in Saudi Arabia	Completed: Published 3-related papers.
Closed projects	
13. Complete the retrofitting of one KFUPM students' dorm	
14. Complete the Energy Efficiency Improvement of one KFUPM Mosque	
15. Conduct the project titled "Performance and efficiency optimization of photo-thermoelectric air conditioner system: net zero air cooling	

2. Future Goals & Strategic Plans

Despite exploring various avenues and engaging with multiple companies regarding sole energy audits, the center has found minimal interest, especially with the existence of numerous ESCO companies, even when offering comprehensive packages that included individual training. Consequently, the center has determined that its future business plan should prioritize human capital development. This modified version of CEEE has been presented to key stakeholders, and the revised plan is shown below.

Table 1: Stakeholders consulted about CEEE business plan

	
Dr. Saleh Mutairi Director General, Community & Offices	Naif Alragass Deputy Director General
KFUPM	SEEC
	
Mohammad Wathaifi Engineering Specialist Vice Chairman Energy Systems Optimization Standards Committee	Sami M. Jradat Measurement & Verification Manager
Saudi Aramco	Quantum Saudi ESCO

The following agreements have been reached regarding the center's direction:

1. It was determined that the existing vision and mission remain valid and will therefore not be altered.
2. The objective will be modified to remove research and development activities due to their duplication with the work of the sister center, IRC-sustainable energy systems.

3. Furthermore, while stand-alone audits will no longer be part of the core objective, they may be included in educational programs for students and others or offered as services to KFUPM or external entities.
4. A new objective centered on Supporting Sustainability at KFUPM will be introduced, offering valuable experiences for students and researchers and benefiting the environment.

The subsequent two tables outline the center's future operational framework.

Table 2: Vision, mission and objectives of CEEE

Vision	
Striving for Educational Excellence in Energy Efficiency	
Mission	
To disseminate knowledge on energy efficiency and to conduct and promote impactful practices in the field of energy efficiency	
Current CEEE Objective	**New CEEE Objective**
Educate & Develop students & professionals	Human Capital Development
Audit Facilities for EE	Energy Efficiency Solutions
Policy Support to SEEC	Supporting Sustainability at KFUPM
Research & Innovate	
Community Awareness	

Table 3 : Operational framework of CEEE

Human Capital Development	**Energy Efficiency Solutions**	**Supporting Sustainability at KFUPM**
Energy-Focused Events	Education and Outreach (content and delivery)	Annual Sustainability Reports
Students' Clubs Support	Consultation (Policy assessment & development)	Net-Zero Energy Models
EE Training & awareness	Technical Studies (Energy-related studies)	EE Technical Support to KFUPM
EE Educational Resources		

Based on this the new KPI (May 2024-May 2025) include:

	CEEE KPI (up to May. 2026)	
Measures	**Marching with Objective**	**Comments**

Conduct at least 5 energy-focused events (seminars, workshops, competitions)	Human Capital Development	
Train 80 students and professionals in energy efficiency.	Human Capital Development	
Develop a new online module or course components.	Energy Efficiency Solutions	
Conduct 3 outreach programs.	Energy Efficiency Solutions	
Complete a consultation project (policy assessments, curriculum, toward a net zero KFUPM campus).	Supporting Sustainability at KFUPM	
Complete 1 technical study (energy-related).	Energy Efficiency Solutions	
Provide data and content for the annual KFUPM sustainability report per year.	Supporting Sustainability at KFUPM	

Appendix I

Energy Auditing of KFUPM Chiller Plants

Appendix II
Photo-thermoelectric air conditioner system: Net Zero air cooling

Appendix III
Saudi Building code

Appendix IV
Net zero house proposal