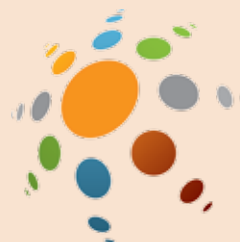
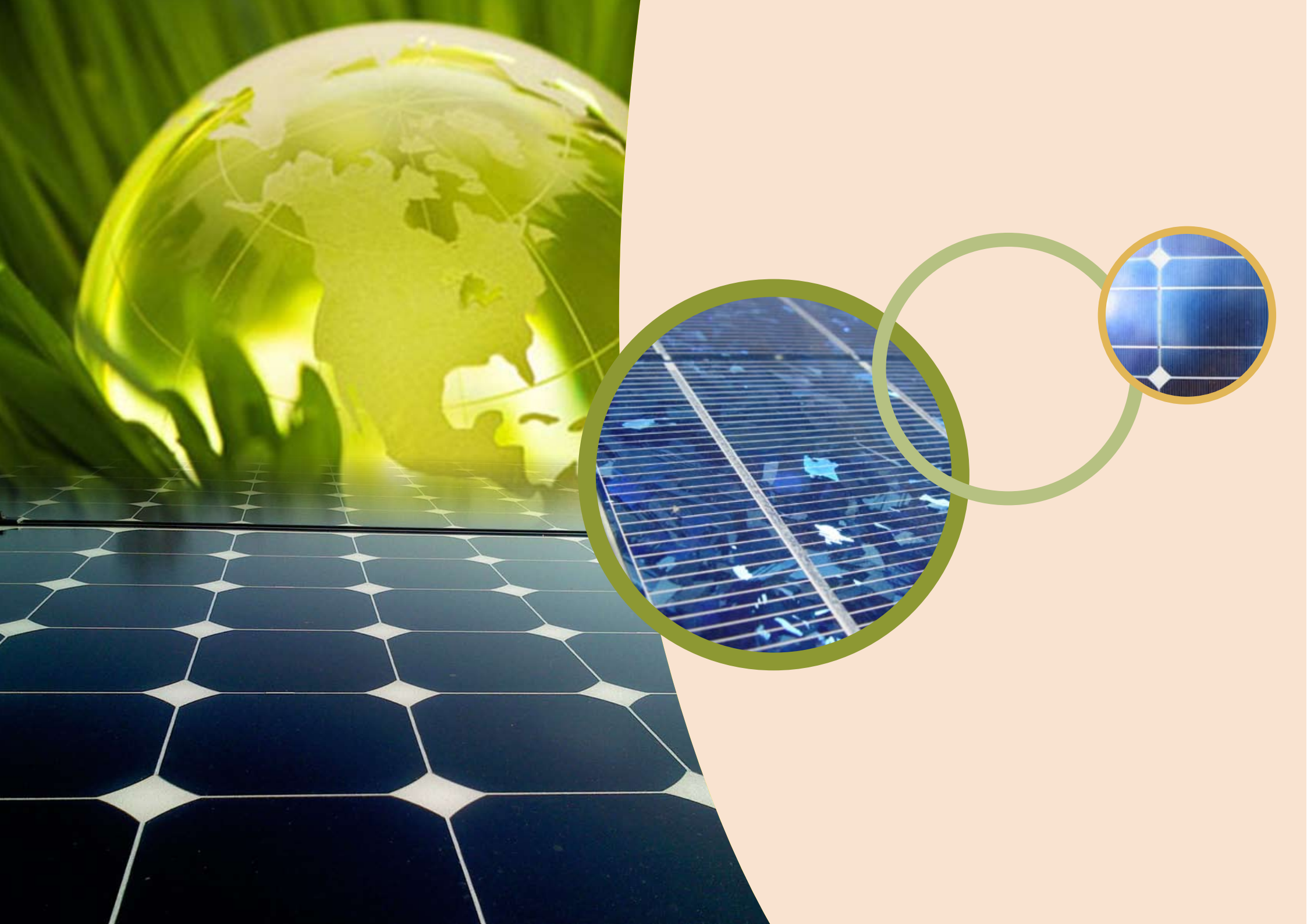




المملكة العربية السعودية
وزارة التعليم العالي
MINISTRY OF HIGHER EDUCATION



Center of Research Excellence in
Renewable Energy

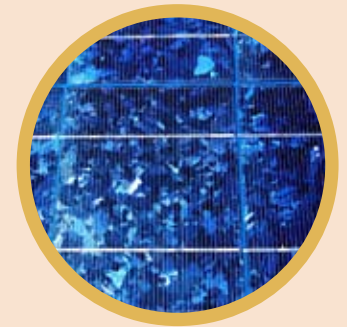


Introduction



Center of Research Excellence in Renewable Energy

The Center of Research Excellence in Renewable Energy (CoRE-RE) is a Saudi national research entity established by the Ministry of Higher Education in 2007. The Center aspires to further the scientific and technological development in major areas of renewable energy with an emphasis on Solar Energy. CoRE-RE implements innovative projects and significant activities for the promotion and market penetration of new and emerging renewable energy technologies. In addition, the center strives to increase the public awareness and eventually cater to the renewable energy industry in the Kingdom of Saudi Arabia (KSA).



Vision

To be the national center that contributes to the advances of research and commercialization of renewable energy technologies in the KSA and the region.

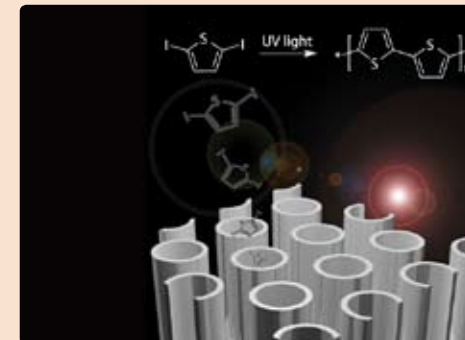
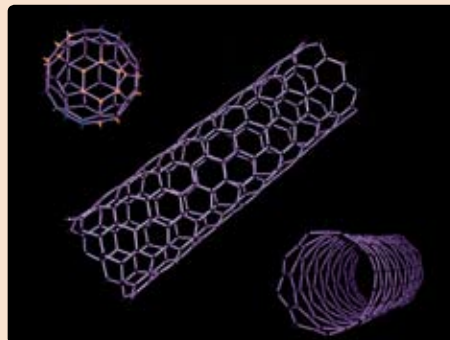
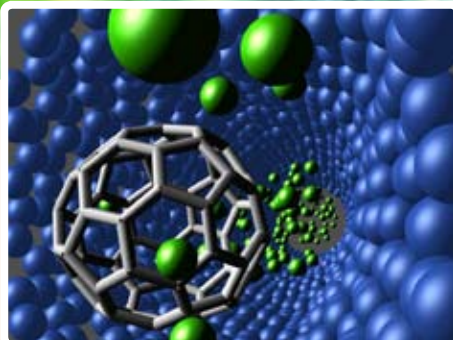
Mission

To conduct research and development that links research, education, business and government resources for technology transfer and the advancement of emerging renewable energy technologies in the KSA.

Objectives

The CoRE-RE key objectives in line with national interest are:

- To build a critical mass of research capacity composed of highly qualified research scientists, research assistants, staff and trained graduate students and infrastructure in the field of renewable energy.
- To conduct research and development in the field of renewable energy.
- To establish collaboration with others (nationally, regionally and internationally) engaged in similar R&D efforts.
- To promote economic development through advancement and commercialization of renewable energy technologies.
- To promote renewable energy technologies and applications in the KSA.
- To promote educational opportunities in the field of renewable energy.



CoRE-RE's research is focused towards excellence in the field of renewable energy in the Kingdom.

Currently there are two research programs:

I. Solar Energy Research Program (SERP)

- 1.1 Solar Cell Research Thrust
- 1.2 PV Module/System and Reliability Research Thrust
- 1.3 Solar Cooling & Solar Heating Research Thrust

II. Fuel Cell Research Program



1. Solar Energy Research Program (SERP)

The Solar Energy Research Program is dedicated to conduct a globally competitive, cutting-edge research in various areas. With the increasing worldwide demand for alternative renewable energy in mind, our mission is to improve existing technologies and conducting cutting-edge research in the development of new ones. The Labs and facilities at CoRE-RE allow us to study all aspects of device performance and afford unique insight into the fundamental science behind each contributing factor. Our research collaborations with leading groups both in the Kingdom and overseas provide opportunities to exploit highly sophisticated procedural and characterization methods in an interdisciplinary environment. Under our Awareness program, undergraduate and graduate students benefit from training and workshops designed to position them as future leaders.

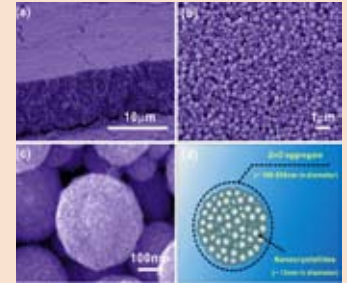
The research thrusts under SERP are:

- 1.1 Solar Cell Research Thrust
- 1.2 PV Module/System and Reliability Research Thrust
- 1.3 Solar Cooling & Solar Heating Research Thrust



1.1 Solar Cell Research Thrust

The ambition of the Solar Cell Research Thrust is to develop cutting edge research in the area of solar cells. One of the major challenges facing the development of Photovoltaic technology is the design of more efficient and cost-effective conversion devices. It takes a good understanding of the physical processes involved in the conversion capability of light into electricity, to synthesize materials of enhanced properties and the engineering expertise to produce innovative design of the device.



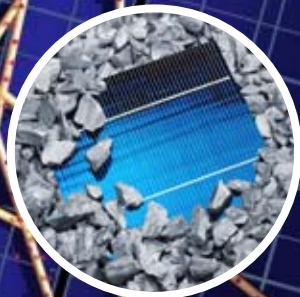
Objectives

The Solar Cell Research Thrust focuses its efforts on amorphous Silicon (a-silicon) based solar cells. To achieve its objectives, the group intends to:

- Establish a state-of-the-art solar cells research laboratory equipped with the necessary tools to synthesize and characterize crystalline thin film silicon solar cells
- Develop strong collaborations with international leading research groups and local industry.

The on-going research program includes the following:

- Engineering of growth stresses in a-silicon (a-Si) thin film and investigation of their impact on the film properties. This research is being developed in close collaboration with MIT.
- Study of Photon and Electron Beam Induced Recrystallization of amorphous silicon thin films. This study is being carried out in collaboration with Advanced Light Source (ALS), Berkeley.
- Study of Silicon/CNT heterostructure based devices.

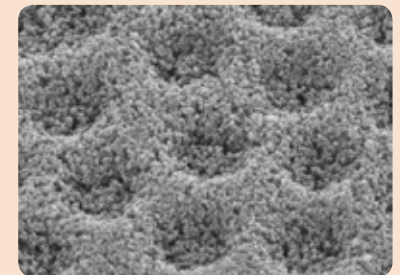
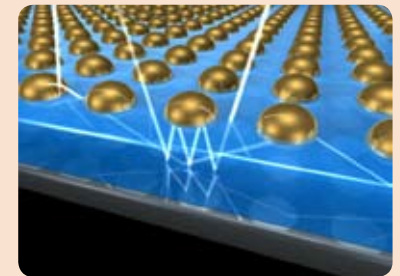


Research Capabilities

Solar Cells Research Thrust

The research scientists and members of our Solar Cells Research Thrust offer services on material characterization and standard testing of solar cells for industry and R&D groups. The following equipment is available at our laboratories:

- Plasma Enhanced Chemical Vapor Deposition (PECVD)
- Electrospinning
- Spin coater
- Spectroscopic Ellispometry (SE)
- Profilometer
- Raman Spectroscopy
- Fourier Transformed Infra-Red (FTIR)
- Microwave Photoconductive Decay (MicroPCD)
- Hall Effect
- Electron Beam Induced Current (EBIC)
- IV and CV measurement system
- Quantum Efficiency

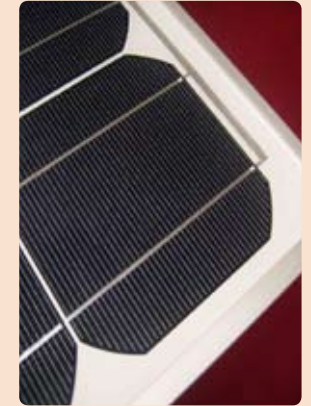


Team Members:

- Prof. N. Tabet (Group Leader)
- Dr. M. Afzaal
- Dr. M. Kamal Hossain
- T.B. Asafa (PhD Student)

1.2 Photovoltaic Module/System Performance and Reliability

The climate in the Kingdom is affecting the performance of PV modules drastically; in particular, dust accumulation on PV modules reduces its efficiency by approximately 40%. The focus of the PV group is to study the performance of PV modules in outdoor testing conditions and to find innovative solutions to improve the efficiency of PV modules. PV module testing requires a complex and wide-ranging series of testing such as safety, power rating and dust accumulation. Dust is one of the major problems that need to be addressed.



Objectives

- Measuring the performance of different PV module technologies under the different environmental conditions of the KSA.
- Understanding of the adhesion mechanisms of the fine dust particles (as found in Saudi environments) to module surfaces. This would include characterizing particle-surface interactions.
- Understanding fundamentals of the influence of moisture on dust accumulation.
- Investigating different surface technologies that can significantly reduce dust accumulation via both wet and dry approaches.
- Analyzing the performance of a 10 kW Hybrid Wind –PV system connected to the grid.
- Modeling of the Hybrid system.



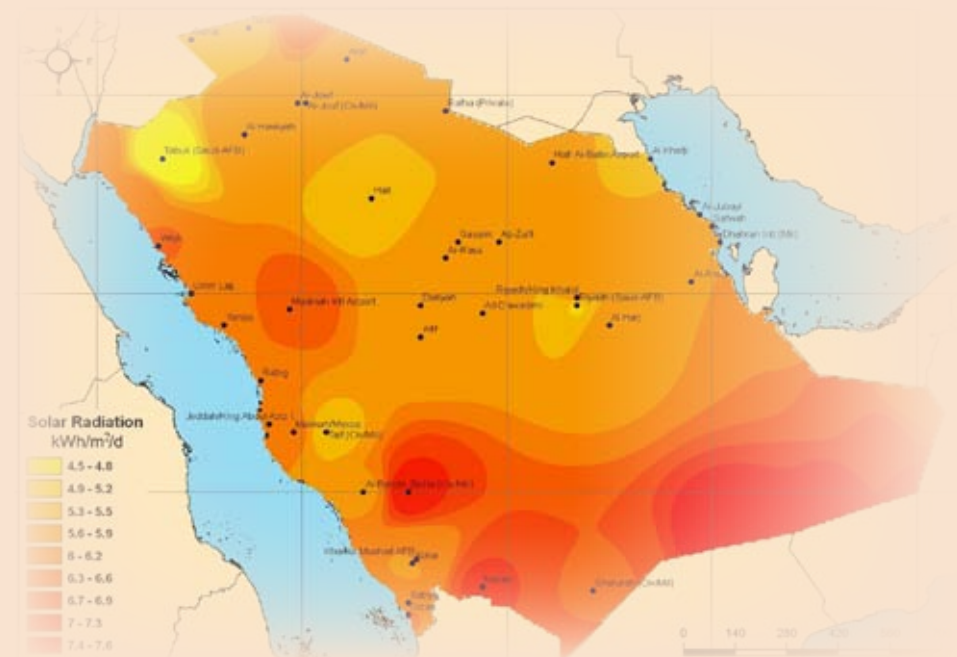
Research Capabilities

Photovoltaic Module/System Performance and Reliability Research Thrust

- Approximately 5 kW installed PV modules
- Solar300 and IV400 for IV measurements of Photovoltaic
- PV modules tracking system
- Solar simulator of PV modulus

Team Members:

- Prof. S.A.M. Said (Group Leader)
- Eng. M. Jamiu



1.3 Solar Cooling/Heating Research Thrust



Solar thermal energy is a technology for harnessing solar energy for thermal energy applications. Solar Energy could prove to be the most influential energy source that could replace fossil fuels in the future. A number of solar heating applications ranging from solar cookers to solar water heating systems are finding place in the household of people around the world. Saudi Arabia receives plentiful of solar radiation each day throughout the year. However, not much of this has been implemented in the kingdom. The utilization of solar energy in domestic applications would be a firm step for the kingdom in promoting the sustainable source of energy and proper utilization of the available fossil fuels for other purposes.

Solar cooling uses abundant solar thermal energy to power a thermally driven cooling process and displace electricity consumption. By displacing fossil fuel derived electricity in the cooling cycle, solar cooling is likely to be an important component of future zero emissions buildings and may also play a role in reducing peak demand on the electricity grid.

As the cost of electricity keep rising and the issue of green house effect becomes of more concern, solar-powered cooling and heating systems shall compete with the conventionally powered refrigeration and air-conditioning systems.

The Solar Heating/Cooling Research group pursues dynamic research activities in the field of solar energy with important domestic and industrial applications.

Much of the research is focused on low and medium temperature applications of solar energy. The group has strong background in Experimental as well as in Computational and Theoretical Research. The research is carried out by the researchers, faculty members and students at the King Fahd University of Petroleum & Minerals.



Objectives

- I. Conduct Research and Development activities that contribute to progress on conversion of solar thermal Energy specifically to the climatic conditions of Saudi Arabia, these includes:
 - Solar Water heating systems
 - Solar Cookers
 - Solar Drying

- II. Build infrastructure much needed to perform testing and certifying solar thermal applications:
 - Solar Water heater testing facility
 - Solar Collectors test facility

- III. Prototype development of potential applications made from local materials, these include Solar Cooker, Solar Dryer and Solar water heating system



Research Capabilities



Solar Cooling/Heating Research Thrust

Currently, Solar water heating systems consist of a major share of solar based thermal applications for residential and commercial applications. Flat plate systems have been revolutionized with special coatings. The use of vacuum tube systems is also gaining significance for applications demanding water at higher temperatures. The cost and economics of these systems are a big problem for their deployment in the KSA.



Team Members:

- Dr. Salem Al Dini (Group Leader)
- Dr. P. Gandhidasan
- Dr. Habib Abualhamayel
- Eng. M.Mumtaz A. Khan



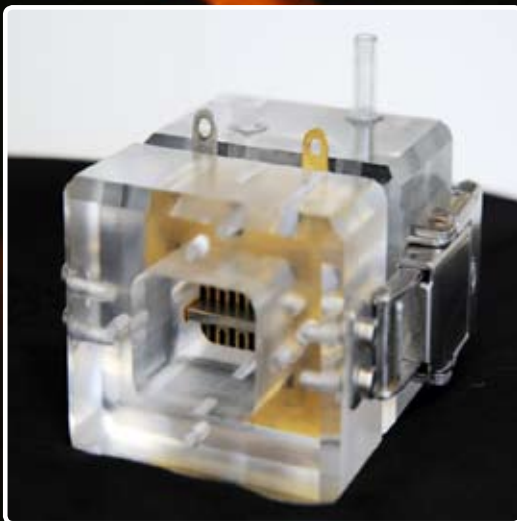
2. Fuel Cell Research Program

Fuel Cell

We need efficient energy conversion system for our future energy infrastructure and Fuel cells are the most efficient energy converter as compare to any other existing systems. Principally, fuel cells are means of storage energy, for example hydrogen/methanol can be produced from any primary energy source or renewable (e.g. solar energy) or even exhaustible (as coal or oil) and can be used as energy in the fuel cell when needed.

Electrochemical reduction of CO₂

Membrane, catalyst and cell development for electrochemical conversion of carbon dioxide (CO₂) to hydrocarbon is important for many reasons, but mainly a way to reduce this green house gas from the environment. At the same time, hydrocarbons have many uses in our energy and industrials systems. The problems addressed in our project are activity and selectivity of the electrocatalysts, solubility of CO₂ in appropriate electrolytes etc. The problem with the solubility has been addresses by using a solid electrolyte in an electrochemical reactor system (ECRS) quite similar to the PEM cell.



Objectives & Capabilities

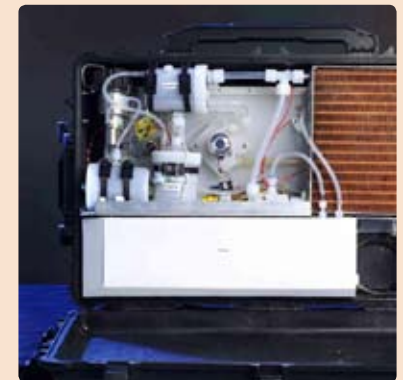


Objectives

- To establish a laboratory in the Kingdom that concentrates and develops the technology in the fuel cell research and electrochemical conversion of carbon dioxide to hydrocarbon
- To develop new type of catalysts for electro oxidation of methanol, for direct methanol fuel cell (DMFC)
- To modify polyelectrolyte membranes (PEMs) for direct methanol fuel cell (DMFC) and solid alkaline (AFC) fuel cells
- To develop the electrocatalysts for electrochemical reduction of CO₂
- To test these electrocatalysts in the electrochemical reactor system (ECRS)

Capabilities of Fuel Cell Research Program

- Total catalysts synthesis and impregnation on supports for direct methanol fuel cell, Hydrogen fuel cell and CO₂ reduction
- Synthesis of Membrane materials, membrane casting, membrane modification
- Complete electrochemical characterization of the catalysts and membranes
- Testing the performance of the materials in the Fuel cell test station



Fuel Cell Lab Facilities



- Biologic Fuel Cell Test Station (FCT-50)
- Arbin Fuel Cell Test Station
- Electrochemical Reactor System (ECRS) for Solid state CO₂ conversion to hydrocarbon
- VMP3 Biologic Multichannel Workstation
- Autolab PGSTAT100 with Current buster and EQCM
- Agilent's 7890A Gas Chromatography
- Carbolite STF Tube Furnace
- Bench top Muffle Furnace
- LABOMED double beam UV-VIS Spectrophotometer
- Milli-Q Advance A10
- Thermo Scientific Lindberg/Blue M Deluxe
- Thermo Scientific Hi-Tem Vacuum Oven

Team Members:

- Dr. S. M. J. Zaidi (PI, project-1)
- Dr. S. U. Rahman (PI, project-2)
- Dr. Mohammed Ba-Shammakh
- Prof. Sk. Ashrof Ali
- Dr. Shakeel Ahmed
- Dr. Mozahar Hossain
- Dr. Amir-Al-Ahmed (Postdoctoral Fellow)
- Mr. Safdar Hossain SK (Graduate Student)
- Mr. Bello Mukhtar (Graduate Student)
- Mr. Shahid Mohammed Bashir (Graduate student)

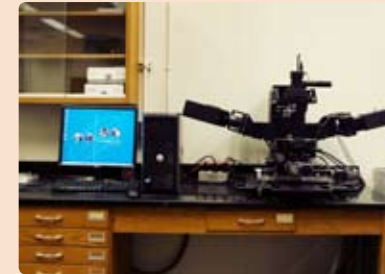
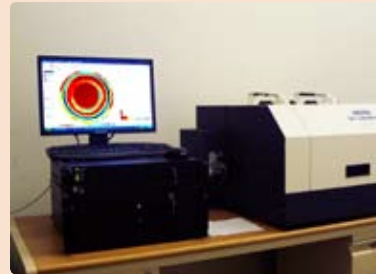
Collaborators

- Dr. S. Basu, IIT, India
- Dr. Vinu Ajeyan, NIMS, Japan
- Dr. Anil Verma IIT, Guwahati, India



Facilities at CoRE-RE

- A state-of-the-art solar cells research laboratory equipped with the necessary tools to synthesize and characterize crystalline and thin film silicon solar cells
- Two outdoor Photovoltaic modules testing facilities at KFUPM campus and KFUPM beach
- Residential solar water heater testing facility
- Fuel cell research laboratory including fuel cells and electro-chemical reactor system for carbon dioxide reduction.



Personnel



Dr. Habib Ibrahim Abualhamayel, Director, CoRE-RE

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Dr. Habib Ibrahim Abualhamayel completed his PhD in Mechanical Engineering from the University of Colorado, Boulder, USA in 1981. He's had many distinguished Research Projects & Representative Publications specializing in the area of Thermal Sciences and Combustion. He's held many vital positions of note such as Chairman of Mechanical Engineering Department at King Fahd University of Petroleum & Minerals, Dean, College of Engineering Sciences and Applied Engineering. Currently he serves the Director of the Center of Research Excellence in Renewable Energy.



Dr. S.A.M Said (Professor), Solar Energy Program Leader, CoRE-RE

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Dr. S.A.M. Said is a Professor in the Mechanical Engineering Department at KFUPM. He received his Ph.D. degree in Mechanical Engineering from the University of Tennessee, Knoxville USA in 1986 in the area of Thermal Sciences (Heat Transfer, Thermodynamics, and Fluid Mechanics). Dr. Said has been involved in more than 30 funded research projects carried out by the Research Institute and the Mechanical Engineering Department and is currently the Solar Program Leader at CoRE-RE.



Dr. Nouar Tabet (Professor)

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Dr. Nouar Tabet is a Professor in the Physics Department at KFUPM. He works at CoRE-RE with the Solar Photovoltaics Division. His area of specialties includes Semiconductors, defects, nanomaterials, solar cells. Dr. Nouar has had many representative publications and been involved in some major research projects. He was awarded with the AL Marai Prize for Innovation in Physics, 2004.



Dr. Salem A. Al-Dini (Assist. Professor)

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Dr. Salem A. Al-Dini obtained his PhD in Mechanical Engineering from Texas A&M University, College Station (2005). His area of specialties include Enhancement of heat transfer and mass transport with Electro hydrodynamic (EHD) (Single-Phase and Two-Phase) and Augmentation of heat and mass transfer with pulsating mechanism. Currently Dr. Salem A. Al-Dini is involved in various funded Research Projects and supervises CoRE-RE's Solar Thermal Division.



Dr. Haitham M. Bahaidarah (Associate Professor)

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Dr. Haitham M. Bahaidarah obtained his PhD in Mechanical Engineering from Texas A&M University, College Station (2004). His area of specialties includes numerical heat transfer, heat and mass transfer, heat transfer enhancement, computational fluid dynamics, and solar energy conversion. Currently Dr. Haitham M. Bahaidarah is involved in various funded Research Projects Related to PV and Solar Thermal Division.



Dr. Maged A. I. El-Shaarawi (Professor)

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Dr. Maged A. I. El-Shaarawi is a Professor in the Mechanical Engineering Department at KFUPM. He received his Ph.D. degree in Mechanical Engineering from The University of Leeds in 1974. His research interests include Fluid Mechanics, Heat Transfer, Thermodynamics, Air Conditioning & Refrigeration and Hydraulic Systems. Dr. Shaarawi has won various awards for his research activities and currently heads the Solar Cooling division at CoRE-RE.



Dr. Saleem Ur Rahman (Assist. Professor)

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Dr. Saleem Ur Rahman completed his PhD in Chemical Engineering from KFUPM in 1995. His area of Research specialization and expertise include Electrochemical Engineering, Fuel Cells, Corrosion, Electro Polymerization, Wastewater Treatment and Mass Transfer. He's currently a Member of Higher Board at Indian International Schools (Saudi Arabia) and Director at A&R Innoventures Consulting Pvt Ltd.



Dr. Javaid Zaidi (Associate Professor)

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Dr. Javaid Zaidi obtained his Ph.D. in Chemical Engineering in 2000 from Laval University, Canada, M.S. from King Fahd University of Petroleum & Minerals (KFUPM). He is currently the Head of the Fuel Cell Research at CoRE-RE. He has published more than 100 research paper in reputed international journals, international conferences proceedings and symposiums and has a book on "Polymer Membranes for Fuel Cells" published by Springer in 2008. He has been involved in several national and international research projects. He received the university's "Distinguished Researcher Award" in 2006 and "Excellence in Research Award" by the College of Engineering Science in 2005.



Dr. Mohammed Afzaal (Research Engineer- II)

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Dr. Mohammad Afzaal completed his BSc (2000) in Chemistry from Aston University, UK and PhD (2004) in Inorganic Chemistry from The University of Manchester, UK. His area of specialization includes Chemical vapour deposition, Solar cells, Nanocrystals, Chalcogenide compounds, Crystal Growth with over 60 high impact publications. Currently He's serving as a Research Engineer II at CoRE-RE, working with the solar cells research thrust.



Dr. Mohammad Kamal Hossain (Research Engineer- III)
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Dr. Mohammad Kamal Hossain currently serves CoRE-RE as Research Engineer - III. He completed his PhD in 2007 in Pure and Applied Science (Faculty of Materials Science and Engineering), Tsukuba University, Tsukuba, Japan (in collaboration with National Institute for Materials Science, NIMS). Masters in 2003 in Microelectronics (School of Advanced Technology), Asian Institute of Technology (AIT), Bangkok, Thailand. His area of specialization includes Plasmonics and laser spectroscopy using nanoscale materials. Currently He's working on micromorph and plasmonic solar cell.



Eng. Muhammed Jamiu Adinoyi (Engineer- II)
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Eng. Muhammed Jamiu Adinoyi serves CoRE-RE as Engineer II. He completed his MSc, Mechanical Engineering from King Fahd University of Petroleum and Minerals and joined CoRE-RE in 2010. Muhammed Jamiu Adinoyi's area of specialization includes Material Science and Engineering and current Research Project revolves around Solar Panels Testing.



Eng. Mohammed Mumtaz Ahmed Khan (Engineer- II)
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Eng. Mohammed Mumtaz Ahmed Khan currently serves CoRE-RE as Engineer- II. He completed his MS in 2010 in Aerospace Engineering from King Fahd University of Petroleum and Minerals. His main research interests are Computational Fluid Dynamics, Photovoltaics modules testing and reliability.



Mr. Abdul Rehman Zaheer (Awareness Program Coordinator)
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Mr. A.R. Zaheer received his MBA degree from National College of Business Administration (NCBA&E), Lahore-Pakistan in 2007. He worked for one year as a Business Unit Manager for IDP Education Australia and as a Team Leader in Pakistan's leading mobile communications company, Mobilink for four years. Mr. A.R. Zaheer joined CoRE-RE in the Awareness Program Committee in 2010.



Mr. Aslam Sabir (Secretary)
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Mr. Aslam Sabir joined KFUPM in 1980 and ever since has held various secretarial positions for different departments of KFUPM. Since 2007 when the center was established he has been serving the CoRE-RE Directorate and working as a secretary for the CoRE-RE Director, Dr. Habib Ibrahim Abualhamayel.



Dr. Amir Al-Ahmed (Research Scientist-III)
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Dr. Amir Al-Ahmed is working with the CoRE-RE as Research Scientist-III. His area of specialization and research interest includes electrocatalysis and membranes (for Fuel Cell, CO2 conversion), Electrically Conducting Polymers (Rechargeable batteries, Sensors, LED etc), nano-composites and nanocatalysts for Hybrid solar cells.



Dr. Faizur Rahman (Research Engineer- II)
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Dr. Faizur Rahman is currently working with CoRE-RE as Research Engineer II. His area of specialization includes Energy Storage Systems, Adsorption Studies, Desalination and Oilfield scaling, Vanadium Redox Battery, Project Evaluation and Feasibility Studies. He's worked on some Major Research Projects serving as the Project Manager and Investigator, funded by various reputable multinational organizations such as Saudi Aramco.

Advisory Board



Dr. Ahmed F. Ghoniem

Ronald C. Crane (1972) Professor of Mechanical Engineering, MIT, USA
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Professor Ghoniem is the Ronald C. Crane ('72) professor of Mechanical Engineering and the director of the Center for 21st Century Energy at MIT. He holds B. S. (1973) and M. S. (1975) degrees in Mechanical Engineering from Cairo University in Egypt and a Ph. D. degree from the University of California, Berkeley (1980). He served as a research scientist at Lawrence Berkeley Laboratory from 1980-83. Since 1983 he has been at MIT where he established the Reacting Gas Dynamics Laboratory and has supervised a number of M.S. & Ph.D. students, post-docs and research scientists. He is a fellow of the American Society of Mechanical Engineers and associate fellow of the American Institute of Aeronautics and Astronautics. His research interest lie in the areas of high performance computing in turbulent reactive flow, computational mathematics, combustion dynamics and active control, modeling and simulation of transport-chemistry interactions in thermochemical and electrochemical systems including high temperature fuel cells, gasification processes and fuel production and analysis of high-performance, zero-emission integrated energy systems with CO₂ capture.



Dr. Ali A. Sayigh

Chairman, World Renewable Energy Network/ Congress, UK
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Professor Ali Sayigh, British Citizen, born in Kufa, Iraq, September 20, 1939. Graduated from London University, & Imperial College, B.Sc. DIC, Ph.D., CEng in 1966. He is Founder and Chairman of the ARAB Section of ISES since 1979, was chairman of UK Solar Energy Society for 3-years and consultants to many national and international organizations, among them UNESCO, ISESCO, UNDP, ESCWA, & UNIDO. In 1990, he established the World Renewable Energy Congress and in 1992 the Network (WREN) which have their Congresses every two years, attracting more than 100 countries each time. He edited, contributed, and written more than 30-books, and more than 400-papers in various international journals and Conferences.



Dr. Hans Muller-Steinhagen

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Professor Müller-Steinhagen is Director of the Institute of Technical Thermodynamics of the German Aerospace Center (DLR) and Director of the Institute for Thermodynamics and Thermal Engineering of the University of Stuttgart. He is also Director of the Steinbeis Transfer Centre for Solar and Thermal Technology, President of the European Committee for the Advancement of Thermal Sciences and Heat Transfer (EUROTHERM), and a member of the Councils of the Prime Minister of Baden-Württemberg concerned with Innovation and Sustainability. He is currently Associate Editor of Heat Transfer Engineering, and a member of the editorial board of several other international journals and committees in the field of thermal sciences.



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Professor Müller-Steinhagen is Director of the Institute of Technical Thermodynamics of the German Aerospace Center (DLR) and Director of the Institute for Thermodynamics and Thermal Engineering of the University of Stuttgart. He is also Director of the Steinbeis Transfer Centre for Solar and Thermal Technology, President of the European Committee for the Advancement of Thermal Sciences and Heat Transfer (EUROTHERM), and a member of the Councils of the Prime Minister of Baden-Württemberg concerned with Innovation and Sustainability. He is currently Associate Editor of Heat Transfer Engineering, and a member of the editorial board of several other international journals and committees in the field of thermal sciences.



Dr. Naif M. Al-Abbadi

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Dr. Naif M. Al-Abbadi is the Director of Energy Research Institute at King Abdulaziz City for Science and Technology (KACST).

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6. Dr. Haitham Bahaidrah
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