



**7<sup>th</sup> INTERNATIONAL CONFERENCE ON ENERGY RESEARCH & DEVELOPMENT (ICERD-7)**

**November 19-21, 2019**

**The Sheikh Jaber Al Ahmad Cultural Centre-Conference Halls  
25 Jamal Abdul Nasser St, Kuwait City, Kuwait**

**Organizers:**



**Sponsors:**





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## State of Kuwait

The State of Kuwait is a small oil-rich desert nation located in the northwestern corner of the Arabian Gulf. Kuwait covers an area of 17,808 sq. kilometers (6,880 sq. miles). At its widest points, Kuwait is 200 kilometers (124 miles) from north to south and 170 kilometers (106 miles) from east to west. The country's most prominent geographical feature is Kuwait Bay, a large natural inlet that extends 40 km into the mainland. The name Kuwait is derived from Arabic meaning "fortress built near water". The capital of the country is Kuwait City.

Located between the latitudes 28.45° and 30.05° north and between longitudes 46.30° and 48.30° east, Kuwait is in the desert zone of the Sahara geographical region. Shaped roughly like a triangle, Kuwait shares borders with Iraq in the north and northwest (240 km) and Saudi Arabia in the south and southwest (250 km); the Gulf bounds Kuwait on the east. On the east it has a coastline of 290 km on the Arabian Gulf.

The population is about 3.55 million. Kuwait City has numerous attractions which include excellent museums, a corniche ornamented with combed beaches and extravagant restaurants, modern shopping complexes and marinas, long and lazy retreats, and new beach resorts.

In addition to the mainland, Kuwait occupies a number of offshore islands, the largest of which is Bubiyan. Due to the location of Kuwait in the Sahara geographical region, the weather of the country is characterized by long, hot and dry summers and short warm and sometimes rainy winters. Dust storms almost always occur with a rise in humidity during summer. The temperature in November is expected to be on the average of 24° C.

The official language of Kuwait is Arabic and the second language, in common use, is English. The local currency is Kuwaiti Dinar (1 KD approximately 3.3 US\$).

## **Address by the Chairman of the Organizing Committee**

As Chair of the conference, and on behalf of the Organizing Committee, I am honored and delighted to welcome you to the Seventh International Conference on Energy Research and Development (ICERD-7), which will be held under the Patronage of His Highness the Crown Prince Sheikh Nawaf Al-Ahmad Al-Jaber Al-Sabah. This conference is jointly organized by ASHRAE, Kuwait University, Kuwait Society of Engineers, Kuwait Institute for Scientific Research and Kuwait Foundation for the Advancement of Sciences.

The Seventh International Conference on Energy Research and Development (ICERD-7) will be held at Sheikh Jaber Al-Ahmad Cultural Centre, on November 19-21, 2019. The theme of the Conference will be "Advances in Energy Research and Development." This exciting conference is entirely dedicated to recent developments in optimizing the utilization of basic energy resources in the major energy consuming sectors in the arid region of the Arabian Peninsula. Special emphasis will be on emerging energy conversion technologies, conservation and management strategies.

The conference has a great tradition extending over the last 20 years addressing topics from Energy Conservation itself, to Fuels and Combustion; Air-conditioning and Refrigerating Systems, to Renewable Energy Technologies. The conference aims to bring together leading academic scientists, researchers and practicing experts to exchange and share their experiences and research results about all advancements in energy applied systems.

The Scientific Committee received a large number of abstracts for oral presentations, many of which were of a high quality, and selection involved some very careful decisions. The reviewing process involved the participation of scientists from all over the world. About 50 technical papers, 6 Keynote speeches, 3 workshops and 3 professional courses will be delivered during the conference.

It has been a great privilege for me to serve as the Chair of ICERD-7 and it is my hope that you find the conference valuable, fulfilling and enjoyable. I would like to thank the conference sponsors and all the organizing and scientific committee members for their contribution to the organization of this conference and for their extremely hard work for the details of important aspects of the conference programs and social activities. I hope this conference will prove to be an inspiring and memorable experience for you.

**Sorour Alotaibi**

## General Information about the Conference

### Conference Theme:

The theme of the conference is "Advances in Energy Research and Development" Special emphasis will be on emerging energy conversion technologies, conservation and management strategies.

The conference objective is to optimize the utilization of basic energy resources in the major energy consuming sectors in the arid region of the Arabian Peninsula.

### Organized by:

- Kuwait University
- ASHRAE
- Kuwait Society of Engineers
- Kuwait Institute for Scientific Research

### Sponsored by:

- Kuwait Foundation for the Advancement of Sciences
- Kuwait Petroleum Corporation
- Ministry of Electricity and Water
- Alghanim International General Trading & Contracting Co. W.L.L.

### Conference Registration:

Registration rates are as follows:

- Early Bird Registration (on or before October 31, 2019): \$400 USD / KD 120
- Regular Registration (from November 1, 2019): \$500 USD / KD 150
- Student: \$65 USD / KD 20

### Venue:

The conference will be held in Sheikh Jaber Al-Ahmad Cultural Centre - Arabian Gulf St, Kuwait City

### Conference Language:

The Official language of the conference is English.

### Conference Accommodation:

Participants are responsible for their travel and hotel accommodation. Free accommodation is provided to the authors presenting papers. Assistance is provided for hotel reservations, entry visas and reception at the Kuwait international Airport.

## Conference Organization

### Organizing Committee

Dr. Sorour Alotaibi, Chair – Kuwait University  
Prof. Walid Chakroun – Kuwait University  
Dr. Osama Alyousif – Kuwait University  
Dr. Bader Alshriaan – Kuwait University  
Dr. Mohammed Al-Alaimi – Kuwait University  
Dr. Fotouh Al-Ragom – Kuwait Institute for Scientific Research  
Eng. Humoud Al-Hadih – Kuwait Society of Engineers  
Eng. Dina Alnakib - Kuwait Foundation for the Advancement of Sciences

### Scientific Committee

Prof. Walid Chakroun, Chair – Professor – Kuwait University  
Dr. Nesreene Ghaddar – Professor – American University of Beirut  
Prof. Bjarne Olesen – Professor – Technical University of Denmark  
Prof. Mehmet Baris Ozerdem – Professor – İzmir University of Economics  
Eng. Ashish Rakheja – Managing Partner - AEON Integrated Building Design Consultants LLP  
Prof. M. H. Hosni – Professor - Kansas State University  
Prof. Tim Wentz – Professor - University of Nebraska  
Prof. Essam Alawadhi – Professor – Kuwait University

### Publicity Committee

Dr. Bader Alshuraiaan - Chair – Kuwait University  
Eng. Humoud Al-Hadih – Kuwait Society of Engineers  
Dr. Shrouq Aljasser – Kuwait Society of Engineers  
Mr. Hussain Shashtari – Kuwait Society of Engineers  
Eng. Bedoor Alkandary – Kuwait University  
Mr. Tayseer Alhasan – Kuwait Society of Engineers

### Finance Committee

Dr. Sorour Alotaibi – Chair – Kuwait University  
Dr. Osama Alyousif – Kuwait University  
Mr. Ali Failakawi – Kuwait Society of Engineers  
Mr. Hussain Shashtari – Kuwait Society of Engineers

### Publication Committee

Dr. Osama Alyousif – Chair  
Dr. Mohammed Al-Alaimi  
Eng. Humoud Al-Hadih – Kuwait Society of Engineers  
Eng. Anas Alhudaib – Kuwait Society of Engineers  
Eng. Saktan Alazmi – Kuwait Society of Engineers  
Eng. Nour AlSalem – Kuwait Society of Engineers  
Eng. Fatma Alanezi – Kuwait Society of Engineers

### Hospitality Committee

Eng. Humoud Al-Hadih – Chair – Kuwait Society of Engineers  
Dr. Bader Alshuraiaan – Kuwait University  
Eng. Waleed Almutawa – Kuwait Society of Engineers  
Eng. Khalid Almutawa – Kuwait Society of Engineers  
Eng. Mohammad Almutawa – Kuwait Society of Engineers

**Committee for Preparation During the Conference**

Eng. Sarah Al-Huwaidi – Chair – Kuwait Society of Engineers  
Prof. Walid Chakroun – Kuwait University  
Eng. Humoud Al-Hadih – Kuwait Society of Engineers  
Eng. Anas Alhudaib – Kuwait Society of Engineers  
Eng. Shaima Alshatti – Kuwait Society of Engineers  
Eng. Nour AlSalem – Kuwait Society of Engineers

**Committee for Opening Ceremony**

Dr. Sorour Alotaibi – Chair - Kuwait University  
Eng. Sarah Al-Huwaidi – Kuwait Society of Engineers  
Eng. Humoud Al-Hadih – Kuwait Society of Engineers  
Eng. Nour Alsubaghah – Kuwait Society of Engineers  
Eng. Nour AlSalem – Kuwait Society of Engineers  
Eng. Suhaila Bakhit – Kuwait Society of Engineers  
Eng. Noura Alameri – Kuwait Society of Engineers  
Eng. Shaima Alshatti – Kuwait Society of Engineers  
Eng. Anas Alhudaib – Kuwait Society of Engineers  
Eng. Saktan Alazmi – Kuwait Society of Engineers  
Eng. Mohammad Alkhamees – Kuwait Society of Engineers

**Social Committee**

Mr. Hussain Shashtari – Chair - Kuwait Society of Engineers  
Dr. Mohammed Al-Alaimi – Kuwait University  
Eng. Ali Mohseni – Kuwait Society of Engineers

**ASHRAE Staff**

Austin Brafford  
Christopher Preyor  
Ragan McHan  
Tony Giometti



## Keynote Speakers

### The Role of Low Carbon Technologies Within the Energy Transition

#### **Dr. Adnan Shihab-Eldin**

Director General, Kuwait Foundation for the Advancement of Sciences



Dr. Shihab-Eldin was a former Acting Secretary General & Director of Research (2001-2006) of the Organization of Petroleum Exporting Countries (OPEC). He also serves as board member or advisor to a number of public and international institutions. From March 1999 to August 2001, he served as Director of the Division for Africa, East Asia and the Pacific, Department of Technical Co-operation, at the International Atomic Energy Agency (IAEA) in Vienna, Austria. Prior to joining the IAEA, from December 1991 to February 1999, he served as Director of the UNESCO Regional Office for Science and Technology (Cairo) and as the UNESCO Representative in Egypt, Sudan, and Yemen. From 1976 to 1986 he was the Director General of the Kuwait Institute for Scientific Research, serving concurrently (1976-1980) as vice Rector for Academic Affairs at Kuwait University. Dr. Shihab-Eldin received a B.Sc. degree in Electrical Engineering in 1965, a M.Sc. degree in 1967, and Doctorate degree (Ph.D.) in Nuclear Engineering in 1970, all from the University of California at Berkeley, USA. Dr. Shihab-Eldin continues to lecture and undertake research in the physical and engineering sciences as energy economics and technology, at a number of universities and research centers in Kuwait, the United States and Europe.

Dr. Shihab-Eldin has published extensively and is a regular lecturer and invited speaker at many international and regional meetings, covering many fields, including Energy Policy, Economics, Technology and the Environment; Oil Markets; Management and Development of Science & Technology in Developing Countries; Higher Education Systems, and other related fields.

## Cooling the World Without Warming the World

### Dr. Dan Hamza-Goodacre

Executive Director - Kigali Cooling Efficiency Program



Dan Hamza-Goodacre is Executive Director of the Kigali Cooling Efficiency Program, a global initiative helping developing countries improve the efficiency of cooling as they reduce pollution from F-gases. Dan has worked on sustainable development in the public and private sectors across the globe for over 20 years. Prior to K-CEP, Dan was Director of Buildings and Industry at ClimateWorks. Before working in philanthropy, Dan was with PwC, where he served as Deputy CEO of the Climate and Development Knowledge Network, a multi-lateral aid program to help developing countries respond to climate change. Dan held various posts with the U.K. Environment and Agriculture Ministry, including: Head of the Secretary of State's office; co-founder of the UK's Adapting to Climate Change Program; Adaptation Policy Lead for the UK Climate Change Act and Sustainable Agriculture Advisor. Dan also worked for the UK Foreign Office as a Climate Attaché. He is a regular speaker and moderator at conferences and events and has written widely on climate and development. Dan is a Chartered Environmentalist (CEnv) and Fellow of the Institute of Environmental Management and Assessment (FIEMA). Dan has an MSc in International Development from Bristol University, where he also lectured and researched global environmental politics. In his early career Dan lived and worked in the rainforests of Latin America.

#### **Abstract:**

We need cooling to keep our children healthy, vaccines and food fresh, energy supply stable, economies productive and environment clean. One billion people face immediate risks from a lack of cooling. But because cooling typically uses super-polluting F-gases and fossil fuel sources of energy, the more we cool, the more we heat the planet. By 2050, space cooling alone will consume as much electricity as China and India today and much of the world's projected renewables capacity. So how do we cool the world without warming the world? Dan Hamza-Goodacre will talk about the challenges and solutions in bringing efficient, climate-friendly cooling to all.

## Requirements and Interactions for Indoor Environmental Quality (IEQ) Parameters

### Prof. Bjarne Olesen

International Centre for Indoor Environment and Energy, Technical University of Denmark



Bjarne W. Olesen, Professor, Ph.D, Dr.H.C., International Centre for Indoor Environment and Energy Technical University of Denmark, Department of Civil Engineering

Master's degree in civil engineering, 1972. Ph.D., Laboratory of heating and Air Conditioning, Technical University of Denmark, 1975. In the period 1972-1990 Research scientist at the Laboratory of Heating and Air Conditioning. Part time affiliated as product manager at Brüel & Kjaer 1978-1992. Senior Research Scientist, College of Architecture, Virginia Tech. in the period 1992-1993. Since 1993 until January 2004 Head of Research & Development at UPONOR-VELTA GmbH KG & Co., Norderstedt, Germany. Since January 2004 full professor in Indoor Environment & Energy at the Technical University of Denmark and director of the International Centre for Indoor Environment and Energy until 2017, Technical University of Denmark. Awarded the Ralph Nevins Award (1982), Distinguish Service Award (1997), Fellow Award (2001) and Exceptional Service Award (2006) from ASHRAE. Honorary member of AICARR (Italy), SHASE (Japan) and VDI-TGA (Germany). Chivalric Order of Dannebrog, from the Danish Queen (2012). Doctor Honoris Causa, Slovak University of Technology, ASHRAE President 2017-18.

#### Abstract:

For design and energy performance prediction of buildings and HVAC systems, it is important to use established requirements for Indoor Environmental Quality parameters. The indoor environmental factors are Thermal Comfort, Indoor Air Quality (IAQ, ventilation), Lighting and Acoustic, where especially Thermal Comfort and IAQ have significant influence on people's health and well-being, and on energy use. A couple of international standards deals with requirements to the indoor environment. Newly published ISO standard, ISO 17772-1/2, and newly published CEN standard EN 16798-1/2 deals with all 4 indoor environmental factors, while ASHRAE Standard 55 deal with Thermal Comfort and Standards 62.1 and 62.2, deals with IAQ/Ventilation. The requirements are however, given without taking into account any interactions between the parameters. ASHRAE Guideline 10 "Interaction Affecting the Achievement of Acceptable Indoor Environments" do give some explanations related to such interactions.

This presentation will focus on the requirements for the indoor thermal environment and indoor air quality; but will give examples of interactions between all 4 indoor environmental parameters. The interactions can be on the perception side, where perception of one parameter is influenced by one or more of the other parameters. Then interactions among physical parameters will also take place; but can in most case be taken into account at design stage. As an example, the benefits of increased daylight indoor can result in increased risk of glare and overheating due to increased sun load.

## Combining Low Energy, High Performance Appliances and Policies – Providing Climate Friendly Cooling for the World with New Regulations

### Dr. Paul Kellett - Programme

Manager, United for Efficiency, UN Environment Programme



Paul is responsible for the day to day management of UN Environment's \$57 M Global United for Efficiency (U4E) Market Transformation Programme for more energy efficient appliances and equipment including maintaining and building relations with countries and private sector partners which include all the major global electrical equipment manufacturers. The global programme enables the faster and widespread uptake of much more efficient electric lighting, cooling appliances, general service motors and power transformers in more than 40 developing and emerging economies, saving them more than 20% of their electricity consumption. The global programme is based on proven market transformation strategies following regional regulatory harmonisation and national level integrated policy approaches. <http://bit.ly/ChileVideoEN> <https://united4efficiency.org/>

#### Abstract:

"Combining Low Energy, High Performance Cooling and Policies for the Built Environment – Providing Climate Friendly Cooling for the World's Buildings with New Global Energy Performance Regulations and Effective National Programs."

Representing more than 50% of buildings' energy use globally, space heating, lighting and cooling require critical policy action in the buildings and built environment sectors, especially in cities. Space cooling demand will increase significantly as economies and populations grow, with energy use for space cooling expected to triple by 2050.

United for Efficiency (U4E) is a Global UN Environment Energy Efficiency Initiative supporting more than 40 countries to save 20 % or more of their electricity for the benefit of all consumers and governments. The presentation on the initiative, which supports countries to transform their entire built environment markets, includes much more efficient LED lighting (and 'Ultra' LED lighting systems), Higher Performance Refrigerators/ Freezers both for Efficiency and Fresher Foods, Climate Friendly and Controlled Air Conditioning, Higher Performance General Purpose Motor Systems and 'Green' Power Distribution Transformers – the five electrical products that consume more than 50% of all electricity. <https://united4efficiency.org/>

The available savings with new, much more efficient electrical product and system technologies for all consumers and governments will be presented and are more than \$ 500 Billion globally by 2030 – available savings in the Gulf region range from more than \$ 2,000 Million per year for Saudi Arabia (\$ 40 Billion cumulatively by 2040) to more than \$ 200 Million per year for Kuwait (\$ 4 Billion cumulatively by 2040), especially from more efficient cooling and lighting. Avoided new power plants range from one 1,000 MW plant in Kuwait to eight 1,000 MW plants in Saudi Arabia for example, saving a further \$ 10 to 20 Billion in unnecessary power infrastructure costs for example. (<https://united4efficiency.org/countries/country-assessments/>)

## Opportunities and Challenges for CSP + Desalination Development

### Dr. Marcelino Sánchez

Director - Solar Thermal Energy Department, National Renewable Energy Centre, Spain.



Dr. Marcelino is the Director of the Solar Thermal Energy Department of CENER with more than 29 years of international research experience in R&D projects in the area of solar thermal energy, especially in projects related to Concentrating Solar Power Technologies (CSPT). During these years he has been working for both public institutions and private enterprises, in Spain and abroad, leading research groups in different working environments with remarkable success. He has led and participated in a large number of national and international R&D projects, most of them EU funded.

Although this experience covers a wide range of developments on different CSPT, his professional career has been more focused on the research and development of solar tower technology covering a wide range of key components from receivers (Open Air, Pressurized Air, Molten Salt, Saturated Steam and Water/Steam) and heliostats (glass/metal, stressed membrane), working from research at laboratory scale to the design, construction and evaluation of commercial solar demonstration plants, unique in its kind, and including the development of experimental prototypes.

He has held, among others, the following positions: R&D Director at Abengoa Solar New Technologies; Responsible of the High Concentration Working Group at CIEMAT; Solar thermal expert at Solargen Europe Ltd; Technical consultant for Energy for Sustainable Development Ltd. He has participated and participates in numerous expert groups, and committees, having been selected by the European Union several times to assist the Commission as International Expert.

#### **Abstract:**

In this keynote speech a review of not only the current technology status of CSP, but also previous experiences CSP+Desal will be done. A critical analysis of current situation will be made identifying the challenges, the main barriers, and the technology potential to identify the main challenges of combining CSP + Desalination in an affective way.

## ASHRAE Building Energy Quotient (Building EQ)

### Eng. Hoy R. Bohanon, Jr

President - Hoy Bohanon Engineering, PLLC, Clemmons, NC



Hoy Bohanon, P.E., Member ASHRAE, BEAP, LEED® AP, is president of Hoy Bohanon Engineering, PLLC. Mr. Bohanon began his engineering career as a research and design engineer, then gained experience as a project engineer, facilities engineer, facilities manager, indoor air quality research engineer, environmental engineer, and business owner. He has a bachelor's degree in mechanical engineering from Georgia Institute of Technology and a master's degree in engineering from North Carolina State University. Mr. Bohanon has written technical papers and articles on indoor air quality, operations, and maintenance and is very active in ASHRAE. He is Chair of ASHRAE SSPC 62.1, past Chair of the Building Energy Quotient Committee, and a member of the Environmental Health Committee. He is a member of ISO-TC 205 and corresponding member of Technical Committees 5.5 and 9.10. He is an ASHRAE Distinguished Lecturer, writes and teaches courses for the ASHRAE Learning Institute, and is a recipient of the ASHRAE Distinguished Service Award.

#### **Abstract:**

ASHRAE has implemented a comprehensive building energy labeling program called Building Energy Quotient (Building EQ). The objective of this labeling effort is to provide motivation for reducing energy use in commercial buildings by expressing the energy performance of buildings in a tangible way. The underlying belief is that public display and disclosure of the energy efficiency attributes of a building and its energy use intensity (EUI) will lead building owners to strongly consider cost effective energy efficiency improvements at the time of design and construction and in any subsequent renovations. Public display and disclosure of energy efficiency attributes and EUI should be a relevant factor in the real estate transaction marketplace for commercial buildings.

Building EQ incorporates both an operational rating, based upon actual energy billing, and an asset rating that normalizes for operational variables. The two rating systems will thus be able to communicate both the performance of the building as operated and the potential performance of the fixed assets of the building.

This session will present the major ideas behind the development of the labeling program and the process for implementation.

1. How can building energy labels influence the energy efficiency of the overall building stock?
2. How the new ASHRAE Building EQ is different from other labeling systems?
3. What metrics are most important for conveying the energy efficiency of a building?
4. What you need to do to get a Building EQ label for your building.

## Schedule Overview

<b>Time</b>	<b>16 - 18 November 2019 - Preconference Course</b>	
<b>8:00 am – 5:00 pm</b>	<b>HVAC Design: Level I – Essentials (Lunch 12:00 pm to 1:00 pm) Kuwait Society of Engineers – Training Center</b>	
<b>Time</b>	<b>November 18, 2019 – Preconference Course</b>	
<b>8:00 am – 5:00 pm</b>	<b>Designing for IAQ: Complying with the Requirements of Standard 62.1 (Lunch 12:00 pm to 1:00 pm) Kuwait Society of Engineers – Training Center</b>	
<b>Time</b>	<b>November 18, 2019 – Preconference Workshop</b>	
<b>9:00 am - 1:00 pm</b>	<b>KFAS Workshop: Standards Development and Commissioned Study (Lunch 1:00 pm to 2:00 pm) Sheikh Jaber Al Ahmad Cultural Centre - Lecture Hall-C4</b>	
<b>Time</b>	<b>Day 1 – November 19, 2019</b>	
<b>9:00 am to 10:00 am</b>	<b>Opening Ceremony Multipurpose Hall-C1</b>	
<b>10:00 am to 10:45 am</b>	<b>Keynote 1 Dr. Adnan Shihab-Eldin Multipurpose Hall-C1</b>	
<b>10:45 am to 11:00 am</b>	<b>Break</b>	
<b>11:00 am to 12:45 pm</b>	<b>Session No: TA1 Heat Transfer and Fluid Flow Lecture Hall-C4 A</b>	<b>Session No: TA2 Alternative Energy Lecture Hall-C4 B</b>
<b>12:45 pm to 1:45 pm</b>	<b>Lunch</b>	
<b>1:45 pm to 2:30 pm</b>	<b>Keynote 2 Dr. Dan Hamza-Goodacre Multipurpose Hall-C1</b>	
<b>2:30 pm to 2:45 pm</b>	<b>Break</b>	
<b>2:45 pm to 3:45 pm</b>	<b>Session No: TP1 Sustainability in Building Performance Lecture Hall-C4 A</b>	<b>Session No: TP2 Water Resources Management Lecture Hall-C4 B</b>

Time	Day 2 – November 20, 2019	
9:00 to 9:45 am	Keynote 3 Prof. Bjarne Olesen Lecture Hall-C4	
9:45 am to 10:00 am	Break	
10:00 am to 12:00 pm	Session No: WA1 HVAC System Design Lecture Hall-C4	Session No: WA2 Sustainability in Built Environments Symposium Hall-C3
12:00 pm to 1:00 pm	Lunch	
1:00 pm to 1:45 pm	Keynote 4 Dr. Paul Kellett Lecture Hall-C4	
1:45 pm to 2:00 pm	Break	
2:00 pm to 3:30 pm	Session No: WP1 Improvement of Heat Exchanger Design Symposium Hall-C3	KFAS Workshop: Roadmap for Refrigerant Technologies in Residential A/C Systems Lecture Hall-C4
Time	Day 3 – November 21, 2019	
9:00 to 9:45 am	Keynote 5 Dr. Marcelino Sánchez Lecture Hall-C4	
9:45 am to 10:00 am	Break	
10:00 am to 11:45 am	Session No: THA1 Renewable Energy Lecture Hall-C4	Session No: THA2 Indoor Air Quality Symposium Hall-C3
11:45 am to 12:30 pm	Keynote 6 Eng. Hoy R. Bohanon, Jr. Lecture Hall-C4	
12:30 pm to 1:30 pm	Lunch	
Time	November 21, 2019	
1:30 pm to 5:00 pm	KFAS Workshop: Application of Concentrated Solar Power (CSP) and Desalination Lecture Hall-C4	
Time	November 21, 2019	
8:00 am – 5:00 pm	Course: Variable Refrigerant Flow Systems: Design & Applications (Lunch 12:00 pm to 1:00 pm) Kuwait Society of Engineers – Training Center	



## Pre-conference Courses and Workshops:

### 16 - 18 November, 2019: 3-days ASHRAE Course

#### Name of Course: HVAC Design: Level I – Essentials

**Time:** 8:00 am – 5:00 pm

**Address:** Kuwait Society of Engineers, Jasim Mohammed Albahar Street, Arabian Gulf Road, Opposite Kuwait Towers - **Training Center**

Daily Lunch: 12:00 PM to 1:00 PM

### Monday, November 18, 2019

#### Name of Course: Designing for IAQ: Complying with the Requirements of Standard 62.1

**Time:** 8:00 am – 5:00 pm

**Address:** Kuwait Society of Engineers, Jasim Mohammed Albahar Street, Arabian Gulf Road, Opposite Kuwait Towers - **Training Center**

Lunch: 12:00 PM to 1:00 PM

### Monday, November 18, 2019

#### KFAS Workshop: Standards Development and Commissioned Study

**Time:** 9:00 am - 1:00 pm

**Address:** The Sheikh Jaber Al Ahmad Cultural Centre-Conference Halls, 25 Jamal Abdul Nasser St, Kuwait City, Kuwait – **Lecture Hall-C4**

**Session Chair:** Dr. Walid Chakroun – Mechanical Engineering Department, Kuwait University

**Presenters:** Mr. Wayne R. Reedy – ASHRAE Fellow  
Dr. Walid Chakroun – Professor – ME Dept., Kuwait University

Lunch: 1:00 PM to 2:00 PM

## Day 1 - Tuesday November 19, 2019

**Opening Ceremony:** 9:00 am to 10:00 am

**Address:** The Sheikh Jaber Al Ahmad Cultural Centre-Conference Halls, 25 Jamal Abdul Nasser St, Kuwait City, Kuwait - **Multipurpose Hall-C1**

**Keynote 1** 10:00 to 10:45 am (Multipurpose Hall-C1)

**Session Chair:** Dr. Walid Chakroun – Mechanical Engineering Department, Kuwait University

**Title: The Role of Low Carbon Technologies Within the Energy Transition**

Speaker: Dr. Adnan Shihab-Eldin - Director General – Kuwait Foundation for the Advancement of Sciences

**Break** 10:45 am to 11:00 am

**Sessions (1 & 2)** 11:00 am to 12:45 pm

**Session No: TA1** (Lecture Hall-C4 A)

**Session Title: Heat Transfer and Fluid Flow**

**Session Chair:** Dr. Raed Bourisli, Mechanical Engineering Department, Kuwait University

1. Paper Number: ICERD7-1116  
Paper Title: Prediction of the Minimum Film Boiling Temperature of Vertical Quenched Rods in Distilled Water Using an Artificial Neural Network.  
Authors: Shikha Ebrahim, Ammar Bahman, Sorour Alotaibi
2. Paper Number: ICERD7-1111  
Paper Title: Numerical Analysis of Flow and Heat Transfer of Minimum Quantity Lubrication in a Turning Process Using Inconel Alloy  
Authors: Khalil Khanafer, Ibrahim Deiab, Wahbi El Bouri
3. Paper Number: ICERD7-1179  
Paper Title: Numerical and Experimental Study of Phase Change Material Melting Process in an Intermediate Fluid  
Authors: Alireza Khademi, Amirhossein Favakeh, Masoud Darbandi, Mohammad Behshad Shafii
4. Paper Number: ICERD7-1183  
Paper Title: Experimental Study of Double Solid Phase Change Material in a Cavity  
Authors: Amirhossein Favakeh, Alireza Khademi, Mohammad Behshad Shafii
5. Paper Number: ICERD7-1115  
Paper Title: Effect of Surface Roughness on Heat Transfer with Phase Change Pool Boiling for Quenched Vertical Cylinders  
Authors: Mariam AlOlaimi, Shikha Ebrahim, Ammar Bahman, Mohammad Alalaimi, Mohammed Alyaseen, Walid Chakroun

**Session No: TA2**

**(Lecture Hall-C4 B)**

**Session Title: Alternative Energy**

**Session Chairs:**

- Dr. Ali Alajmi, Mechanical Power & Refrigeration Technology, Public Authority for Applied Education and Training.
- Dr. Sreekanth Krishnan Nair, Energy and Building Research Center, Kuwait Institute for Scientific Research.

1. Paper Number: ICERD7-1210  
Paper Title: Techno-Economic Analysis of a Power to Gas System Integrated with Biomass Gasification and Synthetic Natural Gas Production for Energy Generation in Gas Engine.  
Authors: Anna Skorek-Osikowska, Łukasz Bartela, Daria Katla
2. Paper Number: ICERD7-1157  
Paper Title: Influence of Various Oxygenated Fuel Additives on Performance and Emissions of a Biodiesel Fueled Engine: An Experimental Study.  
Authors: Dinesha Pijakala, Shiva Kumar
3. Paper Number: ICERD7-1152  
Paper Title: Novel Power Generation Cycle with Chemical Reacting Working Fluid.  
Authors: Davide Ziviani, James E. Braun, Eckhard A. Groll
4. Paper Number: ICERD7-1135  
Paper Title: A Survey of Recent Progress in Energy Conversion and Storage.  
Authors: Divyanshu Sood, V.S.K.V. Harish
5. Paper Number: ICERD7-1142  
Paper Title: History and Future of Mediterranean Oil and Gas.  
Authors: Dacun Li

**Lunch** **12:45 pm to 1:45 pm**

**Keynote 2** **1:45 pm to 2:30 pm** **(Multipurpose Hall-C1)**

**Session Chair:** Dr. Nesreen K. Ghaddar – Qatar Chair in Energy Studies, Professor of Mechanical Engineering, American University of Beirut.

**Title: Cooling the World Without Warming the World - Video Conferencing**

**Speaker:** Dr. Dan Hamza-Goodacre, Executive Director - Kigali Cooling Efficiency Program

**Break** **2:30 pm to 2:45 pm**

**Sessions (3 & 4) 2:45 pm to 3:45 pm**

**Session No: TP1 (Lecture Hall-C4 A)**

**Session Title: Sustainability in Building Performance**

**Session Chairs:**

- Dr. Fatouh Ragom, Energy and Building Research Center, Kuwait Institute for Scientific Research.
- Eng. Dina AlNakib, Program Manager - Flagship Program Research Directorate, Kuwait Foundation for the Advancement of Sciences

1. Paper Number: ICERD7-1169  
Paper Title: Performance Analysis of Integrated Passive Technologies for Net-Zero Energy Building: Case Study of Iran.  
Authors: Seyed Mohammad Ebrahimi Saryazdi, Alireza Etemad, Atefeh Behzadi Forough, Ehsan Livani, Shahriar Bozorgmehri
2. Paper Number: ICERD7-1204  
Paper Title: Energy Autonomous Buildings: A Review.  
Authors: Saeed Mohammadi
3. Paper Number: ICERD7-1205  
Paper Title: Feasibility of Low Energy Cooling Technologies in Residential Sector.  
Authors: Dhanashri Naresh Mankar, Sujata Karve

**Session No: TP2 (Lecture Hall-C4 B)**

**Session Title: Water Resources Management**

**Session Chairs:**

- Dr. Esam Alawadhi, Mechanical Engineering Department, Kuwait University
- Dr. Alia Marafie, Mechanical Engineering Department, Kuwait University.

1. Paper Number: ICERD7-1150  
Paper Title: Economic Feasibility and Carbon Footprint Analyses of Utilizing an Optimized Reverse Osmosis System for Yoghurt Production.  
Authors: Mehmet Baris Ozerdem, Dilara Dogruluk, Ozge Ozer
2. Paper Number: ICERD7-1153  
Paper Title: Advanced Solar Effluent Treatment and Reuse for Sustainable Management of Water and Energy Demands in KSA.  
Authors: Nuhu Dalhat Mu'azu, Mohammed Hussein Essa

**Social Program**

6:00 pm to 8:00 pm – Discover the old traditional life at **Souq Al-Mubarakiya**

8:00 pm to 10:00 pm – Dinner in **Freej Swaileh Restaurant**– Traditional Kuwaiti Food

**End of Day 1**

## Day 2 - Wednesday November 20, 2019

**Keynote 3** **9:00 am to 9:45 am** **(Lecture Hall-C4)**

**Session Chair:** Dr. Sorour Alotaibi – Chairman - Mechanical Engineering Department, College of Engineering & Petroleum, Kuwait University

**Title: Requirements and Interactions for Indoor Environmental Quality (IEQ) Parameters**

Speaker: Prof. Bjarne Olesen – Professor - DTU Civil Engineering, Department of Civil Engineering

**Break** **9:45 am to 10:00 am**

**Sessions (5 & 6)** **10:00 am to 12:00 pm**

**Session No: WA1** **(Lecture Hall-C4)**

**Session Title: HVAC System Design**

**Session Chairs:**

- Dr. Ammar Bahman, Mechanical Engineering Department, Kuwait University.
- Dr. Davide Ziviani, Purdue University.

1. Paper Number: ICERD7-1117  
Paper Title: Analysis of a Compressor with a Variable Built-in Volume Ratio and an Integrated Linear Motor.  
Authors: Sergei Gusev, Davide Ziviani, Michel De Paepe
2. Paper Number: ICERD7-1175  
Paper Title: Improvement of Gas Turbine Performance by Cooling the Intake Air by Absorption Chiller.  
Authors: Mohammad Ansari, Majid Bazargan
3. Paper Number: ICERD7-1176  
Paper Title: Improving Thermal Energy Transfer Performance of Natural Draft Cooling Towers Using Thermo-Aerodynamic Components.  
Authors: Masoud Darbandi, Pooya Javadpoor Langroodi, Ali Behrouzifar, Alireza Khademi
4. Paper Number: ICERD7-1174  
Paper Title: Oil Return in Two Phase Flow in Vertical Tubes of Refrigerating Systems.  
Authors: Mohammad Ansari, Majid Bazargan
5. Paper Number: ICERD7-1189  
Paper Title: Comparative Performance Analysis of a Marine Refrigeration System that Operates with Different Refrigerants via the Exergy Density.  
Authors: A. Sinan Karakurt

**Session No: WA2**

**(Symposium Hall-C3)**

**Session Title: Sustainability in Built Environments**

**Session Chairs:**

- Dr. Osama Ibrahim, Mechanical Engineering Department, Kuwait University.
- Eng. Fareed M Alghimlas, Senior Research Associate, Energy and Building Research Center, Kuwait Institute for Scientific Research (KISR)

1. Paper Number: ICERD7-1104  
Paper Title: Energy Saving Related to Laboratory Ventilation and Air Conditioning.  
Authors: Hari Sankar Dalal
2. Paper Number: ICERD7- 1109  
Paper Title: Study of Thermoelectric Air Duct Cooling/Heating System for Building Energy Efficient.  
Authors: Salem Algarni, Kashif Irshad
3. Paper Number: ICERD7-1118  
Paper Title: Reducing Energy Consumption in Residential and Commercial Buildings by Facility Management.  
Authors: Ilham Saleh Al-Shemmeri, Sahar M.Tareq Ajrawi
4. Paper Number: ICERD7-1143  
Paper Title: An Algorithm for Evaluating Energy Costs for Earth-Sheltered Buildings.  
Authors: Mitra Yadollahi, Ali Shafaat, Mohammadreza Hafezi
5. Paper Number: ICERD7-1131  
Paper Title: Three Sides of Coin: Connecting Cooling Capacity, Environmental Impact and Comfort.  
Authors: Nidhi Rai Jain, Rajan Rawal
6. Paper Number: ICERD7-1206  
Paper Title: Part Load Figures of Merit for Air Conditioners in High Ambient Climates.  
Authors: Mohammed Shamroukh, Sandra Bou Madi, Aimée Younes

**Lunch** **12:00 pm to 1:00 pm**

**Keynote 4** **1:00 pm to 1:45 pm** **(Lecture Hall-C4)**

**Session Chair:** Dr. Souhaila Almutawa – Mechanical Engineering Department, College of Engineering & Petroleum, Kuwait University

**Title: Combining Low Energy, High Performance Appliances and Policies – Providing Climate Friendly Cooling for the World with New Regulations**

**Speaker:** Dr. Paul Kellett - Programme Manager, United for Efficiency, UN Environment Programme

**Break** **1:45 pm to 2:00 pm**

**Session (WP1) and KAFS Workshop 2:00 pm to 3:30 pm**

**Session No: WP1 (Symposium Hall-C3)**

**Session Title: Improvement of Heat Exchanger Design**

**Session Chairs:**

- Dr. Ammar Alsairafi, Mechanical Engineering Department, Kuwait University.
- Dr. Yahya Al-Hadban, Energy and Building Research Center, Kuwait Institute for Scientific Research.

1. Paper Number: ICERD7-1194  
Paper Title: Investigation of Heat Transfer Characteristics in Single and Double Stack Rectangular and Trapezoidal Microchannels.  
Authors: Ibrahim Elbadawy, Mohamed Fayed, Yousef Gharbia
2. Paper Number: ICERD7-1201  
Paper Title: Effect of Outdoor Heat Exchanger Designs on the Performance of Residential Heat Pump System.  
Authors: Man-Hoe Kim, Shehryar Ishaque

**KFAS Workshop: Roadmap for Refrigerant Technologies in Residential A/C Systems**

**Time:** 2:00 pm to 3:30 pm

**Address:** The Sheikh Jaber Al Ahmad Cultural Centre-Conference Halls, 25 Jamal Abdul Nasser St, Kuwait City, Kuwait - **Lecture Hall-C4**

**Session Chair:** Eng. Yaqoub Almatouq - Environment Public Authority - Kuwait

**Presenters:** Dr. Fotouh Al-Ragom – Program Manager – Energy Efficiency Technology Program - Energy and Building Research Center – Kuwait Institute for Scientific Research (KISR)  
Eng. Stefan Thie - EPEE – European Partnership for Energy and the Environment – Brussels  
Dr. Omar Abdelaziz - Assistant Professor – Zewail City of Science and Technology – Egypt

**Social Program**

6:00 pm to 8:00 pm – Visit **Sheikh Abdullah Al Salem Cultural Centre**.

8:00 pm to 10:00 pm – Dinner in **Kuwait Towers**

**End of Day 2**

## Day 3 - Thursday November 21, 2019

### Keynote 5                      9:00 to 9:45 am                      (Lecture Hall-C4)

**Session Chair:** Dr. Mohamed Elsayed – Chairman - Electrical Engineering Department, College of Engineering & Petroleum, Kuwait University

**Title: Opportunities and Challenges for CSP + Desalination Development**

**Speaker:** Dr. Marcelino Sánchez, Director - Solar Thermal Energy Department, National Renewable Energy Centre, Spain.

### Break                                      9:45 am to 10:00 am

### Sessions (8 & 9) and Course                      10:00 am to 11:45 am

**Session No: THA1**                                      **(Lecture Hall-C4)**

**Session Title: Renewable Energy**

**Session Chairs:**

- Dr. Nawaf Al-Mutawa, Mechanical Engineering Department, Kuwait University.
- Dr. Abdulrahman Almutairi, Mechanical Power & Refrigeration Technology, Public Authority for Applied Education and Training.

1. Paper Number: ICERD7-1125  
Paper Title: Consideration of Combined Thermal Radiative, Conductive and Convective in Solar Channels With and Without Porous Media.  
Authors: A. Nouri-Borujerdi
2. Paper Number: ICERD7-1139  
Paper Title: Experimental and Numerical Study of Heat Transfer and Pressure Drop in Entry Length of Solar Air Heater with Irregular Spacing of the Ribs.  
Authors: Mohammad Ansari, Majid Bazargan
3. Paper Number: ICERD7-1107  
Paper Title: Two Solar Screens Installed on the Exterior of a Window Energy and Illuminance Studies.  
Authors: Esam Alawadhi
4. Paper Number: ICERD7-1192  
Paper Title: Achieving 40% Renewable Capacity Generation Using an Optimal Mix in Kuwait by 2040.  
Authors: Ahmad Bennakhi, Yousef M. Al-Abdullah, Charlie Heaps
5. Paper Number: ICERD7-1208  
Paper Title: Assessment of the Potential for Natural Gas Substitution with Methane-Rich Biogas in Spain.  
Authors: Anna Skorek-Osikowska, Diego García-Gusano, Javier Dufour



**Session Title: Indoor Air Quality**

**Session Chairs:**

- Dr. Ali Hajiah, Energy and Building Research Center, Kuwait Institute for Scientific Research.
- Dr. Adel Alshayji, Mechanical Engineering Department, Kuwait University.

1. Paper Number: ICERD7-1138  
Paper Title: The Use of Personalized Ventilation with Mixed Mode Ventilation to Save Energy and Attain Comfort in an Office in Beirut.  
Authors: Nesreen K. Ghaddar, Safaa Khalil, Kamel Ghali
2. Paper Number: ICERD7-1140  
Paper Title: Effect of the Human Prayer Cycle on the Dispersion of Particles and Indoor Air Quality.  
Authors: Kamel Ghali, Douaa Al Assaad, Nesreen K. Ghaddar
3. Paper Number: ICERD7-1181  
Paper Title: Ventilation System & Particle Dispersion Analysis of Operation Theater Using CFD.  
Authors: Sanjeev Anand, Saurabh Sawhney, Shubham Verma, Yatheshth Anand
4. Paper Number: ICERD7-1124  
Paper Title: Building-Integrated Carbon Capture: Carbon Dioxide Removal Through Buildings' Mechanical Systems.  
Authors: Fahad Ben Salamah, Harvey Bryan
5. Paper Number: ICERD7-1202  
Paper Title: Ventilation Efficiency of a Trench Cooling System.  
Authors: Oliver Höfert, Maciej Danielak

**Keynote 6                      11:45 am to 12:30 pm                      (Lecture Hall-C4)**

**Session Chair:** Eng. Anoop Peediyakkan – ASHRAE Kuwait Chapter BOG Member & CTTC Chair

**Title:** ASHRAE Building Energy Quotient (Building EQ)

Speaker: Eng. Hoy R. Bohanon, Jr., P.E – President - Hoy Bohanon Engineering, PLLC, Clemmons, NC

**Lunch                                      12:30 pm to 1:30 pm**

**Workshop**                      **1:30 pm to 5:00 pm**

**Name of Workshop: Application of Concentrated Solar Power (CSP) and Desalination**

**Time:** 1:30 pm to 5:00 pm

**Address:** The Sheikh Jaber Al Ahmad Cultural Centre-Conference Halls, 25 Jamal Abdul Nasser St, Kuwait City, Kuwait - **Lecture Hall-C4**

**Session Chair:** Dr. Sorour Alotaibi – ME Dept., Kuwait University

**Presenters:** Dr. Marcelino Sánchez - Director - Solar Thermal Energy Department of CENER

Dr. Mansour Ahmed – Associate Research Scientist – Kuwait Institute for Scientific Research (KISR)

Eng. Javier García-Barberena - Business Dev. Manager - CENER

**Thursday November 21, 2019**

**Name of Course: Variable Refrigerant Flow Systems: Design & Applications**

**Time:** 8:00 am – 5:00 pm

**Lunch** 12:00 pm to 1:00 pm

**Address:** Kuwait Society of Engineers, Jasim Mohammed Albahar Street, Arabian Gulf Road, Opposite to Kuwait Towers - **Training Center**

**End of Day 3**

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