ICSEWEN21

Book of Abstracts

ICSEWEN21

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Keynote

Smart Buildings and IoT on a joint mission to enable carbon neutrality

Dragan Boscovic*

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This talk discusses the role of IoT in enabling Smart Buildings to achieve carbon neutrality through measurement of carbon consumption and waste, reduced energy consumption, and on-site renewable energy generation. To face excessive Greenhouse Gasses (GHG) emissions, Smart Building designers, owners, and operators will need to adopt a corporate social responsibility policy and accept social accountability - to itself, its stakeholders, and the public. In the carbon-neutral building era, the buildings will still produce some carbon, even if their carbon footprints are drastically reduced. Their GSG production will need to be offset by acquiring or buying carbon credits in the marketplace from entities engaged in capturing carbon dioxide formed during Smart Building operations and storing it so that it is not emitted into the atmosphere. The talk will present a blockchain-based design to trade carbon credits in offer-based trading to achieve this goal while preserving the privacy and authenticity of sensitive data with blockchain's dedicated channels and private data collections.

Keynote

Development of low-pressure reverse osmosis (RO) hollow fiber membranes for energy efficient water reuse

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Water scarcity is receiving increasing attention worldwide and becoming more challenging in view of expanding population, climate change and socio-economic activities. Membrane separation technology has been widely used for water reuse, but most of these processes are energy-intensive. It is important to further develop highly-effective and energy-efficient membrane-based water treatment technology to address the challenge imposed by the water-energy nexus. This presentation will introduce our work on developing low-pressure reverse osmosis (RO) hollow fiber membranes for energy efficient water reuse. The newly developed RO membrane was made by incorporating special bio-materials, which come from the building blocks of cellular membranes, into the polymer matrix of the selective layer to tailor its structure during the interfacial polymerization reaction. A significant enhancement in water permeability was achieved while maintaining good salt rejection. A long-term pilot test with the capacity of 14 M3/day produced water was carried out at a local water reclamation plant and the results will be presented.

Keynote

Climate change, air pollution, and public health: from science to policy

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Environmental pollutants cause harmful health effects and have been a global concern for decades. It has been estimated that a quarter of human diseases such as perinatal disorders, infant mortality, respiratory disorders, allergy, malignancies, cardiovascular disorders, endothelial dysfunction, mental disorders, and various other harmful effects are due to chronic exposure to pollution, and that proper management of pollutants is necessary to protect against detrimental human health impacts. Human poisoning occurs through inhalation of smoke or ingestion of contaminated soils, water, and/or vegetation. Several emerging pollutants are stable, non-biodegradable, and persistent and, can accumulate in food chains, lasting for many years in different environmental segments. Currently, a key problem in understanding the environmental health problems is the lack of appropriate technologies and theoretical approaches. Innovative methods and models are required to reveal the toxicological pathways and interaction mechanisms of diverse pollutants in air, water, and soil. This section focuses on, but is not limited to, exposure of environmental pollution and its health impacts including sampling techniques, methods for analyses of pollutants in environmental or biological samples, human exposures, source apportionment, and toxicity mechanisms.

Keynote

Corrosion Challenges for Stainless Steels in Hot Climates

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Almost all significant industrial facilities operate a large steam system that includes multiple steam generators. Various components of these systems are potentially vulnerable to different corrosion mechanisms, including Flow Assisted Corrosion (FAC) in the feedwater piping and Under Deposit Corrosion (UDC) in the evaporator tubes. To mitigate these threats, water chemistry throughout the system must be rigorously controlled. The UDC mechanism involves deposition of a porous layer of magnetite particles on the waterside surface of the evaporator tubes. Beneath this layer, wick-boiling leads to a very high concentration of contaminant species, until at some point the concentration exceeds threshold level that causes rapid corrosion. The most prevalent form of UDC in modern plants involves chloride contamination, which may eventually lead to tube failure by hydrogen damage. Industry practice to mitigate this risk is to manage feedwater quality to minimize the risk of FAC and hence reduce the amount of iron (as ferrous ions and magnetite particles) that enters the steam generator; minimize chloride contamination; monitor the extent of deposition and then chemically clean the tubes before the deposits reach the levels necessary to initiate UDC. One other critical factor is the heat flux, which drives both the magnetite deposition and the wick boiling processes. Despite the trend toward higher heat-flux values in power generation, typical values remain low compared to those in the oil and gas sector. In this paper we describe an investigation into the relationship between heat flux and the critical deposit thickness for initiation of chloride-driven UDC.

Keynote

Climate Change Policy in the GCC

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Oxford Institute for Energy Studies

The energy transition will create serious challenges for oil and gas exporters, though this group is far from homogenous, and some are in a better position to adapt to these challenges. Diversifying away from the oil and gas sector is often presented as an effective transition strategy to confront these challenges. However, diversifying from this core sector is fraught with uncertainties and most oil and gas exporters have not implemented the reforms essential for the success of such a transformation. A complementary transition strategy would be to increase the competitiveness and the resilience of the oil and gas sector. This would allow oil and gas exporting countries to draw on their sources of competitive advantage to mitigate the potential impacts associated with the energy transition. Rather than just compete on cost alone, exporters could also compete on reducing emissions. Technologies such as CCUS that store carbon in terrestrial sinks could allow these countries to continue to monetise their hydrocarbon reserves while simultaneously harmonising the transition to a net-zero emissions world and enabling CCUS as a key mitigation sector and one in which some oil and gas exporters could establish a competitive advantage. This requires exporters to take a more active role in developing and scaling up CCUS and geological storage through investments in the sector. However, it should also be recognised that producers' economies would have to undergo some of the deepest transformations and shifting the costs to producers alone is not viable. If the costs are too high or domestic competition from other sectors for the use of hydrocarbon revenues intensifies during the transition, then scaling CCUS to levels that are needed for it to be an effective mitigation strategy will not materialise in these countries. Here lies the importance of developing burden sharing frameworks and mechanisms that allow for the costs to be shared more equally both across the supply chain and between exporting and importing countries.

Keynote

Why crystals will save the world?

Mike Zaworotko

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That composition and structure so profoundly impact the properties of crystalline materials has provided impetus for exponential growth in the field of crystal engineering over the past 30 years. Crystal engineering has evolved from structure design (form) to control over bulk properties (function). When coupled with molecular modeling, crystal engineering offers a paradigm shift from the more random, high-throughput methods that have traditionally been utilized in materials discovery and development. Simply put, custom-design of the right crystalline material for the right application is now at hand. New classes of porous crystalline solids exemplify this situation. Hybrid Ultramicroporous Materials, HUMs, have set new bechmarks for gas and vapior seelctivity, whereas Flexible Metal-Organic Materials, F-MOMs, offer new approaches to adsorbed gas storage. Examples of HUMs and F-MOMs will be detailed including their performance with respect to important gas separations (e.g. CO2 capture, C2H2 capture, natural gas upgrading) and water purification.

Keynote

Desalination Technology Development: Trend & Innovation

Friedrich Alt*

Desalination Technology Research Institute, Seawater Conversion Corporation (SWCC), KSA

Reducing energy consumption and CO_2 emission are key factors for future seawater desalination projects. Even so the traditional thermal desalination technology could have been built in the past with higher performance ratios, respectively lower energy consumption, the balance between CAPEX and local fuel cost led unfortunately to the application of systems with relatively high energy consumption. A first positive impact in regards to energy consumptions started with the introduction of the SWRO technology, which may with current state of the art design concepts consume less than 20% of the energy compared to most existing thermal desalination plants. While the reduction of energy consumption is one key element for future seawater desalination, the maximization of using renewable energy will be a second requirement. While large efforts are made toward production of renewable energy, it will be required also to apply suitable energy storage systems, to allow a constant energy supply as per consumer needs. In addition it may be required to design and build desalination plants with a larger flexibility in load variations to optimize CAPEX for needed energy storage systems, which means designing desalination plants for an output above the current common 100% design capacity based on 24 hr per day constant load. The sustainable water production will also require to improve the membrane technology further, towards minimum energy consumption and to look into other technologies which may in future be able to replace the membrane technology. Last not least, we should not forget the human part. We all have to contribute to a sustainable water supply and a reduction of the environmental impact by reducing our water consumption and consumption of energy in form of electrical power and fuels consumed by cars, airplanes, etc.

Keynote

Role of the Smart Grid in Facilitating the Integration of Renewables

Saifur Rahman*

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With the focus on environmental sustainability and energy security, power system planners are looking at renewable energy as supplements and alternatives. But such generation sources have their own challenges - primarily intermittency. It is expected that the smart grid – due to its inherent communication, sensing and control capabilities – will have the ability to manage the load, storage and generation assets (including renewables) in the power grid to enable a large-scale integration of distributed generation. In a smart grid, information about the state of the grid and its components can be exchanged quickly over long distances and complex networks. It will therefore be possible to have the integration of sustainable energy sources, such as wind, solar, off-shore electricity, etc. for smoother system operation. But in order for this to be possible, the electric utility will have to evolve, and change their ways of operation to become an intelligent provider of these services. This lecture introduces the operational characteristics of renewable energy sources, and various aspects of the smart grid - technology, standards and regulations. It also addresses the interplay among distributed generation, storage and conventional generation to provide an efficient operational strategy in the context of the smart grid.

Keynote

Advancement in Corrosion Management to Enhance Material Durability

Ibrahim Ali Muzghi *

QLGC

The financial and environmental impact of corrosion is significant. As per NACE 2016 IMPACT study the annual cost of corrosion equates to 3-4% of GPD of industrialized countries. Along financial impact, corrosion poses a significant threat to environment and public safety. The negative environment impact primarily due to disposal of valuable asset and utilizing additional energy and resources for replacements. Corrosion engineers succeeded in implementing several measures to lessen impact of corrosion, but unfortunately few contributed to environmental issues such Volatile Organic Compound VOC emission and carryover of corrosion inhibitors with disposed fluids. It is evident that robust corrosion management is vital to protect environment and enhance sustainability of materials used for construction. Advancement in corrosion management in terms of corrosion resistant material development, corrosion mitigation strategies and monitoring will be addressed.

Keynote

Smart Fast Charging Technologies for Electrified Transportation and Autonomous E-mobility

Sheldon S. Williamson
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This keynote talk will review presently available DC fast charging systems, followed by a brief description and evaluation of fast-charging infrastructure. Different power converter topologies and viable configurations will be presented, compared, and evaluated. These topologies will be compared based on their power levels, efficiency, cost, and specifications. This presentation will also introduce both home and public charging interface designs from a power electronic intensive solution perspective. Several grid-connected as well as PV/grid interface topologies for EV charging will be presented, with detailed comparative points highlighted. The modeling, sizing, design, and implementation of a novel high-efficiency, single-stage PV/grid/EV charging infrastructure will be presented. The designed charging infrastructure supports both Levels 1 and 2 DC charging. This is a new concept for charging and is vital due to the inevitable penetration of renewable energy sources. The above-mentioned research initiatives will be described in the presentation and industry-specific projects will be highlighted. This presentation will highlight the current status and future opportunities within Ontario Tech University's research program on transportation electrification and electric energy storage systems. Ontario Tech's research initiatives within the Smart Transportation Electrification and Energy Research (STEER) group has the potential of providing a significant link for future progress with regards to efficiency and performance improvement of electric transportation and autonomous e-mobility.

Keynote

Corrosion and microbial adhesion on PV Solar panels and their prevention via coating options

Reza Javaherdashti
Eninco Engineering, Netherlands

Use of solar energy is an integral part of any sustainability program in the field of energy and to make it as efficient s possible it is a must to know beforehand what limitations can happen under real life conditions and how to address them to make investment into this industry as feasible as possible

Corrosion is an electrochemical corrosion in which an active metal releases electron via a metallic path and at the cathode it is received. The ions thus produced are transferred through an aqueous environment (electrolyte). There is a wide range of corrosion reactions that are referred to as electrochemical corrosion such as atmospheric corrosion, galvanic corrosion, microbiologically influenced corrosion (MIC) and the like. A Photovoltaic (PV) solar panel unit can be taken as a system in which various corrosion scenarios are imaginable such as but not limited to salt corrosion/salt grime, galvanic corrosion and moisture ingress (that can form electrolyte). Corrosion can affect:

a) solar invertors electrical

b) wires, contacts, and junction box in the solar panels (unless made up of Gold).

c) Panel frames are normally made up of marine grade Aluminium alloy

When the surface of solar panels become "dirty", they lose their efficiency to a very large extent: it has been reported that while dust particle accumulation during drought seasons (a process known as "soiling") could lead into a decrease in the yield a loss of up to 0.1% of the power production per day. In addition to factors such as soiling, it is quite likely for desiccant-resistant bacteria to form films, wrongly referred to as biofilm, on these panels. The role of these bacterial settlements could account for a decrease in efficiency by 11% after 18 months, roughly equivalent to 0.02 % per day. The amount of efficiency decreases when bacteria are involved is quite significant should they be the only contributing factor to cover the panel's surface.

Bacterial films that are wrongly termed as biofilm are establishments in which bacteria along with non-biological agents such as dust can be developed and cover the surface of the panel and thus cause soiling. Biofilm is a wrong term because these establishments are neither totally biological nor a film. The more correct term proposed by this author is Temenos. In this presentation, after a quick review of the main issues involved in electrochemical corrosion and Temenos formation, one practical way to prevent soiling and thus control both corrosion and microbial adhesion will be explained. Of the five methods by which both corrosion and bacterial adhesion can be managed, use of coatings is the most appropriate one from both economic and ecological point of view. Anti-soiling coating that will be briefly discussed in this presentation is an option that PV solar panel industry must consider seriously to be able to manage the costs involved in both applying and maintenance of PV solar panels.

Keynote

Revisiting sustainability paradigms for a global ecological transition

Silvana Dalmazzone*
University of Turin, Italy

In the upcoming decade worldwide socio-economic systems will have to undertake a radical ecological transition to face the challenges raised by global environmental change. This processes in turn require a deep reexamination not only of standard approaches of what constitutes a healthy economic system, but also of the instruments we use to identify the targets, implement the policies, and measure our progress towards sustainability.

Keynote

Multifunctional materials for emerging technologies

Federico Rosei*
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This presentation focuses on structure property/relationships in advanced materials, emphasizing multifunctional systems that exhibit multiple functionalities. Such systems are then used as building blocks for the fabrication of various emerging technologies. In particular, nanostructured materials synthesized via the bottom–up approach present an opportunity for future generation low cost manufacturing of devices. We focus in particular on recent developments in solar technologies that aim to address the energy challenge, including third generation photovoltaics, solar hydrogen production, luminescent solar concentrators and other optoelectronic devices.

Keynote

Novel techniques for quantifying urban air pollutant exposures

Albert Presto*
Carnegie Mellon University, USA

Urban atmospheres are impacted by numerous anthropogenic sources. The spatial and temporal distributions of these sources create strong spatial gradients and time-of-day differences in air pollutant concentrations and composition. These gradients, combined with high population densities, can generate both significant air pollutant exposures among affected populations and large exposure gradients, where some populations are more impacted than others. This talk focuses on recent efforts to use a combination of mobile sampling and distributed low-cost sensors to quantify urban air pollution. Mobile sampling enables high spatial resolution measurements with chemical specificity. The high degree of chemical detail allows us to attribute particulate matter (PM) to specific sources such as traffic and restaurant cooking. In multiple US cities, we show that these two sources are major drivers of observed spatial gradients in both PM mass and composition. Low-cost sensors allow for longer-term investigations of specific neighborhoods, and provide information on temporal trends. These temporal impacts include extreme emissions events from industrial facilities and longer-term shifts such as emissions changes associated with the COVID-19 pandemic.

Keynote

Monitoring and Predicting Air Pollution and Greenhouse Gas emissions in the Eastern Mediterranean Middle East region: Challenges and Opportunities

Jean Sciare*
The Cyprus Institute, Cyprus

Environmental conditions in the Eastern Mediterranean and Middle East (EMME) region are exceptional. The area is subject to intense dust storms and heat extremes, and in some parts photochemical air pollution is unparalleled. Although the EMME region has been identified as a climate change hot spot with very high loads of atmospheric pollutants, it has received only little attention, e.g. in reports of the Intergovernmental Panel on Climate Change (IPCC). One reason is that observational data is insufficient, unavailable or of limited quality.

In the framework of the European Horizon 2020 "EMME-CARE", a 45 million euro project co-funded by the Cyprus Government, the Cyprus Institute is co-developping with strategic European partners a joint research and innovation strategy to better address regional societal challenges related to climate change and air pollution. New long-term atmospheric observations along with model developments for better prediction, mitigation, and adaptation are among the activities that the Cyprus Institute is engaging at national level. Bilateral partnerships with top research and higher education institutions are also established all over the EMME in order to build regional scientific and technical capacities with less dependence from occidental economies.

This presentation will introduce at first the regional climate change and air pollution challenges. It will highlight the different strategies currently implemented by the Cyprus Institute to address them. It will also showcase new atmospheric measurement and model results obtained recently over the Eastern Mediterranean. Finally, it will present the next steps of the strategy focusing on the Middle East region in collaboration with top research organizations such as the Qatar Environment and Energy Research Institute (QEERI).

Keynote

Water-food nexus and vulnerability in a globalized world

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Along with increased globalization and higher importance of long value-chains in the food domain, the economic and environmental system tends more and more to a detachment between places of production and consumption and to an increased countries' vulnerability. Through the outflow of virtual water embedded in food exports, countries renounce to precious domestic water resources, while through the inflow of VW included in food imports, countries benefit of water belonging to other areas of the world. The adoption of a framework of analysis based on the so called "water-food nexus" is useful to design sustainable and fair policies.

DAY ONE

23 November 2021

Modeling and Experimental Investigation of Polymeric Membranes

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Polymeric membranes are widely used in water treatment applications such as microfiltration, ultrafiltration, and nanofiltration. For these applications, membranes are required to have good mechanical strength, stability, and durability in addition to controllable porosity and filtration functionalities. The mechanical behavior of polymeric membranes is significantly influenced by the porosity and pore morphology. In this study, polysulfone (PSF) membranes with four different concentrations of polyvinylpyrrolidone (PVP) (1 wt.%, 3 wt.%, 5 wt.%, and 8 wt.%) were prepared through the phase inversion method. Experiments are carried out to quantitively characterize the microstructure as well as investigate the mechanical behaviors of the fabricated polymeric membranes. ImageJ software was used to perform a quantitative analysis of the enlarged bottom cross-section SEM images. The pore size distribution, average pore size, and average cross-section porosity are determined for pure PSF and PSF/PVP membranes. The Young's modulus for pure PSF membranes are determined from the stress-strain curves determined through DMA analysis. The average values for porosity and Young's modulus of pure PSF membrane are found to be 42% and 163.7 MPa, respectively. In this research work, a computational tool will be developed, which accounts for the porosity and pore morphology factor, to simulate the thermo-mechanical behavior of the polymer nanocomposite membranes. Numerical simulation is conducted using the Finite Element Method (FEM) and the commercially available ABAQUS software to estimate the pore morphology factor in the mechanical behavior of the polymeric membranes. Results suggest that pore morphology factor (n) is estimated to be 1.5 using FE-Representative Volume Element (RVE) for the case of pure PSF membrane.

Enabling the just and inclusive energy transition in the GCC region

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The GCC region shares a rich geography known for its oil and gas resource wealth and climate vulnerability while it is considered the most fossil fuel-dependent region in the world. Moreover, the region is facing major environmental challenges, including chronic water shortages, air pollution, desertification and land degradation, difficult weather conditions and long-term damage to ecosystems and local biodiversity. In addition, other aspects of vulnerability are linked to rapid and largely unchecked demand growth for energy, lack of economic diversification and environmental awareness, market distortion and insufficient enforcement of regulations among others. The pursuit of climate resilient low carbon development pathways based on the framework of circular carbon economy is one way in which countries can frame priorities and strategies to achieve the global goals set out under the 2030 Agenda and the Paris Agreement. To do this, climate change considerations should be mainstreamed across national development planning processes in an integrated manner, that mobilizes and draws upon public and private sector resources. In this context, the purpose of this paper is to discuss and analyses the multifaced aspects of energy vulnerability within the Gulf region, assess progress towards Sustainable Goal 7 (SDG7), provide best practices and lessons learned on synergies between energy, water, food and climate actions and other SDGs. It also intends to suggest priority actions required to enable a just and inclusive energy transition while protecting the planet for future generations, which constitute one of the most fundamental challenges across all GCC countries in the coming decades.

Cleaner energy generation and their opportunities for industrial development

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In the last years, global warming has become increasingly dangerous, obliging countries to respond effectively to this menace. Since the production of energy from fossil fuels is the principal source of CO2 emissions, technological solutions have been oriented to replace or reduce this type of energy. This represents an enormous challenge for countries with important oil and gas industries, which impacts the supply chain and governments' revenues, and therefore should be contemplated when planning cleaner forms of energy generation. The different options of new forms of energy or reduction of CO2, emissions such as renewables or CCUS, will influence the industry associated and consequently the industrial base of the country. In this regard, one form of energy generation that serves the dual objective of cero CO2 emissions and leveraging the already established supplier base is nuclear energy. This is especially true in countries that already have engineering companies supplying the Oil & Gas industry, and which can scale up their engineering capabilities for also becoming nuclear suppliers, as is the case of many gulf countries. In order to validate this perspective, this qualitative research focuses on the case of Argentina, which has developed a sound local nuclear supplier industry based on prior engineering capabilities mainly developed by supplying the Oil and Gas industry. As many gulf countries are engaging in the nuclear sector, the case of this medium-developed country may serve as an illustration of how to take full advantage of the existing capabilities when planning new energy sources.

Reduced CO_2 Footprint of Buildings in Agro-Industrial Communities in Qatar with Improved Insulation Standards and Solar Cooling - Supplementary Material

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Food production in arid countries like Qatar is strongly linked to water and energy resources to grow plants or cattle in a protected and controlled environment. The high energy demand for air conditioning in agro-industrial communities leads to significant CO2 emissions. In a case-study on buildings that are typical in the agro-industrial sector, the reduction potential for these emissions is investigated. Therefore, greenhouses and community buildings with an insulation according to the Passivhaus standard and solar cooling with photovoltaic driven compression chillers are compared to conventional buildings. An innovative solar cooling system is developed: Power is generated in hybrid photovoltaic / thermal collectors to enhance the electric efficiency of the PV cells and to deliver heat for food processing or other purposes at a high temperature level. A compression chiller model is designed, that is based on the experimentally determined performance of the refrigeration cycle for harsh operating conditions in Qatar. Different refrigerants are compared regarding their cycle performance and Global Warming Potential. A result of the study at hand is that greenhouses are very well suited for solar cooling since their cooling load is nearly congruent to photovoltaic power generation due to their low thermal inertia and radiative cooling during the night. The case study reveals that an insulation according to the Passivhaus standard and the proposed solar cooling system reduces the CO2 emissions caused by the air conditioning of greenhouses by 98% and of residential buildings by 94.7% compared to conventional buildings.

Developing a Protocol to Evaluate Membrane Filtration for Oil-Water Separation

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Large volumes of oily wastewater are produced in various industrial processes such as oil and gas. Membrane filtration processes like microfiltration (MF) and ultrafiltration (UF) are proven to be effective in industrial wastewater treatment, including oil-water separation, as they generate suitable quality permeate for water reuse applications. Various research efforts have been conducted in areas of developing and/or modifying commercial MF/UF membrane materials through synthesizing new advanced polymers that promise improvement in oil-water separation performance. Although multiple MF/UF testing procedures were developed, there is still a gap in literature on having a comprehensive protocol that assesses the performance of the membranes in terms of flux, rejection, fouling, and cleanability. This study delivers a robust bench scale testing procedure incorporating experiences and lessons learned from literature. The protocol was designed to mimic industrial conditions by using a representative synthetic produced water solution and operating multiple consecutives cycles of oil-water filtration followed by membrane chemical cleaning. The procedure was initially validated on multiple commercial MF/UF membranes having different pore sizes/MWCOs and chemistries obtained from various manufacturers. The protocol steps were then effectively applied on novel membrane materials under development to compare their performance against relevant commercial products. Hence, the robust bench-testing procedure is proposed to be utilized by researchers who are developing innovative membrane materials to allow for comparison of their new membranes against relevant commercial products for industrial applications.

Life Cycle Assessment of construction and demolition waste-based geopolymers suited for use in 3-dimensional additive manufacturing

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This study performs a life cycle assessment on a novel process to produce geopolymer binders for 3D printing additive manufacturing. It removes the need for cement for concrete production in the construction sector. Portland cement is the main contributor to CO2 emissions in concrete production. Instead, construction demolition waste (hollow brick (HB), red clay brick (RCB), roof tile (RT) and glass (G)) is utilized as a sustainable resource. The life cycle assessment is done to identify hotspots (relevant processes or raw material) to improve the environmental performance of the whole process at an early stage of development. Additionally, the life cycle study is done to evaluate the environmental impacts of energy, water, and waste emissions at various points in the life cycle. The construction demolition waste requires crushing, milling/grinding, and mixing with electrical input to produce the geopolymer binders. The energy and material flows are modeled based on ISO 14040 standards on GaBi software in a cradle-to-gate analysis. The composition (6.25M NaOH, 10% Ca(OH)2) of alkali activators is selected as the base case for the assessment. The life cycle impact assessment results show the environmental impacts to be 635 (kg CO2 eq.), 5.06 (kg SO2 eq.), 0.104 (kg N eq.), 3.14E-10 (kg N eq.), and 12.2 (CTUe.) for the global warming potential, acidification potential, eutrophication potential, ozone layer depletion potential, and Ecotox air respectively for 1 m3 of geopolymer binder produced.

Biochar and energy production using biosludge from gas-to-liquids process water treatment

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Biological treatment processes are one of the most common methods of wastewater treatment. However, these processes result in biosludge as a by-product, and its dewatering and disposal constitute one of the largest costs of wastewater treatment. In this study we investigate the pyrolysis of biosludge coming from treatment of gas-to-liquids water to generate energy and biochar – a material that can be reused in water treatment or in agriculture. Thermogravimetric analysis (TGA) was conducted with the biosludge samples to analyse their degradation behaviour for slow and fast pyrolysis at heating rates of 10 and 40 °C/min under an inert nitrogen atmosphere between 0 and 1000 °C. For both the heating rates, the total weight loss at the final temperature is approximately 67-73%; however, the more significant part of biosolids degradation occurs between 200 °C and 500 °C. The TGA curves reflect three critical stages at temperature ranges of 0-100°C, 100°C - 400°C and 400 - 800°C. Several peaks were observed in the differential thermogravimetric curves at around 100, 200, 300 (highest peak), and 700 °C associated with moisture evaporation, hemicellulose, cellulose, and lignin pyrolysis, respectively. Lab-scale pyrolysis studies showed that biosolids produced substantial yields in an inert nitrogen environment. The studies conducted at a constant heating rate (8 °C/min) and residence time (3 hours) but varying temperatures of 350, 440, and 550°C, reflected decreasing biochar yields reducing from 60% to 30% with the increase in temperature. These indicate potential for high biochar or high fuel gas yields.

The Significance of the Reuse of Treated Sewage Effluent (TSE) for Agricultural and Industrial Applications in the GCC Region

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Climate change could profoundly alter future patterns of both water availability and use, thereby increasing global levels of water stress. The potential changes in water availability and use may aggravate global 'water stress'. The Gulf Cooperation Council (GCC) countries lack renewable freshwater resources, yet demand for water is increasing. Water reuse reclaims water from a variety of sources then treats and reuses it for beneficial purposes such as agriculture and irrigation, groundwater replenishment, industrial processes, and environmental restoration. Water reuse can provide alternatives to existing water supplies and be used to enhance water security, food security, sustainability, and resilience. Health risk due to presence of pathogens, contaminants of emerging concerns, heavy metals and other compounds in treated wastewater is one of the primary limiting factors that hamper its reuse potential. Antibiotics resistant bacteria is a serious problem associated with wastewater treatment and reuse. Wastewater treatment plant and its effluent have been identified as the breeding ground of antibiotic resistance bacteria. Combined presence of antibiotics and huge spectrum of bacteria in wastewater treatment plant has enabled the bacterial community to swap genes that resist antibiotics and eventually turning into superbugs. Of concern is the uncertainty of potential adverse effects on wildlife and humans due to chronic exposure to low concentrations of these compounds. The application of advanced oxidation processes would add significant improvement to treated wastewater quality. This approach will benefit the GCC region with new water supply for agricultural and industrial applications.

Qatar Energy Transition; parametrising possible options

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Qatar invests in a single energy source basing its economy entirely on fossil fuel. This impacts the energy trilemma at three levels; environmentally, Qatar has a large carbon footprint, economically; hydrocarbons are a depleting source of energy; and lastly, energy security is proportionate to resource diversification. Therefore; Qatar energy system resilience is bound to energy transition. In order to gain insight into current paradigm and possible changes; energy system modelling is a useful tool. In the literature, and up to our knowledge, Qatar energy system modelling is a fairly recent hot topic which is available in only one optimisation approach. In parallel, this project pursues a simulation approach using MUSE (ModUlar energy system Simulation Environment); which is an open source modelling system developed at the Imperial College London. Energy system modelling consists of two main work packages; data collection and analysis which is essentially the building block of the model; and scenario investigation and forecasting which tests energy transition options and thereafter advises energy policy making. Data collection comprises historic energy information and future technology options. For Qatar, energy transition could occur at a number of sectors; for example, energy diversification could include solar power and biomass; service demand could utilise enhanced technologies like district cooling and electric vehicles; and clean energy could introduce hydrogen as a future fuel. As the quality of the model is highly data-driven; this paper will focus on possible options and will parametrise technologies for possible energy transition in Qatar.

Bridging homogeneous and heterogeneous catalysis through MOF support platforms and other efforts to obtain new class of highly active recyclable catalysts

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Dr. Madrahimov's research focuses on developing environmentally friendly and recyclable catalytic systems with high stability, activity and selectivity to prepare value added products from feedstock chemicals. His research group achieves this via immobilizing the molecular catalysts on the Metal-Organic Frameworks (MOFs). MOFs are a new type of highly stable crystalline catalyst supports and impart the immobilized catalysts with high stability, recyclability and ability to operate in gas phase. The catalysts developed in Dr. Madrahimov's research group have been applied to a variety of processes to obtain value added products from feedstock chemicals. One example of these processes is a QNRF NPRP funded collaborative work with Qatar Shell to apply the MOF-immobilized catalysts for olefin oligomerization reactions that produce highly valuable terminal alkenes that are used for producing specialty polymers, detergents and other valuable chemicals.

Ni promoted catalysts supported over halloysite clay for dry reforming of methane

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Dry methane reforming (DRM) converts two greenhouse gases, CH4 and CO2, into syngas. Syngas is a valuable gas consisting of carbon monoxide and hydrogen, used as a feedstock in several processes for chemicals production and Fischer-Tropsch fuels. DRM is a more sustainable process when compared to steam methane reforming for syngas production, as it utilizes CO2. One of the significant issues related to this process is the catalyst deactivation due to coke formation. Various catalyst systems have been previously reported for DRM. Nickel (Ni) has gained more attention among metal catalysts due to its low cost, availability, and good performance. On the other side, halloysite nanotubes (HNT) have recently been reported as a suitable support for Ni-based catalysts due to their superior resistance to coking and Ni-sintering, in addition to their abundance and low cost. This research explores the different parameters involved in the synthesis of Ni/HNT catalysts to optimize their synthesis as well as their catalytic activity. The catalysts were prepared using a wet impregnation method with several Ni precursor salts here investigated. The effect of HNT acid treatment and the acid type was also explored. The addition of cerium, magnesium, yttrium, and lanthanum as a promoter was also investigated. The surface morphology and physical properties were analyzed using different characterization techniques such as BET, TEM, and XRD. The H2SO4 treated HNT showed a higher surface area and smaller pore size of 188 m2/g and 11.05 nm, respectively. A negligible difference concerning the Ni% loading and precursor was observed.

Tailoring Enhanced Alkaline and Neutral pH Saline Water Oxidation Through Early Transition Metal and S,B-Codoped CoFe Oxyhydroxides

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Electro catalytic water splitting into hydrogen and oxygen is a key process for capitalizing on intermittent, green energy such as wind and solar. Pivotal to the effective utilization of this ever-growing technology is ameliorating the innately poor kinetics, harsh oxidative environments, dependency on expensive noble-metals, and high overpotentials for the anodic oxygen evolution reaction. To address these notable challenges, we rationally developed an earth-abundant electrocatalyst for direct utilization of abundant seawater. Buffered saline electrolytes were chosen to mimic seawater in neutral and alkaline pH environments for systematically investigating effects of high chloride concentration and pH on cell performance. In this work, we adapted a facile two-step solution-combustion method followed by wet-chemistry synthesis scheme in congruence to designing a highly electroactive S,B-codoped Co-based ternary oxyhydroxide with Fe and early transition metal (i.e., Cr, V) dopants. The crystalline defective Co3O4 cores ensure high conductivity and structural rigidity, while the amorphous oxyhydroxide shell attains a high electrochemical surface area, enhanced hydrophilicity, and synergistic maintenance of low-overpotential active sites. An array of textural, chemical, and electrochemical characterization techniques were employed to characterize intrinsic properties and catalytic performance of the developed electrocatalysts. The as-prepared S,B-(CoFeCr)OOH electrocatalyst required low OER overpotentials of 174 and ~300 mV to achieve current densities of 10 and 500 mA cm-2, with a low Tafel slope of 45.8 mV dec-1 in alkaline saline (1M KOH + 0.6M NaCl) electrolyte. Further, chronopotentiometric stability tests indicated stable performance in neutral pH saline (1M PB + 0.6M NaCl) environment for 50-hours at elevated current densities.

Novel 2D/2D NiCeAl-LDH/g-C3N4 heterostructures for visible-light-driven photocatalytic hydrogen production

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Graphitic carbon nitride (g-C3N4, abbreviated as GCN), a metal-free polymeric semiconductor, exhibits attractive features in the field of energy production owing to its bandgap of 2.7 eV, suitable electronic band structure, high thermal chemical stability and facile synthesis from inexpensive precursors, such as cyanamide, thiourea, dicyandiamide, or melamine. 1 However, the fast recombination of the charge carriers still limits its photocatalytic performance for H2 generation. 1 Among the several strategies to improve its photoactivity, designing two-dimensional (2D) heterostructured nanohybrids has shown to be an effective approach. 2 These 2D/2D heterostructured materials can offer a short migration distance and boost the separation of photoinduced carriers, thus improving light conversion efficiency.2 Therefore, the present work aims to enhance the photocatalytic activity of exfoliated GCN (GCNN) towards H2 generation by assembly with a novel 2D NiCeAl-layered double hydroxide (LDH). Different wt.% of xNiCeAl-LDH (x = 0.5, 1, 1.5, 3, and 7 wt%) were impregnated into GCNN via electrostatic co-assembly method. The materials were irradiated using vis-LED at 420 nm and tested towards H2 generation, with the addition of Pt as a cocatalyst and EDTA as a sacrificial electron donor. The 1.5NiCeAl-LDH/GCNN nanohybrid presented the highest rate of H2 generated, 2 times more than pristine GCNN. The enhanced photocatalytic activity was attributed to efficient interfacial contact between both layered materials that allowed a facile separation of the photoinduced charge carriers.

Improving water access in rural and peri urban area through Multi village approach - A case of the Bimbo Municipality (Central African Republic)

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Africa faces huge challenges with multiple issues that adversely affect public health. One major challenge is the ability for both rural and urban Africans to access a clean water supply. To address this problem, the goal of this research is to promote water supply through a multi-village approach in order to facilitate access to drinking water in sufficient quantity and acceptable quality for the well-being of the population, then to combat water inaccessibility according to the Sustainable Development Goals N°6, for universal, equitable and affordable access. This system is focused on areas not served by central water supply systems but also in arid areas where access to water resources is problematic. This approach takes into account social factors including all ethnic subgroups, thus promoting social cohesion; economic factors by considering water supply tariffs as a mechanism for achieving desirable, levels of demand. The result of the approach is to serve a large number of villages and neighborhoods with a single pumping station; to promote smart water by providing sufficient quantity and acceptable quality of water to the inhabitants, to reduce water insecurity and to protect vulnerable people who run real danger like women and children by walking long distances to find water.

Novel High Performance Ceramic Membrane for Wastewater Treatment: Phosphate and Oil Removal

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A novel hybrid ceramic membrane incorporated with activated carbon (AC) was prepared and tested for two distinct end uses: a) phosphate removal from treated sewage effluent (TSE), and b) oil removal from saline water. The membrane was prepared by incorporating the cheap and high surface-area powdered AC within an alumina framework (Al_2O_3/AC). The prepared membrane formed a tortuous matrix of micro- & nano-channels, that eventually improved the overall porosity and total pore area of the membrane by 90% when compared with pristine alumina membrane. Moreover, the developed ceramic membrane showed an increase of 71% in its hydrophilicity and an increase of 45% in its oleophobicity when compared to pure alumina membranes. Due to the enhancement in the porosity and hydrophilicity, the hybrid membrane showed a remarkable increase in the permeate flux in comparison with the plain membrane. The phosphate removal capacity of the modified membranes was evaluated by the treatment of TSE. The novel membranes exhibited superior phosphate removal while maintaining high permeate flux compared to bare alumina membranes. The prepared Al_2O_3/AC membrane has demonstrated excellent oil removal efficiency up to 99%. The modified membrane showed superior anti-fouling behavior during the filtration of oil and real TSE when compared with pure Al_2O_3 membrane. The results of this work showed that the novel Al_2O_3 /AC membrane can be used for the efficient removal of phosphate residue from TSE and pretreatment of oil-containing wastewater.

Developing an Optimal Framework for Sustainable Power Supply Chain based on Energy- Water--Environment-Food Nexus (EWEFN) Approach

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Providing sustainable power supply with increasing water, energy and food demands considering their limited resources along with climate change crisis which is among main challenges for resource management. Besides promotion of innovative technological solutions, facing these challenges requires applying novel approaches to the decision-making process. Water, energy and food systems are highly interconnected, and their interlinkages should be addressed in an integrated framework. Energy-Water-Environment-Food Nexus (EWEFN) approach is providing a strong connection for such framework, also able to facilitate achieving Sustainable Development Goals (SDGs). Furthermore, in order to investigate development policies based on Nexus perspective, it is necessary to provide decision makers with appropriate analytical tools. Accordingly, developing an optimal framework for sustainable power supply chain based on EWEFN approach is performed in this research. First, the EWEFN conceptual model is presented based on the interconnections of the integrated system and then, a mathematical optimization model is developed based on explicit quantification of relationships between system components. The objective function is defined to minimize the total annual cost to the electricity supply chain as a pivotal sector in this study. The model is designed so that various development scenarios can be created by decision makers, using combination of technical and policy input parameters. Investigating the effects of boosting renewable power and energy efficiency, wastewater recycling and reuse, desalination technologies, power plant cooling technologies and new agriculture-related technologies are considered in scenario planning. Finally, considering both technical and policy perspectives, an integrated index is introduced in order to compare different scenarios.

Nanofunctionalised graphene oxide hybridised electrospun membrane filters for removing pathogens and contaminants of water

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The growth of waterborne pathogens and the discharge of partially treated/non-treated chemical waste has become a severe environmental and health risk.1 Traditional wastewater treatment methods have become less effective, and the most current techniques require multiple stages for the disinfection of antimicrobial-resistant (AMR) pathogens and combined removal of toxic/non-biodegradable chemicals from wastewater.2 This study proposes a solution to this scientific bottleneck by creating a new membrane as a wastewater depollution material. The GO materials were synthesised by oxidising graphite using a modified Hummers' method. The GO was nanofunctionalised using CuO and ZnO following a series of thermal, chemical reactions creating CuO-GO and ZnO-GO composite materials. Additionally, this composite material was then electrospun into thin membranes; GO/PVA, CuO-GO/PVA and ZnO-GO/PVA, Figure 1. These membranes were tested against Escherichia coli (E. coli) bacteria and Candida albicans (C. albicans) fungi, Rhodamine-6G, and amoxicillin as representative contaminants. These contaminants were spiked to create synthetic wastewater (20 mL) where the membranes water filters were analysed under gravity filtration. It was found that the GO/PVA filters showed a 5 log< reduction of E. coli and C. albicans pathogens from 1×106 CFU/mL. The membranes also removed 10 ppm Rhodamine-6G up to 98%, where the CuO-GO efficiently removed 10 ppm amoxicillin (>80%). The study introduces a novel hybrid composite membrane consisting of multiple layers of GO/PVA, CuO-GO/PVA, and PVA as a fast, economic, eco-friendly, efficient, reusable, and one-step filtration method for the synthetic wastewater system.

Unsupported climate ambitions: The lack of requests from the Gulf Cooperation Council countries and the broader Arab region to multilateral climate finance vehicles

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The year 2021 witnessed both the release of the physical science report of the International Panel on Climate Change assessment report 6 (IPCC AR6) and the Glasgow summit on climate change for which more ambitious climate policies were requested from the international community. Against a regional background of large exposure and vulnerability to climate risks, and amidst a global dynamic of global energy transition towards decarbonized energy mixes, this paper critically investigated the climate policy ambitions of the Arab countries of the Middle East and North Africa (MENA) region. Using first a critical content analysis, this article reviews the Nationally Determined Contributions (NDCs) of all Arab countries of the region, for both the 2015-16 and the 2020-21 NDC submission periods, and compares them with the multilateral funding obtained by these countries from key multilateral sources of climate finance and technology transfer: the United Nations Climate Technology Centre & Network (CTCN) and Green Climate Fund (GCF), as well as the World Bank's Global Environmental Facility (GEF), over the 2016-2021 period. In parallel, qualitative interviews with civil servants and United Nations international civil servants in the region as well as energy researchers were conducted to understand the issues faced by the Arab governments in raising climate finance. The results indicate that Arab countries, and especially the countries of the Gulf Cooperation Council, rarely request funding from the multilateral climate finance architecture. On the one hand, this source of multilateral finance is considered difficult to obtain and/or more constraining than grants and loans provided by, e.g., the European Union or China. This situation includes countries such as Lebanon and Iraq. On the other hand, some long-time donors to multilateral development aid, including medium income developing countries such as Bahrain and Oman, abstain from requesting multilateral assistance for mitigation purposes, despite the occurrence of brown- and black-outs in their countries, largely due to a foreign policy positioning of 'provider' of aid. However, these countries are unlikely to realize the necessary energy transition in their national mix nor the national economic diversification if they do not tap into this multilateral source of mitigation finance. At the regional scale, this form of opportunity cost (estimated at above 1.5 to 3 billion US dollars per year of un-obtained finance) leaves unchanged the dual issue of high levels of Green House Gas emissions (GHGs) per capita and general air pollution from the power sector that have been negatively affecting the MENA population's public health and environment, and the global climate crisis at large.

DAY TWO

24 November 2021

Desalination & Cooling Using Innovative Dual Absorber Absorption Cycle: A Patented Process

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Water scarcity and hot weather are two challenges in arid countries. These two problems are usually rectified by two separate systems: seawater desalination and vapor-compression air conditioning systems. These systems are characterized by their energy intensiveness. Thermal desalination systems are the dominant desalination systems in Kuwait. Vapor compression air conditioning systems consume the precious electric power in a range between 60% and 75% of the total power produced in GCC. The proposed process combines a thermal desalination system and a cooling cycle into one system utilizing low-temperature thermal energy, such as solar energy or waste heat. The desalination system is an innovative humidification-dehumidification (HdH) desalination system. The cooling effect can be used for air conditioning (district cooling) or inlet air cooling for the GT power cycle. The proposed system mainly relies on innovative design for the LiBr absorption cycle integrated with the HdH desalination system. In this paper, the energy analysis of the proposed system and parametric study on the effect of system operating parameters will be investigated.

Drone sunshade

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Qatar is considered one of the fastest-warming regions worldwide, at least outside the Arctic. He also said the changes there could help give us a sense of what the rest of the world can expect if we do not reduce emissions that pollute factories. Something that discourages customers and cohabitants from shopping in the open area due to physical exertion and high risks faced by people. Heat stress peaks in the GCC from 11 am to 4 pm in the summer season. Heat stress is increasingly becoming an obstacle to economic and psychological effectiveness. This work will design and develop a cloud-based drone cloud (Canopy) to demonstrate a concrete vision for open hotspots and a new way of public spaces. The agile and transportable cloud (canopy) drone is enabled according to the position of the sun and the presence of people in open areas by the combination of mechanical construction and a programmable algorithm. The chassis consists of lightweight aluminum, a polyester cover, a water tank, a water pump with integrated contact, a solar panel, and sensor electronics. The drone cloud (canopy) enables it to move autonomously across a large public area according to the sun's position. This flexibility allows the canopy to quickly revitalize public spaces and help people exercise in open areas in countries with high temperatures. The drone (Canopy) supplies the air around people through the rain mist from the drone-mounted cold water pumping system as well as the shade.

Corrosion of DNV450 pipeline steel under hydrodynamic conditions in presence of CO_2

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Corrosion rates and mechanisms of carbon and low alloy steels (CS and LAS, respectively) used in downhole equipment and pipelines are influenced by the presence of acid gases such as H2S and CO2 and the protectiveness of the scales subsequently formed on their surfaces. The presence of H2S and CO2 often results in the formation of a corrosion-protective surface layer, e.g., FeCO3 and Fe1+xS films. However, despite these intact films being protective against corrosion, they are prone to breakdown, which could be followed by the localised dissolution of the metal. Electrochemical methods such as monitoring corrosion potential, linear polarization resistance, electrochemical impedance spectroscopy are powerful tools that can be employed to monitor formation and stability of these protective films in the laboratory. In this study, we investigated formation of iron carbonate film under pH-stabilised conditions at 60°C and different hydrodynamic conditions. A newly developed Parr instruments rotating cylinder electrode was used for the measurements. In-situ electrochemical methods such as linear polarization resistance and electrochemical impedance spectroscopy followed by ex-situ characterisation methods of scanning electron microscopy, energy dispersive spectroscopy and X-ray diffraction were used. Effects of different hydrodynamic conditions were monitored and possible underlying mechanisms were discussed.

Desal Chiller – Bifunctional Vapor Compression Cycle for Simultaneous District Cooling and Seawater Desalination

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In many arid regions, water scarcity and high cooling demand are connected. In metropolitan areas, there is a trend to install district cooling plants, while additional desalination systems provide potable water. Here, the concept of unifying a vapor-compression chiller with MVC desalination is presented. Refrigerant is seawater, the product is both cooling capacity and potable water (figure 1a). The novel system's setup and its energetic performance will be thoroughly discussed. Pros and cons will be evaluated yielding perspectives for future development. Assessing the energetic performance, ten setups were considered (table 2). Reference is a conventional R134a chiller with air or seawater cooled condenser and additional RO or MVC desalination system. Power consumption was simulated for steady state (table 3) and with annual weather data of Doha/Qatar and Almería/Spain (figure 2). Best option is a flash-intercooled 2-stage compression cycle (figure 1b) reducing power consumption by 37% over the reference (air cooled/MVC). Anyway, condensation temperature is the most sensitive parameter (figure 3). Thus, DesalChiller's advantage is melting away in cooler climates or when compared to seawater cooled chillers (figure 4). However, further advantages lie on hand: applying the eco-friendly R718, two products are provided with one installation. Power savings are maximal during peak load hours. Power consumption is similar to the RO reference. This allows to replace RO by MVC yielding advantages in feedwater tolerability, product water quality, ZLD capability and solar operation. Drawback might be NCGs at evaporation pressures of < 10 mbar. A thorough cost analysis will follow.

Comprehensive air pollution forecasting system

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Air quality models are essential tool for air quality research and management. In this study and operational air quality forecasting system with web-based reporting tool is developed using combination of WRF and CAMx models.For this purpose a web-based emission inventory calculation system is developed to calculate urban emission inventory in high spatio-temporal resolution. The system supports 11 category of pollution sources including: vehicles (hot/cold/evaporative/non-exhaust), powerplant, bus terminal, airport, refinery, industry, gas station, railway activity, residential, general and commercial sources.Emission inventories are typically available with an annual/month-total emissions value in terms of regulated pollutants such as CO, NOx, VOCs, and PM and are available at the location of pollution source.CAMx, however, require emissions data on an hourly basis, for each model grid cell, and for each model species. Therefore, in order to prepare emission input data needed by chemical transport model (CAMx model) a JAVA-based tool developed to translate emission inventory data into CAMx input format.For preparing meteorological input data needed by CAMx model an operational weather forecasting system using WRF model were developed with three nested domains (27, 9 & 3 km).Finally, in order to calculate hourly concentration of pollutants, CAMx model were developed with 3 nested domains (27, 9 & 3 km).All of the components implemented in the forecasting system, are running operationally one time a day to predict hourly fate of concentrations for the next 3 days.The weather and pollution forecast results will publish through the online platform https://apfs.tehran.ir/.

Insulative Coatings - Fit For Purpose

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Corrosion Under Insulation (CUI) is a very serious problem impacting the oil and gas, petrochemical, power and heavy industries. Due to the high costs associated with CUI, many industries have begun abandoning conventional jacket insulation. Recent advancements in trade association standards have helped engineers select, apply and inspect different types of insulative coatings in lieu of conventional jacket insulation. New insulative coating standards by NACE are helping to minimize corrosion costs while simultaneously improving insulation efficiency with a side benefit of personal protection. However not all insulative coatings are made to address the same challenges. Some insulative coatings are designed to block heat load thus reducing energy consumption. By differentiating between process and solar heat, engineers can correctly specify insulative coatings which are fit for purpose. This distinction can also help determine the correct application thickness, method and cost. The choice of thickness and type of insulative coating is critical for the end users to receive the perceived benefits they wish to achieve. In the quest for insulation optimization, a variety of insulative coatings are now a proven alternative to conventional jacket insulation.

Performance Assessment of Low-Temperature Multi-Effect Desalination (MED) Unit at Higher Top Brine Temperature

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Desalination technology offers the sustainable solution of providing freshwater supply to the water-scarce coastal areas such as the region from Karachi and Gwadar cities situated in Pakistan. Reverse osmosis (RO) desalination is an energy-efficient technology. However, recent advances such as the integration of adsorption/absorption vapor compression systems and the development of new antiscalants for the multi-effect desalination (MED) technology have made it a competitive choice. The MED unit's current top brine temperature (TBT) is 65 °C (because of salt precipitation in the evaporators), for which 8 – 10 falling film evaporators can be installed. But with the progress in antiscalants, the TBT can be stretched to 85 °C that reflects the incorporation of more evaporators and hence more freshwater productivity. For this purpose, a mathematical model of the MED unit is developed in Engineering Equation Solver (EES), and the performance of the MED unit is assessed at higher TBT. The mathematical model is validated with the empirical model available in the literature and with the commercial desalination plant located inQatar. It is found that the performance ratio of the MED unit with TBT of 80 °C is 22.8% higher than that of 65 °C TBT. Furthermore, the specific heat transfer area is 18% higher, and the cooling water requirement is 76% lesser for the MED unit with TBT = 80°C as compared to the MED unit with TBT = 65 °C.

Ultraviolet Radiation Interaction with COVID-19 Virus: Nano-Scale Resonance Frequencies

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In this work, we introduce a study on the interaction of ultraviolet radiation with the COVID-19 virus as a nano-scale particle. We shed a light on the ultraviolet (UV) radiation interaction with the virus and its aggregations. The visible light and the UV, as electromagnetic waves, interaction with the virus is studied by 3D full-wave simulation. The wavelengths in the range of 150 to 600 nm are considered in the simulations with 5 nm wavelength increment steps. The optical properties, and hence the electrical properties of the materials composing the virus are taken from reported experimental results in the literature. For those materials without well-defined optical properties, we make approximation assumptions. The obtained results show that the UV sub-bands interact and are absorbed differently by the virus and its aggregation. The UVC sub-band has very strong interaction and absorptance with the virus, whereas the other UV sub-bands, UVA and UVB, and the visible light interact weakly with the virus and its aggregation. Strong absorption of the radiation by the virus is observed at the UVC band with strong resonance peaks. The obtained results show that the virus resonates and interacts strongly with certain wavelengths of the UVC band, 150nm to 280 nm. This finding can lead to more effective sterilization of the COVID-19 virus, and other similar size viruses, by using the proper UV wavelengths.

On the systematic evaluation of an epoxy coating for CUI mitigation at elevated temperatures

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Corrosion under insulation (CUI), which predominantly appears as a form of external corrosion, can largely impact the overall integrity of industrial infrastructures such as piping, vessels, and processing units if the issue is not attended to or maintained regularly. Petrochemical piping asset loss that is associated with CUI accounts for approximately 10% of the overall maintenance expenditure annually. Protective coating, which performs as the last barrier to prevent the rapid corrosion of an underlying metallic substrate, plays a critical role in the sustainable maintenance of industrial assets. In particular, protective coatings exposed to high temperature and cyclic temperature conditions are more susceptible to failure. In this work, a systematic experimental design for accelerated laboratory tests and field exposure tests is proposed, in conjunction with the implementation of the state-of-the-art CUI rigs. In addition, a CUI performance evaluation test protocol for high-temperature organic coating performance is presented for the first time. Herein, the performance of a polyamine-cured epoxy is studied along the temperature gradient up to 180°C. Post analysis was conducted to understand coating degradation in terms of mechanical, electrochemical, and chemical aspects, which involved visual examination, adhesion tests, peel-off tests, Scanning Electron Microscopy (SEM), Electrochemical Impedance Spectroscopy (EIS), and chemical analysis using Fourier-Transform Infrared Spectroscopy (FTIR), and Thermogravimetric Analysis (TGA). The proposed combination of electrochemical, spectroscopic, mechanical, and chemical techniques enhances current knowledge and methodology towards the understanding of coating degradation mechanism.

Pilot Testing of a High-performance Anti-scalant for High Salinity and Top Brine Temperature MED Desalination Plant

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Scaling is a significant problem in thermal as well as membrane desalination processes. In thermal desalination technologies such as multi-effect distillation (MED) and multi-stage flash (MSF), scale formation on the tube surface causes reduction in the heat transfer rate leading to lower production and efficiency. Different factors may affect the scaling phenomenon including, but not limited to, temperature, seawater flow, salinity and composition. Antiscalants are commonly used to inhibit scaling in the desalination processes. This study investigated antiscalant performance for the falling film design MED pilot plant in collaboration with SOLENIS. Industrial standard antiscalant was compared with a high-performance inhibitor, POC 3000, to evaluate its efficiency under a high salinity of 57,500 ppm at 65 ºC and 75 ºC temperatures. The effect of the dosing rate for each antiscalant was also studied and optimized for the pilot plant. Compositional and structural analysis were conducted to identify major component in the scaling and its crystalline structure. Moreover, the structure analysis also identified inhibition mechanism for each antiscalant.

A Multi-Agent model for Residential households trading market of Renewable Energy in Qatar

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The current polices in Qatar do not encourage renewable energy adoption due to strong subsidies that keep electricity tariff at a considerable lower level than other energy markets. This study describes a Peer-to-peer (P2P) energy trading market framework that addresses this problem by supporting the deployment of renewable energy increasing grid flexibility. P2P trading allows households to buy and sell electricity directly from each other. These transactions refer to direct energy transactions between peers, in which energy is traded at a rate decided by energy producers. Those peers are small, decentralized energy producers such as residential homes. The energy price is assumed to be dynamic, depending on time of the day, and the generation to demand ratio at that time of the day. An honest and smart marketplace is simulated that enables households to exercise the best choices in either selling electricity to neighboring households or the national grid utility company or consuming it behind the meter. This study proposes the integration of concepts and approaches based on Agent Based Modelling and Game Theory to simulate the P2P energy trading available from rooftop PV in a residential compound located in the Education City, Qatar. Multiple scenarios will be presented and discussed to study how to promote solar PV trading considering battery storage, subsidy reduction, the introduction of a carbon tax, and more PV potential. Table 1 shows the input parameters for the scenarios considered in the study. Figures 1 and 2 show the energy available for selling in two scenarios.

Environmental Benefits Recycled Aggregate

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The government set targets to balance between development needs and protection of the environment. The use of recycled materials in construction contributes to sustainable development. It enables conservation of primary materials and reduces accumulated wastes in landfill sites, with cost savings and lower energy consumption. The Qatar National Vision 2030 emphasises the importance of sustainability and commits to ensuring that economic growth and social development are balanced with protection of the environment. The Qatar National Development Strategy 2018 – 2022 affirms the importance of managing waste in line with the waste hierarchy (reduce, reuse, recycle and only send to landfill as a last resort), increasing the recycling of waste, and set a target for recycling. Recycling of solid waste in construction would have great benefits on the environment in terms of protecting the environment and reduction of carbon footprint. A carbon footprint analysis indicated the clear advantage of using recycled aggregate in reducing carbon emission by 55-75%. The reduction in carbon footprint is mainly associated the transport of imported aggregate from neighbouring countries, and provide benefits in terms of: developing innovative construction products from wastes, less reliance on imported raw materials cost savings and environmental benefits by reducing transportation of materials and disposal of wastes. Additional benefits for reducing project delays due to shortages of materials, and developing new business opportunities with jobs associated for processing and marketing of recycled aggregate.

Performance analysis of a 5 kW PV grid connected system in Khartoum

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Hot dry climate regions enjoy high solar irradiation but with high ambient temperature. These two factors have a contradictory effect on the power generated from PV systems. This work studies the combined effect of high ambient temperature and high irradiation on the performance of PV systems. The study is based on monitoring a grid-connected 5 kW PV system installed on the rooftop of the Energy Research Center of the University of Khartoum, Sudan. The performance of the system was monitored by metrological and power measurement equipment from April 2017 to March 2018. The results showed almost constant power output from the PV system with an average final yield of 4.57 kWh/kWp and a 0.21 standard deviation from this average value. This is because in summer the output power degradation is compensated by the high irradiation and in winter the low irradiation is compensated with low temperature. The annual deviation of the temperature and irradiation is small in Khartoum due to its location near the equator. Also, Khartoum has few cloudy hours in the whole year due to its desert climate. This result was compared with the annual performance for other countries with different climates for evaluation. The conclusion from this work is that hot dry regions are suitable for PV system's power generation not only for their high irradiation but also for the stable annual output power from the system.

Environmental risk limitation of swelling materials with portland cement: Case Study Tebessa City (Algeria)

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This work presents the investigation results to limit the swelling parameters, swelling pressure (PS), and free swell ratio (FSR), of Tebessa city in Algeria. The city is located in a semi-arid zone, where the soil formations are generally clayey formations characterized with a high variation of volume change. The analyzes results of a series of normal Proctor compaction tests, methylene blue tests, Atterberg limits, and oedometer free swell tests were performed on expansive overconsolidated clay, treated with different cement contents, and compacted under the optimum Proctor conditions. The test results show that the increase in cement contents increases the (PS), and decrease the (FSR), with a quick hardening of samples. These results are confirmed by the improvement in bearing capacity, translated by an important increase in soil strength. It accomplished that the most performance of mixture treatment is corresponding to 6% cement contents.

Implementation of a Novel PMU-Based EMS System for TNB Wide-Area Intelligent System

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This paper presents a novel implementation of a Phasor Measurement Unit (PMU) based Energy Management System (EMS) and the advancement of PMU-based Linear State Estimation (LSE) and its use case for TNB Wide-Area Intelligent System (WAIS). TNB LSE uses PMU stream in IEEE Std. C37.118 and real-time snapshots provided by the conventional Supervisory Control and Data Acquisition (SCADA) based state estimator from existing TNB EMS. TNB LSE server generates real-time PMU output stream in IEEE Std. C37.118 and LSE cases for external applications. An online cascading analysis application with automated remedial actions is integrated into TNB WAIS for applications of Wide-Area Monitoring, Protection and Control (WAMPAC). The online cascading analysis application is solved by using fast AC contingency analysis and screening all potential cascading events resulting from the N-k initiating events. The severity of cascading events is determined and ranked based on a calculated performance index (PI). Optimal mitigation measures are determined to alleviate violations for each cascading criterion met, and thus updated into the control action table. A closed-loop WAMPAC system is set-up and tested using the real-time hardware-in-the-loop (HIL) testing platform. The results indicate that the optimal mitigation measures determined by the online cascading analysis application are effective in alleviating thermal, voltage and stability violations, and are promising for real-time applications for TNB WAIS.

Analysis Of Sustainability Aspects Of Facade Systems Using Bim : A Case Study For Lusail Plaza Tower

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Now a day's energy crisis has reached its peak level throughout the globe, increase in population has results in corresponding increase in use of conventional resources. Efficient use of energy must be enhanced in order to have a sustainable future, about 40% of total world's energy is consumed by the buildings. Façades are the most strategic and visible part of the building which leads to an improvement in appearance and environmental performances in buildings. Facades play a significant role in the quality of a building. Façade is the medium through which the interaction takes place between the activities, inside and outside. Recently architects and engineers are strategically designing and installing dynamic facades not only for their aesthetic values, but also for improving the buildings' energy performance. The high integration of these strategies for dynamic facades increases their durability and suitability, with current building demands, which targets for energy efficiency and thermal comfort level. The study aims to the concept and the importance of dynamic facades according to their design and types, implementations, current challenges and climate impacts. Moreover, a building with and without dynamic facades with automated control systems and its effect on the building environment is analyzed and the study tries to demonstrate the application and strategies of these façade systems on the buildings in Doha, Qatar. The study aims at integrating the dynamic facades in buildings as an environmental control system to achieve a sustainable design to reach excellent energy performance in buildings.

Preliminary study on adopting sustainable materials in the construction industry at Qatar

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The construction industry has now become one of the main sources of environmental pollutants. Many operations and decisions are carried out in the construction sector without regard to the short and long-term effects on the environment, eventually leading to resource depletion, damage to the ecosystem, poor waste management, while also indirectly affecting the economy and human health. Qatar's construction sector is booming, and without signs of slowing down, therefore it is time to start carefully studying the activities in the construction industry and developing more sustainable methods. One such solution is the use of sustainable materials (SM). This paper evaluating how SM can be incorporated in construction sites by looking from the stakeholder perspective and the various factors associated with it. A detailed literature survey is carried out to identify various factors that influence the decision making on adopting SM. The key factors identified are governmental support, environmental awareness, and stakeholder engagement. The model of study was developed based on the theory of planned behaviour (TPB). To conduct this study, data was collected from stakeholders which include contractors, consultants, and engineers. A survey questionnaire was prepared and distributed to 700 participants with a response rate of 60%. The analysis of data was done using the Statistical Package for the Social Sciences (SPSS). The results show that the factors governmental support, environmental awareness, and stakeholder engagement have a greater effect on SM along with other TPB variables, including subjective norms and attitudes.

Initial Insights into Air Quality and Particulate Matter Characteristics in the Greater Doha Area

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Air pollution has major adverse effects on public health and global climate. According to World Health Organisation estimates, exposure to outdoor and indoor air pollution results in around 8 million deaths every year. Exposure to fine particulate matter (PM) resulting from human activities continues to place a significant burden on human health. Nitrogen dioxide is associated with appreciable mortality and ozone has a substantial negative effect on crop yields, threatening food security. As a result, air quality improvement strategies are considered as priority by policymakers. QEERI has embarked on an ambitious research effort to quantify particulate pollution in the greater Doha area and to characterise its temporal and special variability. Furthermore and in order to identify and quantify the main sources of particulate matter pollution in the area, we have started a programme of systematic investigation of the chemical composition of particulate matter at a number of locations within the greater Doha area. In this effort, an aerosol chemical speciation monitor (ACSM, Aerodyne Inc., USA) has been deployed as part of QEERI's air quality monitoring network together with three sets each of black carbon monitors (Aethalometer AE33, Magee Scientific, USA) and find dust measuring devices (FIDAS 200E, PALAS, Germany). This contribution will provide insights into air quality characteristics in Doha obtained from QEERI's air quality monitoring network and initial results of the interplay between the main regulatory and health relevant PM mass fractions (PM10, PM2.5 and PM1) and chemical characteristics of black carbon and the wider chemical composition of PM2.5.

Initial Insights into Air Quality and Particulate Matter Characteristics in the Greater Doha Area

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The present work is a feasibility study of gas turbine pilot burner repair including Finite Element Analysis (FEA) and application of Additive Manufacturing (AM) know-how. The study was conducted to enable AM application and with a view to enhancing the gas turbine burner performance.

The typical failure mode of this part is crack propagation at the face center and at the igniter and liquid lance holes Example images of cracks are shown below (Figures 1-1 & 1-2). Pilot Burner Cracks are occasionally witnessed at the 8,000hour inspection and often noted at the 16,000 hours inspection. To apply the appropriate repair, first the problem should be understood correctly, and the root cause of the failure analyzed. More details are in the problem definition in section 3.

An extensive detailed study of Finite Element Analysis (FEA) has been carried out to identify the thermal stress behaviour and how this affect the life of the part. Moreover, the proposed repairs considered in this work were to change the material and add cooling to reduce likelihood of crack occurrence and increase the life by minimum of one overhaul cycle (32k).

Two different repair scenarios will be considered in this study;

1. Machine the damaged burner face and print Hastelloy X (3-6mm thickness) on top of the stainless-steel body. It was concluded that, a material test would be required to assess the differential thermal growth of these two different materials and how the interaction, or the behaviour, will be between them in hot operating service environment.

2. Machine the damaged burner face and print Hastelloy X plus additional cooling to extend the life. It was concluded that engine test would be required for the gas turbine pilot burner after the 3D-printing was completed successfully.

One of the main reasons for this study is the low yield / high scrap rate post operation (approx. of 50%), the short life, and therefore higher cost. To eliminate those issues the repair yield target was targeted to be higher than 90% and the life cycle planned to be extended one additional cycle, therefore achieving the cost saving.

DAY THREE

25 November 2021

Approach for mitigation of soiling based on direct humidity sensing

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The measurement of small leakage currents at a constant DC voltage has proven to be a very sensitive method of detecting variations in electrical surface resistivity [1]. An important environmental influence that affects the surface resistivity is the surface humidity, especially condensation of thin water films [2]. In the presence of dust particles, the condensation behaviour changes so that the first increase of leakage current (in the course of capillary condensation) occurs already before the dew point temperature is reached. The thin water films lead to a dramatic increase of particle adhesion by capillary forces [3, 4]. In addition, the formation of cementation, caking and ageing can probably start by presence of capillary condensation. In this work, the correlation of leakage current and particle adhesion is investigated. The basis of the investigation is a contamination test setup that is able to simulate different environmental conditions with regard to sample surface properties and air temperature as well as air humidity, type of dust and level of sample coverage. We show the correlation of leakage current level of glass surfaces and particle adhesion under the influence of different dust types and sample surface properties. We use as measure of particle adhesion the dust coverage ratio (Cwb/Cini), which is the ratio of the initial dust coverage and the dust coverage after wind blow. Based on these results we propose a method to avoid these adhesion processes by a sensor-based limitation of the surface moisture.

Evaluation of low-cost sensors for monitoring ambient particulate matter in Qatar

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Air pollution is one of the largest environmental health risks, with an estimated toll of almost 7 million deaths in 2019 (HEI State of Global Air). Fine particulate matter or PM2.5 is a key contributing pollutant; especially in the middle-east, PM10 is also important. Traditional "reference-grade" monitors for measuring PM2.5 mass are expensive and resource-intensive, and so monitoring networks are usually sparse; QEERI operates a network of six such stations across Greater Doha. Micro-environments such as high traffic, industrial activity, and construction can result in hyperlocal pollution not captured by these reference stations. Low-cost sensors can fill in this data gap, enabling high spatial and temporal resolution measurements of air pollution that can also be used to develop and improve air quality models. However, low-cost optical PM2.5/PM10 sensors need to be evaluated for conditions unique to the middle-east generally and Qatar in particular. We are conducting extensive field testing of a variety of low-cost and lower-cost devices for PM measurements across Doha. We find that sensor design can limit product performance especially for super-micron aerosol. Preliminary results also show that changes in aerosol size distribution (e.g. during dust storms) result in significant underestimation of PM2.5 mass by these sensors. Finally, as seen elsewhere, aerosol hygroscopic growth can also impact sensor performance. We shall discuss these results and optimal sensing strategies for Qatar during this presentation.

Monolithic Perovskite/Silicon Tandem Solar Cells and Their Outdoor Performance Under Harsh Desert Climate

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Perovskite solar cells (PSCs) have emerged as a promising photovoltaic technology owing to their low fabrication cost and high power conversion efficiencies (PCE). Since 2012, great progress has been made in this field, and consequently, single-junction PSCs have reached certified PCEs of 25.5%. In addition, because of their band-gap tunability, perovskites are attractive absorber materials to fabricate multi-junction solar cells aimed at surpassing the single-junction Shockley-Queisser efficiency limit, promising high-performance photovoltaics at an affordable cost. Specifically, wide-band-gap perovskites (1.65–1.75 eV) made of mixed-halide compositions are critical enablers for efficient silicon-based tandem solar cells as top-cell absorbers. Hence, monolithic perovskite/silicon tandem solar cells, which can potentially emerge as the next generation photovoltaic technology, are of interest in the photovoltaic community. With this motivation, at the KAUST Photovoltaic Laboratory (KPV-Lab), we have been developing perovskite-silicon tandem solar cells targeting efficiency beyond the single-junction limits of silicon solar cells. We have been engineering optimal bandgap perovskite absorbers as well as minimizing the parasitic absorption losses originating from carrier selective contacts and transparent electrodes. Besides, we have been developing novel charge transport layers and contact passivation schemes. More importantly, we have been constantly testing the outdoor performance of this solar cell technology under the harsh desert climate of Saudi Arabia. Therefore, this contribution aims to summarize our recent advancement in the fabrication of high-performance monolithic perovskite/silicon tandem solar cells and the existing challenges towards improving the stability of this technology under harsh desert climate.

Calibration of low-cost air quality sensors for the measurement of NO2 pollution under Qatar's harsh service conditions

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In the wake of human activities within large cities such as Doha, Qatar, the air pollution at the local up to the district levels, stemming from fossil fuelbased cars and some industries, increases levels of toxic gas p ollutants such as NOx, or NO2 as a telltale gaseous species.At a time when many cities worldwide adopt ban policies for vehicle models that are the largest emitters, it is foremost important to determine the level s of pollution, for instance around densely populated areas that are also hubs for the traffic at the city scal e. Beyond the human health aspect, difficult to trace back to the harmful contaminant sources, an efficient way to investigate the exposure levels is the deployment of a dense network of air quality sensors across the city. These city-wide measurements of air quality can then be used in turn to strategize pollution mitigation policies. In this regard, the emergence of low-cost sensors is particularly useful for the coverage of numerous possible hot spots as for the emission or outdoor exposure to NO2. Such sensors are usually 10–100 times more cost-efficient per sensor than the equivalent high-end grade air quality sensor, used for instance by environmental national agencies. However, the tradeoff is the quality of the measurements, e.g. with a measurement error depending on ambient temperature, relative humidity, or effects due to the reactivity of other gaseous species with the sensor's technology. Such impacts on the measurement quality is critical in Qatar, where the sensor manufacturer's calibration may become completely irrelevant due to the very harsh climate. The paper presents evaluation results for such low-cost NO2 sensor technologies, and a localized calibration methodology for application in Qatar. The reported method to accurately calibrate the measurements relies on collocation experiments of the sensors with high-end reference-grade monitors for several months under Qatar's summer season, then the use of computational methods to identify the optimal calibration model.

Mercury prediction in groundwater of Naameh Landfill (Lebanon) using an Artificial Neural Network (ANN) model

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Naameh Municipal solid waste landfill located in Chouf Caza (Lebanon) is the biggest landfill in the country and it operated for almost 18 years whereby it received baled wastes from 51% of the Lebanese regions. Mercury is a highly poisonous metal which is mostly found in the environment. The mercury is at the top of the parameters of water quality that requires investigations for planning and management. In order to assess the status of mercury in the groundwater of Naameh landfill, Artificial Neural Network (ANN) models were used as indicators of water quality and for the prediction of mercury. Two types of feedforward networks have been used including multilayer perceptron (MLP) and radial basis function (RBF). A number of different MLP neural networks algorithms and RBF networks trained and developed with reference to pH, EC, TDS, TON, calcium and magnesium to predict mercury concentrations in groundwater. Six scenarios were used to train MLP and RBF networks for choosing the best model for predicting water quality parameters in the landfill's groundwater. The performances of MLP and RBF models were evaluated by utilizing the coefficient of determination (R2). The results showed that the computed values of R2 for MLP and RBF were 0.791 and0.881,respectively.In addition, the prediction results showed that both types of networks are very good for predicting mercury concentrations in the groundwater of our study area. Moreover, the results reveal that mercury residues will persist for an additional two years although the landfill's operation ended year 2016.

PV panels performance in hot desert environment conditions

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Desert has been identified as the ideal area for PV solar installation that produces enough electricity demand, particularly due to its geographic location and enormous solar irradiation potential. However, various studies indicate that high temperature value and high ultra violet irradiation in the desert climate could have serious performance degradation. In this work, results of an experimental investigation are presented. The study was carried out at research unit of renewable energy in Saharan middle, Adrar, Algeria. Solar panels have showed strong degradation performance, it have a drop in power up to 30% in 11 years, whereas a solar panel's performance warranty typically guarantee 90% of power produced at 10 years. Hot desert climate influence the electrical parameters and have contributed to the early degradation. The tested modules revealed some physical material defects. The finding results of this study contribute to manufacturers for improving materials used for the PV modules components operating in desert environment conditions and restructuring their future warranty agreements. The paper aims to promote a better understanding of links between degradation performances of photovoltaic panels and desert climate conditions.

Ultra-Short Transcient with First Multi Quadrupole ICPMSMS is Fast Enough to tackle all Challenging Direct Analysis of Highly Interfered Ultra Trace Elements

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Water contamination is a major concern for the protection of ecosystems, climate change and regarding the current water scarcity. The increase in the presence of organic and inorganic pollutants and nanoparticles poses a problem, both for human health and for the balance of ecosystems. One way for monitoring of difficult & highly inferred elements in water is by using ICPMS. However, the advantages of UHPLC & Single Particle/Single Cell mode (SP/SC) in synergie with ICPMSMS have not been studied thoroughly for the highly inferred elements like Halogenated, Silica, Phosphorus, Sulfur, Iron at sub-ppb level and even some Rare Earth analysis at sub-ppt level. Moreover, their simultaneous monitoring of ultra short transient signal is even more challenging. A new paradigm is rising with the new generation and the innovative geometry ofICPMultiQuadMS/MS. Almost all periodic table (>60 elements at sub ppt to sub ppb level) were separated, acquired and accurately quantified in less than 2 minutes (60-100" in SP/SC per elements). High throughtput, high sensitivity and interferences free were obtained with MSMS separation enhancement. The innovative approach and the challenge here were also in mimizing the time acquisition, the cross contamination mitigation and the automation for an optimum cost/performance ratio. MSMS is acting as a multi dimensional mass filter to improve the monitoring of Halogenated, Silica, Sulfur or Rare Earth containing molecules in our environment or (nano)material. This method presents similar performance than GC/UHPLC-HRMS or TEM for nanoparticles analysis, but it is faster, cheaper, with almost no matrix effect and quantitative.

Environmental Management of Large-Scale Lng Project Development

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Large scale development projects are instrumental to Qatar's economic growth, social development, and prosperity. For economic benefits to be sustainable, environmental issues must be identified at the initial stage and assessed for the entire life cycle of a project. Environmental design assessment at the early stage of the project, enhances the overall environmental sustainability of the project.The development of large-scale Liquified Natural Gas (LNG) projects creates environmental challenges that include incremental air emissions contributions to existing air emissions inventories, generation of waste and discharge of effluents to receiving water bodies. Environmental risks such as marine (flora and fauna), soil and groundwater impacts are inherently associated with these large-scale development projects and pose additional environmental liability issues. Uncertainty, complexity, and variability in environmental regulations further add to the challenges associated with the environmental management process.
To manage environmental risks during construction, commissioning, and operational phases of LNG development projects, Qatargas has developed a comprehensive cradle-to-grave environmental management system, which assess a project's technology in line with best available environmental controls and long-term environmental impacts of the development. This presentation will present an overall environmental management framework of large-scale LNG projects, including key environmental challenges and mitigation measures associated with terrestrial and marine developments.

The Application of Leak Detection and Repair (LDAR) Program in Qatargas: Success Story of Achieving Sustainable Reduction in Fugitive Methane Emissions

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Qatar gas is the world's largest LNG company and produces 77 million tonnes per annum of Liquefied Natural Gas (LNG) from its 14 LNG trains and ~14 million tonnes (700 BCF) per annum of sales gas from its Al-Khaleej 1 and 2 facilities. In addition, Qatargas also operates Laffan Refinery (LR) and Laffan Refinery 2 (LR2) condensate refineries with a total processing capacity of ~306,600 barrels stream per day. Other associated facilities within the integrated chain include two Helium processing facilities, the world's biggest sulfur granulation and ship-loading facility, and large hydrocarbon storage and loading facilities in Ras Laffan Industrial City (RLIC), Qatar. Methane as a Greenhouse Gas (GHG) has a Global Warming Potential (GWP) 28 times more than that of carbon dioxide (CO2). The oil and gas industry therefore has a keen focus on reducing methane emissions. As the World's Premier LNG Company, Qatargas is actively implementing a range of projects and initiatives to minimize the Company's GHG footprint. One such initiative is a dedicated Leak Detection and Repair (LDAR) programme to mitigate fugitive methane emissions from the Company's LNG and sales gas facilities. The methane LDAR programme identifies and quantifies fugitive methane emission leaks from piping components and equipment using a 'Smart LDAR Approach' based on a combination of Optical Gas Imaging (OGI) and physical hydrocarbon measurement. This approach optimizes field monitoring and accelerates the identification of leaks which are then mitigated through maintenance and repair, thereby reducing losses while also enhancing process safety.

My Carbon Footprint: Raising Awareness among Employees & Community to Reduce their Carbon Footprint

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Qatar gas' 2021 Go Green Campaign, 'My Carbon Footprint', demonstrates to employees and other stakeholders the difference they can make as individuals in the fight against climate change. The initiative is a part of Qatargas' commitment towards cultivating sustainable environmental practices and fostering community wellbeing in line with Qatar National Vision 2030.'My Carbon Footprint', is an immersive online learning experience encouraging people to calculate their carbon footprint through a Personal Carbon Footprint (PCF) Calculator. Participants take part in a webinar with quizzes and activities on climate change. As of August 2021, more than 500 employees have participated in the virtual training sessions, and more than 700 employees have calculated their personal carbon footprint using the PCF calculator which is available to all on the Qatargas website.As part of the Qatargas community outreach programme, we have also taken this campaign to schools where-in we involve the students in interactive sessions. The main approach of this campaign is to understand issues, challenges and potential solutions for climate change mitigation. The PCF provides a baseline at where an individual stands with respect to their carbon footprint with the overall online material and webinar or in-person interaction providing tips and insight to improve upon this.The presentation will provide an overview of the development of the Personal Carbon Footprint (PCF) Calculator and the overall collaborative approach adopted as part of the Go Green programme within the company, with the community and educational institutions.

Hydrogen embrittlement: the game changing factor in the applicability of high strength alloys in hydrogen economy

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The safe handling of large-scale hydrogen required for establishing a hydrogen economy is a big challenge due to the so-called hydrogen embrittlement problem. It is well known that when hydrogen comes in contact with a high-strength metal, it deteriorates its mechanical properties. In this paper, we will look into the challenges regarding understanding and controlling hydrogen embrittlement to facilitate a low carbon hydrogen economy.

Managing Adaptation and Mitigation measures to secure Sustainability under Climate Change

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Climate change affects global water resources and water systems in different ways and magnitudes, that could cause serious effects on the ecosystem and eventually on human health.These effects will add challenges to the sustainable management of water resources, which are already under severe pressure globally. The availability of water for basic human needs. The effects of climate change can be highly idiosyncratic at the local scale. Current trends and future projections indicate major shifts in climate, and more extreme weather events in many parts of the world. Food Security and the Energy-Water-Environment Nexus is central to sustainable development. Demand for water, food and energy is increasing, driven by a rising population, rapid urbanization, and economic growth. Agriculture is the largest consumer of the world's freshwater resources, and more than one-quarter of the energy used globally is expended on food production and supply. Management measures must be taken to secure sustainability under Climate Change to ensure that; groundwater use is within managed and controlled measures, and minimize dependence on nonrenewable groundwater sources by industrial and agriculture sectors. Adaptation encompasses a combination of natural, engineered and technological options, as well as social and institutional measures to moderate harm from climate change. Adaptation options exist in all water-related sectors and should be investigated and applied where possible. Supply and Recharge Management is an important adaptation measure to enhance recharge of groundwater, taking into account water quality of recharged water to adapt the impact of drought and climate change.

Impact of Recliamed Wastewater on Alfalfa Crops production Under Different irrigation Systems

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This research is conducting at Ramtha research station for treated wastewater studies in Jordan as a part of Non-Conventional Water Re-use in Agriculture in Mediterranean countries (MENWARA) project activities. The objective of this research is to study the impact of using drip, surface, sprinkler and sub-surface irrigation systems on Alfalfa water productivity and crop quality under the reclaimed wastewater (RWW) condition. Completely randomized plot design in four replications has been used as experimental design for Alfalfa crop irrigated by RWW. Each experimental plot area is 25 m2, the applied irrigation water were calculated based on cropwat software using Penman-Monteith equation. The primary Results showed no E.coli was detected (< 3 MPN/gm) on the alfalfa irrigated with RWW using sub-surface irrigation either taking the upper plant part or lower plant part near soil surface of the fresh harvested plants , while E.coli was detected in fresh harvested alfalfa for drip and surface irrigation in the lower plant parts only near soil surface (less than 15 cm). Also, results revealed that there was accumulation of Cl, Na and Fe in plant tissues irrigated by sprinklers as well as all plant parts were polluted by E.coli. The detected E. coli in fresh alfalfa in sprinkler irrigation method treatments was disappeared after two weeks of plant drying. Results for five cuts showed that alfalfa has the highest water use efficiency under subsurface irrigation compared with other irrigation methods.

Critical Deposit Loading Thresholds for Under Deposit Corrosion in Steam Generators

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Almost all significant industrial facilities operate a large steam system that includes multiple steam generators. Various components of these systems are potentially vulnerable to different corrosion mechanisms, including Flow Assisted Corrosion (FAC) in the feedwater piping and Under Deposit Corrosion (UDC) in the evaporator tubes. To mitigate these threats, water chemistry throughout the system must be rigorously controlled. The UDC mechanism involves deposition of a porous layer of magnetite particles on the waterside surface of the evaporator tubes. Beneath this layer, wick-boiling leads to a very high concentration of contaminant species, until at some point the concentration exceeds threshold level that causes rapid corrosion. The most prevalent form of UDC in modern plants involves chloride contamination, which may eventually lead to tube failure by hydrogen damage. Industry practice to mitigate this risk is to manage feedwater quality to minimize the risk of FAC and hence reduce the amount of iron (as ferrous ions and magnetite particles) that enters the steam generator; minimize chloride contamination; monitor the extent of deposition and then chemically clean the tubes before the deposits reach the levels necessary to initiate UDC. One other critical factor is the heat flux, which drives both the magnetite deposition and the wick boiling processes. Despite the trend toward higher heat-flux values in power generation, typical values remain low compared to those in the oil and gas sector. In this paper we describe an investigation into the relationship between heat flux and the critical deposit thickness for initiation of chloride-driven UDC.

Longitudinal and sectoral analysis of Greenhouse gas emission by nations in MENA region with special reference to Qatar

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This study analyses the Greenhouse Gas (GHG) emission inventory of nations in the Middle East and North Africa (MENA) region with a special reference to the state of Qatar. The study analyses emission from 2015 to 2020 by different sectors viz., agriculture, buildings, extraction, manufacturing, maritime, oil and gas, power, transport and waste. The study uses the Greenhouse gas emission data from Climate TRACE (Tracking Real-Time Atmospheric Carbon Emissions), calculated using satellite data and artificial intelligence, which makes it more reliable and comparable than the data reported by emitting entities due to differences between scientific methods used. Using descriptive statistics, the study analyses the GHG emission by MENA nations and its longitudinal and sectoral trends. Further, it examines the longitudinal and sectoral differences in emission using Analysis of Variance (ANOVA) and post hoc analysis. Findings of the study emphasizes on the need for mandatory legislation which could enable emitting entities to adopt measures to reduce emission, take action in alignment with the carbon budget constraints and to achieve carbon neutrality. Qatar being the world's largest supplier of Liquefied Natural Gas (LNG) (which are cleaner and efficient energy sources compared to conventional fuels) helps in contributing to both GHG emission reduction globally. By implementing the National Climate Change Policy, the nation is on its drive towards becoming a carbon neutral economy and contributing to achieving the goals of the Paris Agreement. It can play a leading role by enabling rentier states in the region on their transition to carbon neutral economies.

Poly (acrylamide acrylic acid) grafted on steel slag as an efficient magnetic adsorbent for cationic and anionic dyes

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In this study, an efficient magnetic polymeric composite was synthesized from steelmaking waste. Steel slag was modified with acrylamide acrylic acid (SSAA) copolymer for removal of methyl orange MO and methylene blue MB from synthetic solutions. The SSAA composite was characterized by TGA thermogravimetric analysis, SEM scanning electron microscope, XRD X-ray diffraction, BET Brunauer–Emmett–Teller surface area, and FTIR Fourier transform infrared. The adsorption behavior of SSAA for MO and MB was investigated, and the impact of various parameters was examined using one factor at a time (OFAT) and RSM-BBD response surface method-Box Behnken Design. The kinetic data of MO and MB were well described with the second-order kinetic model, and the dominant rate-limiting step is the film diffusion. The isotherms of Dubinin–Raudshkevish (D–R) and Freundlich well described the MB and MO experimental results, respectively. The maximum uptake efficiencies of 97% and 94% and capacities of 47 and 463 mg/g were reported for MO and MB, respectively. The thermo- dynamic investigations suggested favorable, spontaneous adsorption of MO and MB on the SSAA. Physical adsorption was found to be the dominating mechanism for MB, while the chemisorption mechanism was reported for MO. Those mechanisms were confirmed by the regeneration studies. The reported investigations revealed that the SSAA composite could be used for cationic and anionic dyes removal from wastewater, spontaneously and feasibly, as indicated by the thermodynamic study.

Forecasting Methods for a Blockchain-based Local Energy Trading Markets

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Blockchain technology provides energy, consumers, prosumers and utilities with a novel, secure and cost effective energy-trading solution through the automation of direct energy transactions within a distributed database architecture rooted in cryptographic hashing and consensus-based verification. The target of this study is illustrating the forecasted households' s power profiles as well as operation of any blockchain process and apply a generic ABM simulation framework for electricity exchange (see Figure. 1). An original version of a resilient multi agent structure for a Transactive Energy (TE) type of Distributed Energy Resources (DER) within the ECCH microgrid dependent on blockchain engineering was designed & simulated. Recently proposed blockchain-based LEMs use auction designs to match future demand and supply. Thus, such blockchain-based LEMs rely on accurate short-term forecasts of individual households' energy consumption and production. Often, such accurate forecasts are simply assumed to be given. The present research tested this assumption by first evaluating the forecast accuracy achievable with state-of-the-art energy forecasting techniques for individual households and then, assessing the effect of prediction errors on market outcomes in three different supply scenarios. Experimental results are reported in the attached file.

Integrated Electrical Resitivity And Slimgram Em34-D Application For Groundwater Exploration In Ayegunle Oka- Akoko, Ondo State, Southwestern Nigeria

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The integrated geophysical methods used in this study have assisted as an excellent alternative to investigating the groundwater potential of some selected areas within Ayegunle / Oka Akoko. Both the electromagnetic and electrical resistivity data were inverted and interpreted in terms of the distribution of the geo-electric parameters in the area. Interpretation of the electromagnetic profiles identified some conductive zones, which were considered priority areas for depth sounding. The geo-electric parameters obtained from the inverted vertical electrical resistivity sounding data were used to delineate the aquifer types of the region: fractured bedrock and weathered bedrock. Also, cross-sections and contoured maps were analyzed based on the hydro-geological potential of the study area. Based on these, the area was categorized into high, intermediate and low groundwater potential. The integrated geophysical study has revealed that there is appreciable groundwater yield and its potability for rural dwellers.

Web-based hybrid electricity demand forecasting platform

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Short-Term load forecasting (STLF) is an integral part of the energy planning sector. In this study a hybrid STLF system based-on weather forecast is developed for predicting hourly electricity demand. Based on the most important parameters, the problem divided into several smaller sub-problems to solve simpler problems using artificial intelligence and machine learning. The most important parameters used in breaking STLF into sub-problems are seasonal effects, working days, holidays, hours of day, etc. Considering mentioned parameters, a large number of sub-problems arise which leads to a drastic reduction in the number of data for training each sub-model. Since, neural networks are not appropriate for such problem, fuzzy-sparse hybrid models is used which provide higher accuracy. Because artificial intelligence algorithms typically generate sawtooth predictions for daily load profiles, an auxiliary sequence model has been used to solve the sawdust problem. In addition, due to significant impact of weather condition, hourly forecasts of meteorological parameters for the next 4 days are used as input to load forecast model. Finally, an adaptive error adjustment module has been developed to correct the bias error with a positive or negative mean. The system has a web-based user interface by which it is possible to import data, submit forecast request and generate reports on weather and load forecast results. The system is implemented and evaluated for the city of Tehran through a full year. Results show that 56.3%, 32.3% and 11.4% of hours predicted with MAPE error below 2%, between 2-5% and over 5%, respectively.

Biochar: A unique bio-resource for climate-smart agriculture and water food energy nexus

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Food waste is a significant environmental concern producing methane gas and nutrient rich leachate in landfills. Producing biochar from food waste can help in achieving sustainable agriculture. This study uses food waste leachate as an organic fertilizer for plant growth and the leftover residue to produce biochar as a soil amendment. 23 vegetable wastes blends were degraded for four days to produce leachate. After leachate extraction, the leftover residue was used to produce biochar by slow pyrolysis at five different temperatures - from 400 to 600 °C, at a heating rate of 5 °C.min-1 and with 1 h residence time. The biochar produced at 500 °C showed optimum properties for agriculture purposes with a BET surface area of 14 m2.g-1, maximum cation exchange capacity of 43 cmolc.kg-1, and suitable elemental composition (Ctotal:Cfixed:N = 0.68:0.43:0.05). Laboratory-scale pot tests at 0.5% and 1% biochar loading using mung bean (Vigna radiata) were conducted and both conditions improved plant growth. The extracted diluted leachate was applied as a liquid fertilizer and improved soil fertility compared to the 0% biochar. The 1% biochar showed a 43% improvement in water retention to the control. An increase of 1 and 1.35 mL KMnO4.g-1 of soil catalase activity and 0.11 and 0.2 µg.g-1.h-1 of soil urease activity was observed over the control by 0.5% and 1% biochar application. The study shows 0.5% biochar is a sustainable approach towards a water.

Hydrogen embrittlement of Ni-base alloys: a multiscale study

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Hydrogen (H) is envisioned to play an important role in the emerging greenhouse gas-free economy of the future. However, most of structural materials in direct contact with H suffer from the hydrogen embrittlement (HE), which calls for new approaches for HE-resistant alloy design. The main goal of this work is to show a possible way of mitigating the harmful effect of H on the mechanical performance of high strength alloys by applying multiscale modelling and advanced experimental approaches to design and investigation of new Ni-base alloys for applications in H-containing environments. The methods of HE investigation include density functional theory calculations, macro- and micromechanical experiments using electrochemical H charging, as well as the atom probe tomography and scanning electron microscopy analysis of the alloy chemical composition and microstructure.

Spatio-temporal changes in Qatar in the wake of global climate change - with special reference to the floristic diversity of the country

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We have assessed the conservation status of Qatar's endemic flora by understanding its floristic distribution and composition using modern GIS (Geographical Information System) and niche modelling techniques. A range of approaches were applied including unsupervised classification analysis in ArcGIS to create spatial and temporal maps and to analyze the vegetation and land use dynamics. The study also involved evaluation of the therapeutic and anti-microbial effects values of some commonly growing desert plants.The Maxent niche predictive models indicate that species like Cyperus conglomeratus have a higher probability of surviving only in the northern parts of Qatar in comparison to the central and northern parts. The most important bioclimatic variable in determining the niches of the plants is Bio 17, precipitation of driest quarter and altitude.Some plants like Suaeda aegyptiaca, Scrophularia deserti, Heliotropium bacciferum, Pulicaria undulata, and Zygophyllum fontomesii were found to have significant antimicrobial properties.It is concluded that Qatar is undergoing a rapid change in regards to its land-use. Qatar has scarce but important flora which could be exploited for phytochemical extraction and commercialization. Some of these plants have specific niches which could be affected by climate change in the future and have an impact on the overall biodiversity of Qatar. Therefore, Qatar needs planning at the government level to mitigate these changes. This could aid in the selection of suitable plants to grow for sustainable utilization of the current flora towards a better environment and health benefits for the residents of Qatar.

Failure analysis of Incoloy 800 water immersion heating element

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Driven by regulations and restrictions on using fossil fuels and reduce carbon dioxide emissions, electrical heating is becoming a good choice for many domestic and industrial applications. High-temperature oxidation along with corrosivity of the service environment brings many challenges to heating element design and to service engineers. Heating elements fail in service due to many reasons such as design, overheating, sheath tube failure, corrosion, and overheating. One way to improve design, reliability, and improve product performance is by conducting failure analysis.In this paper, metallurgical failure analysis of a water immersion heating element was conducted. Optical microscopy (OM), scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), microhardness, and X-ray radiography were used to analyze the different components of the failed item. The failure was attributed to pitting corrosion that started on the outer surface of the Inconel 800 sheath material. The failure started by pitting as a result of a chloride-containing fluid which then proceeded as stress corrosion cracking (SCC).

Coral Management Program to Protect Qatar's Rich Marine Biodiversity

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Qatar gas in collaboration with the Ministry of Municipality and Environment (MME) has been leading a range of environmental initiatives focused on sustaining and preserving Qatar's marine biodiversity. Among these initiatives, coral projects are key and provide sustainable habitat for vibrant populations of fish, sea urchins, algae and varied flora and fauna. Since 2007, Qatargas has relocated over 7,500 live corals from nearshore pipelines to offshore protected areas including the deployment of over 400 artificial reef modules at several locations across Qatar. More recently, Qatargas in collaboration with MME and Qatar University (QU) has stewarded a unique and ambitious Coral Management Program that comprises of artificial reef deployment, coral relocation and first of its kind land-based Coral Nursery. As part of the program, about 4,500 live corals were relocated to alternate sites based on comprehensive marine surveys and an additional 1,000 corals were taken to coral nursery at Aquatic Fisheries Research Center (AFRC), Ras Matbakh for coral husbandry. At AFRC, the extracted corals have undergone a cycle of rehabilitation under controlled conditions. This will be followed by fragmentation and eventual out-plantation of fragments to recipient sites. Coral Nursey has the potential to become a National Coral Bank thereby contributing to future marine biodiversity and coral protection projects, both in Qatar and the region. Moreover, it will optimize the Technological Readiness Level of the procedures and facilities for propagation of local coral species in a nursery (fragmentation and husbandry). This paper will present an overall framework for coral relocation and coral nursery.

Utilization of industrial biosludge in Qatar: A risk assessment approach

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Biosolids or biosludge is a semi-solid by-product of wastewater treatment and is produced in large quantities in Qatar by municipal and industrial effluent treatment plants (ETP) in the process of treating sewage and process water respectively. Moreover, millions of litres of treated sewage effluent (TSE), is produced per day and can be considered as sources of irrigation water in production of industrial non-food crops. This effort aims to demonstrate the technical feasibility of reclaiming non-arable land using ETP by-products by identifying the gaps that exist between marginal soils in Qatar and arable soil. The application of biosludge and treated effluent water in non-food agriculture was subjected to a thorough risk assessment and mitigation strategy. The risks (impact X probability) were classified into different categories, technical, economical, commercial, organisational, and political. The most severe risks such as leaching of heavy metals underwent higher scrutiny in mitigation measures. A major factor in this approach is the modelling of contaminants and their fate in the Framework for Integrated Sustainability Assessment (FISA). This was compared to a collection of environmental quality standards (sourced worldwide). The model indicates that majority of parameters were in compliance with international standards, while some were in violation. Such approach allows evaluation of limits of application of specific by-products in agricultural use. Further validation of the model is subject to future research.

POSTER PRESENTATION

Design and Control of Bi-directional Charging Station for Plug-in Electric Vehicles

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As the number of electric vehicles (EVs) increases, there is a growing need to create more energy-efficient charging infrastructure systems around the world that can charge vehicles faster than ever before. New EVs have higher ranges and larger battery capacities than their predecessors, necessitating the development of fast charging solutions to support quick charging requirements. In this study, design and control of bi-directional fast EV charger station was presented. The considered power topology in this study consists of a three-phase T-type converter (AC/DC power stage) and a dual active bridge converter (DC/DC power stage). First, the design of the three-phase T-type converter and the dual active bridge converter were presented. After that, the control of the designed charging system was developed based on the sliding mode control technique. Finally, the control and hardware were successfully verified through the PSIM simulation environment.

Supervised Machine Learning Approach towards Accelerating the Development of High-performance non-Pb Perovskite Solar Devices

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In this research, SCAPS (Solar Cell Capacitance Simulator) was utilized to build and probe non-toxic Cs-based perovskite solar devices, and investigate modulations of key materials parameters on ultimate power conversion efficiency (PCE). The input materials parameters of the absorber Cs-perovskite layer were incrementally changed, and with the various resulting combinations, 63,500 unique devices were formed and probed to produce device PCE. Versatile and well-established machine learning algorithms were thereafter utilized to train, test and evaluate the output dataset with a focused goal to delineate and rank the input materials parameters for their impact on ultimate device performance and PCE. The most impactful parameters were then tuned to showcase unique ranges that would ultimately lead to higher device PCE values. As a validation step, the predicted results were confirmed against SCAPS simulated results as well, highlighting high accuracy and low error metrics. Overall, the results from this investigation provide much-needed insight and guidance for researchers at large, and experimentalists in particular, towards fabricating commercially viable non-toxic inorganic perovskite alternatives for the burgeoning solar industry.

A SCAPS Simulation Investigation of non-toxic MAGeI3-on-Si tandem solar device utilizing monolithically integrated (2-T) and mechanically stacked (4-T) configurations

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In this study, solar cell capacitance simulator (SCAPS) was utilized to investigate a tandem solar device with Methyl-ammonium germanium iodide (MAGeI3), an organic perovskite, as top cell active layer, and crystalline silicon (c-Si) as the bottom cell. Validation studies were done against established single-junction device structures including MAPbI3 and c-Si. Our simulation-based results showcase a robust congruence with experimental data, with obtained power conversion efficiency (PCE) values of 20.19%, and 23.01% for MAPbI3 and c-Si based single junction devices, respectively. For the thesis of this work, both four-terminal (4-T) and two terminal (2-T) perovskite-on-silicon tandem architectures were investigated. Our numerical simulation for the monolithic stacked 2-T tandem structure of MAGeI3-on-c-Si produced a PCE of 28.71 %, while a PCE of 32.2 % was obtained for the standard MAPbI3-on-c-Si. For the current matching condition in the 2-T tandem devices, the optimum thickness of MAGeI3 and MAPbI3 were found to be 626 nm and 223 nm respectively. For the mechanically stacked 4-T configurations, MAGeI3-on-c-Si and MAPbI3-on-c-Si produced PCE values of 29.85 % and 33.67%, respectively, with optimum top cell absorber thickness values of 1.7 µm and 1.4 µm, respectively. Each device architecture was optimised by carrying out extensive studies including modulations in absorber thickness, bulk defect density, interfacial defect density, and back contact metal work function. Our in-depth analyses highlight a remarkable potential for MAGeI3 to be utilized as the top cell of a perovskite-on-silicon solar device, boasting high efficiency and intrinsic non-toxicity.

Novel ultrafiltration composite membranes embedding bio-inspired polydopamine-functionalized graphene oxide nanosheets

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Graphene oxide (GO)-based materials have gained a significant interest in the membrane functionalization sector in the recent years. Inspired by their unique and tunable properties, several GO-based nanomaterials have been utilized for various membranes in water treatment and desalination sectors. In this work, novel polysulfone (PSF) ultrafiltration membranes incorporating polydopamine-functionalized graphene oxide (rGO-PDA) were fabricated and investigated. GO nanosheets with high oxidation degree were synthesized using an improved Hummers' method. A bio-inspired GO functionalization using PDA was then conducted to produce rGO-PDA nanosheets. The high-oxidation of graphite and the successful functionalization with PDA were confirmed using several analytical techniques including CHNSO elemental analysis, XPS, FTIR-UATR, and Raman spectroscopy. Pristine PSF, PSF/GO, and PSF/rGO-PDA composite membranes were then prepared using the phase inversion technique and were analysed using FTIR-UATR, SEM, AFM, and contact angle. The SEM images showed better distribution of rGO-PDA in the membrane matrix whereas the pristine GO aggregated and partially blocked the pores. Thus, the flux increased with the embedding of rGO-PDA without affecting the rejection properties, while it decreased with the pristine GO. The highest pure water permeability was obtained with PSF/rGO-PDA-0.1 to be approximately twice that of the pristine PSF and PSF/GO-0.1. All membranes exhibited complete rejection of BSA and HA and almost similar rejection against different dyes. The flux recovery ratio of the pristine PSF after three fouling cycles (FRR3) against BSA and HA were recorded to be 57.8% and 70.7%, respectively. FRR3 was enhanced by around 30% with PSF/rGO-PDA composites against both foulants.

Plant Design For Renewable And Sustainable Energy Use In The Gulf Countries: Complete Case Study Of Moringa Seeds- Biodiesel In Oman

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The problem of climate change has been exacerbated by the continuous dependence on fossil fuel, which has served as the mainstay of economy in the gulf countries. Opportunities for climate mitigation and economy diversion beckon in the exploration of sustainable and renewable bioenergy from natural sources which are abundant in the desert areas. One such source of renewable energy is the extract of seeds of Moringa Oliefera trees in the Sultanate of Oman. The plant is found spread around the country where the weather and soil are appropriate for its faster growth. This work illustrates the complete process system for the production of biodiesel from the Moringa seeds starting from site selection, process economics, operations, maintenance as well as waste management. This work expatiates the fundamental operations and conditions for the involved processes such as distillation, transesterification, mixing, adsorption drying, neutralization, and separation. The reactive production of catalyzed fatty acid of various basic conditions was also examined. Mass and energy balances for the process were clearly discussed. Health, safety and environmental management, as it relates to the biodiesel production system was not left out.

Novel functionalized halloysite nanotubes with antimicrobial properties for water treatments

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A novel robust and time efficient one-step thermal decomposition method has been developed for synthesis of halloysite nanotubes (HNTs) impregnated with silver and iron oxide nanoparticles. The developed preparation method is simple, cost- and time-effective, and can be employed for large scale material fabrication. Different characterization techniques, including X-Ray diffraction (XRD), scanning and transmission electron spectroscopy (SEM and TEM), energy dispersive X-Ray spectroscopy (EDS), have been used to characterize the functionalized HNTs composite materials. It was shown that prepared HNTs possess high antimicrobial properties towards both Gram- positive and Gram-negative bacteria species. The performed studies showed that the functionalized HNTs could be used as a promising low cost adsorbent with antibacterial properties for water treatment applications.

Optimal Design and Operation of Solar Assisted Cooling Systems: Applications in Desert Climates

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This research aims to address the design and operation challenges that arise when integrating solar energy into district cooling systems. Such systems are perceived to be expensive to employ in wide applications due to their ad hoc and oversized design. Hence, this research introduces a comprehensive optimization process that allows the cost-effective design of such systems. The research develops two mathematical models with the type of mixed-integer linear programming (MILP) for conventional and solar electric cooling systems. The MILP determines the optimal design and optimal hourly quantities of cold water and electricity to store and produce while meeting the cooling demand. Qatar University campus is taken as a case study. Moreover, the MILP is solved using real collected data and several sensitivity analyses are performed. Lastly, an economic comparison between the conventional, solar electric, and previously developed solar thermal cooling systems is performed to highlight the most economical system. The findings indicate that photovoltaic (PV) panels employed in solar electric cooling systems cover 42% of the chiller's electricity demand. Furthermore, the solar electric cooling system is found to be the most economical as its cheaper by 5.5% and 55% than conventional and solar thermal cooling systems, respectively. Lastly, the sensitivity analysis shows that PV panels have the most impact on the annual cost of solar electric cooling systems compared to others. Moreover, the analysis shows that the annual cost of solar electric cooling systems increases by 10% when the electricity prices increase by 20% making it the most economical system.

Cadmium ion sensor based on (E)-N′-(4-Bromobenzyledene)-4-methyl benzenesulfonohydrazide and used for the environmental remediation

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A new (E)-N′-(4-Bromobenzyledene)-4-methyl-benzenesulfonohydrazide (4-BBMBSH) compound was prepared by using an easy condensation procedure from 4-Bromobenzaldehyde (4-BBD) and 4-Methyl-benzenesulphonylhydrazine (4-MBSH) and crystallized in MeOH. BBMBSH was examined for structure confirmation by means of different techniques for example 1H-NMR, 13C-NMR, FT-IR, and UV-Visible. Structure of 4-BBMBSH was performed with a diffraction method (Single crystal X-ray diffraction, SCXRD). 4-BBMBSH compound applied for the recognition of metal ion (Cadmium ion) by using a reliable current-voltage (I-V) progress. A sensitive and selective cadmium ion (Cd2+) sensor was modified by deposition of slight layer of 4-BBMBSH on a level GCE with conducting polymer matrix (Nafion, NF). Analytical sensing parameters for example sensitivity, LOD, and LOQ of the projected sensor to Cd2+ were found from the calibration curvature as 2215.19 pAμM-1cm-2, 10.03 pM, and 334.29 mM respectively. This imminent NF/4-BBMBSH/GCE sensor was used for the specific determination of Cd2+ in natural samples and found satisfactory result.

Ensemble Projection of Future Climate and Surface Water Supplies, North Saskatchewan River Basin Above Edmonton, Alberta, Canada

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Changes in temperature and precipitation are expected to alter the seasonal distribution of surface water supplies in snowmelt-dominated watersheds. A realistic assessment of future climate change and inter-annual variability is required to meet the growing demand for water supplies in all major use sectors. This study focuses on changes in climate and runoff in the North Saskatchewan River Basin (NSRB) above Edmonton, Alberta, Canada, using the MESH (Modélisation Environnementale communautaire - Surface Hydrology). The bias-corrected ensemble of the Canadian Regional Climate Model (CanRCM4) is used to drive MESH for two 60-yr time periods, a historical baseline (1951–2010) and future projection (2041–2100), under a Representative Concentration Pathway (RCP) 8.5. The precipitation is projected to increase in every season, there is a significant trend in spring (0.62) and fall (0.41) and insignificant in summer (0.008). Winter extreme minimum temperature and summer extreme maximum temperature is increasing ~ 2–3 °C in the near future and ~5–6 °C in the far future. Annual runoff increased by ~19% compared to the base period. The results reveal long-term hydrological variability enabling water resource managers to better prepare for climate change and extreme events to build more resilient systems for future water demand in the NSRB.

Optimizing the capacity of electric vehicle charging stations based on queueing theory

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In the recent years there has been an increasing rate of adoption of electric vehicles (EVs). An essential enabler for this new trend is the development of charging infrastructure for EVs. The charging times of EVs at such stations is significantly longer than in the case of fossil fuel based vehicles. Consequently, the queueing time for EVs becomes longer and a serious issue for further adoption. Because of this, it is necessary to dedicate special attention to minimize the drop rate with the goal of maximizing the quality of service. In this research, the focus is on optimizing the number of chargers in individual charging stations within a system in a metropolitan area. This is achieve firstly by developing a mathematical model based on the Erlang loss formula for representing the M/M/c/c queuing model. The novelty of the model is in including the relation of the capacity of a charging station to the number of EVs it attracts. Due to the complexity of the proposed model, a metaheuristic method is developed for optimizing the capacity charging stations in such systems. The developed mathematical model and corresponding optimization method are used to analyze the potential charging infrastructure based on real world data for cities.

Simulation of third generation cadmium telluride (Cdte) photovoltaic power plant in hot and dry climates and comparison with conventional solar panels

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Most areas of our country that have adequate sunlight intensity are areas with hot and dry climates, especially in the central regions of the country, and one of the most important losses in energy production of photovoltaic power plants is temperature losses due to ambient temperature and Therefore, it is important to provide solutions such as the use of cadmium telluride (cdte) solar panels, due to the lower temperature coefficient (temperature effects) than conventional photovoltaic panels based on silicon wafer in solar power plants in areas with hot and dry climates. Considering that solar energy is a type of renewable energy source and also our dear country Iran has a very good position in the field of using solar energy, so providing solutions in this field such as using photovoltaic solar power plants is very felt. In this research, using specialized PVSYST simulator software in the subject, the output of photovoltaic solar power plant using cadmium telluride (cdte) solar panels in the desired area with hot and dry desert climate compared to the solar power plant. The usual solar panels based on silicon wafer and also in comparison with cloudy and mountainous weather conditions in the other area are examined and the output of electrical parameters such as the energy produced by the output of the photovoltaic power plant is analyzed.

Impact of dust from construction on measured and satellite-based solar radiation

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Qatar's first solar PV power plant is under construction, and QEERI has been operating on-site a solar monitoring station since 2019. Although sensors are checked and cleaned twice a week, since plant construction started the increased sensor soiling had visible effects on measurements. To quantify the impact of increased soiling, we compare the direct (DNI) and global (GHI) irradiances just before and after each cleaning, before (Jan-May 2020) and during (Jan-May 2021) construction. We also evaluate satellite-derived solar radiation at the site to study the potential impact of increased dust on the satellite model. For ground data, normalised irradiances were used: the clearness indices Kt = GHI/Eth and Kn = DNI/Etb, where ETh and ETb are the top-of-atmosphere horizontal and direct irradiances. For satellite data, we use the HelioClim-3 database. We first determine the bias of satellite-derived GHI and DNI against non-soiled ground measurements, then use the bias-corrected satellite data to evaluate the effect of increased dust on satellite data. Figure 1 shows the relative differences in Kt and Kn for the selected days before (until day 25) and during construction. The increase in differences is clear, especially from day 35 (February, 2021) as works got close to the station. Figure 2 shows relative bias between ground and calibrated satellite data during construction, on days when the sensors were cleaned; the bias analysis will be used to evaluate the impact, on the satellite method, of increased soiling.

Study of Contamination, Piezometric Variation, and Hydrochemical Parameters of a Cracked Karst Aquifer Case of Cheria Plain – Algerian Northeast

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This work aims to contribute to the study of groundwater and hydrochemical variations of plain Cheria-Tebessa, Algeria. Two campaigns for piezometric and hydrochemical measurements on 28 wells and boreholes were carried out in 2015 in March and May in addition to those made between 2002 and 2010. The piezometric maps show a non-significant change in piezometric levels between 1060 and 1080 m, but the increase of 1100 m was observed in 2010 due to heavy precipitation and a tangible decrease in 2015 due to overexploitation and severe drought. Pumping tests were carried out in 03 boreholes, to calculate the specific flow: 2 - 0.05 - 0.316 l/s/m and transmissivity: 0.19×10-2 - 0.862 ×10-2 - 2.83 × 10-3 m2/s, indicates that the aquifer is heterogeneous. The hydrochemical analysis shows a very important elevation of certain elements such as chlorides and sulfates which have exceeded 400 mg / l characterizing the southern region due to alluvial filling and pollution from the river that drains wastewater. The dominant elements are chlorinated magnesium where hides the bicarbonate concentration in the waters of the region. The major elements (Mg++, HCO3-, SO4-2, Cl -, Ca++) revealed a significant concentration in the south of the region more than in the north, the majority of those elements are above the potability threshold. Also, a significant decrease in nitrate concentration was observed from 100 mg/l up to 0.1 mg/l certainly due to the decrease in the use of fertilizers in agricultural activity.

Exploring wind and solar energy potentials at a location in Qatar

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Qatar seeks to lower its carbon emissions by adopting renewable energies. Solar and wind are fast growing renewable options with good potentials in Qatar; while both sources can provide plentiful energy, they are intermittent and depend on weather. In this contribution, to compare the energy obtained from solar and wind in one location in Qatar for a one-year period, we use solar (direct normal (DNI) and global horizontal (GHI) irradiances) and meteorological (temperature, relative humidity, pressure, and wind speed and direction) measurements, from one QEERI site. To compare wind and solar potentials, we calculate the average power per unit area (W/m^2) and average energy per unit area integrated over hourly periods (Wh/m^2), available to energy conversion technologies. Solar daily, monthly and annual averages are derived from one-minute DNI and GHI data. We extrapolate wind speed from its original 10-min measurements at 2m height to the desired altitude, calculate the air density ρ from the temperature and atmospheric pressure measurements, and calculate the corresponding wind power in W/m^2 using WP=(1/2)*ρ*(WS^3). Figure 1 shows monthly averages of GHI and wind power calculated at 100 m height. The corresponding energies are 392.35 and 2147 kWh/m^2/year for wind and solar respectively. Note that these are only the inputs to power conversion systems, and are not the energy supplied by these systems. We will study potential correlations between solar irradiances and wind speed, and discuss its implications for renewable energy supply balancing.

Spatio-temporal variation of nitric pollution of groundwater in three agricultural regions in the northern Sahara of Algeria

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The intensification of irrigated agriculture in the Saharan regions, the excessive spreading of fertilizers, the excessive application of manure, poorly controlled irrigation, the rise of the water table in certain regions have generated nitric pollution of groundwater in these regions. In this context, a spatiotemporal study was carried out in three Saharan regions (Ouargla, Oued Righ valley and Oued Souf region) with the aim of establishing a diagnosis of the state of pollution. In order to ensure representativeness of the water points sampled in each region, monitoring of the piezometric level, of the nitrate concentration was carried out during the November 2011/June 2012 campaign at the level of a network comprising 90 water points (wells, boreholes) at a rate of 30 sampling points for each region. The nitrates were determined according to standard AFNOR methods. The results obtained show that the contents of these ions differ significantly depending on the region and the point of water sampling. In addition, 35% of the water analyzed had nitrate levels higher than the standard set at 50 mg L-1 by the WHO. However, the highest nitrate contents were recorded in the water sample of Oued Souf region, i.e. a nitrate content of 165.02 mg L-1. Due to its diffuse nature, nitric pollution remains difficult to control and requires adequate management and good management of irrigation and the use of agrochemical inputs and organic manure in this type of region characterized by the fragility of their hydro-ecosystems and their great vulnerability to pollution.

Management of a water distribution network by coupling Geomatic solutions and hydraulic modeling: Case of Ghazaouet, Algeria

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The rapid population growth, increase in unaccounted for water along with climate change serve as a major problem in both rural and urban water supply. The insufficient technical plans, the absence of appropriate information and the lake of topographical data related to the water distribution networks are major problems for the developing countries. Coupling hydraulic models with GIS can enhance the decision-making process for the management of the water distribution network. The current study proposes these tools in assessing the performance of a drinking water distribution network. A methodology was developed by coupling QGIS 6.0 to a hydraulic model EPANET2.0. The approach adopted in this work showed how the use of QGIS effectively manages water distribution network data and the use of the EPANET Hydraulic model to analyze for malfunctions in the system. After simulation of the existing water distribution network, results were presented in various forms. The results obtained verify that the pressures at almost all junctions at all pipes are feasible enough to provide adequate water to the network of the study area. Simulated water pressure varied significantly indicating that the pipes in some sections of the network needed augmentation and may lose their hydraulic capacities. The velocity was presented to be low on average for most of the sections where water was delivered by gravity and highlighted needs for pumping to boost supply due to the varying topography of Ghazaouet city.

Evaluation of Sustainability for Different Energy Storage Methods in Hot Climates

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Energy storage systems critically assist in the implementation of sustainable energy sources. However, energy performance, water use, and greenhouse gas emissions have received less attention, especially for arid climates. This study presents and compares 13 different energy storage methods, namely, compressed air, pumped hydro, hot water storage, flywheels, hydrogen, molten salt, ammonia, Zn-air battery, lithium-ion battery, redox flow battery, supercapacitors, fuel cells, and superconducting magnetic storage in terms of energy density, water usage, temperature degradation, and location dependency to be implemented in hot arid regions. The highest rankings for energy storage techniques are Zn-air batteries, superconductors, and flywheels, with overall rankings of 7.18, 6.73, and 6.61. By conducting thermodynamic analysis, the energy efficiencies are obtained for the considered energy storage methods. It varies between 10.9% and 74.6% for some systems; also, source-to-electricity efficiencies were calculated. A life cycle assessment study is conducted to evaluate and compare the environmental burdens associated with selected three energy storage systems: compressed air energy storage, vanadium redox flow battery, and molten salt thermal storage. The redox-flow battery has the highest global warming potential of 0.121 kg CO2 eq./kWh. The system with the least harm to the ozone layer is the compressed air energy storage unit valued at 7.24 × 10−13 kg R11 eq. Using solar photovoltaics for energy storage inputs was shown to lower the associated environmental impacts critically. The overall sustainability index values for the molten salt, compressed air, and redox-flow battery are 90%, 43%, and 33% when solar energy is considered.

Hybrid liquid desiccant air-conditioning system with a direct expansion evaporative cooler

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There is a need to control air and temperature and humidity in humid regions, especially when fresh air is demanded. This study investigates the performance of a hybrid liquid desiccant (LD) air-conditioning system with a direct expansion (DX) evaporative cooler. Temperature, relative humidity, and power consumption were measured and reported using a wireless data-gathering device at the air conditioning unit's key locations. The results showed that the hybrid unit had a 34 % saving in the cooling load. In addition, the air hybrid liquid desiccant air-conditioning system with the DX evaporative cooler saved about 32% in power consumption, compared to an uncooled desiccant that saved 23%.

The "Ghout" in the Algerian Sahara desert: an agrosystem dying between upwelling and drawdown the aquifer

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The Sahara covers more than 80% of Algeria's territory. This hostile environment was almost unfit for life because of a hyperarid climate and difficulty to obtain water for watering plants. The inhabitants of the Souf region (Algeria), practiced agriculture through the creation of small basins called "Ghout". This agrosystem is characterized by the digging of a plate several meters deep until the approach of the water. The Ghout is then cultivated with date palms, these draw water through its roots which touch against the water table. With frenetic demography and the appearance of modern agriculture flush with the ground. The Ghout was faced with environmental problems, namely the rise of the water table the factor which engendered the end of the 1990s the flooding of hundreds of Ghouts, even their death. To cope with this phenomenon, urgent decisions have been taken by the State where the water evacuation network was installed. This decision was relatively successful at the beginning by reducing the water table but, with the appearance of a new crop (potato under mini-pivot) and irrational pumping of water, we are now witnessing the drawdown of the water table. (since 2012), which again threatens the Ghout system. Through this tension of the Ghout between an asphyxiating rise and a drying drawdown. These two successive observations have led to an ecological imbalance endangering an entire ingenious system that has endured since the most distant times. Our study aims to focus on the causes and results of these anthropogenic environmental imbalances.

Evaluation of thermal stability and safety of different types of commercial lithium-ion battery cells

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Understanding the heat generation of a lithium-ion battery cell is critical for performance, thermal stability and safety of battery packs and systems. In normal operation, heat generation inside the battery cell can increase temperatures and accelerate degradation process that shorten the usable lifespan. If heat generation inside the battery cell is higher than the heat dissipation, the battery can enter a thermal runaway reaction leading to severe fires and safety hazards. In this regard, we have evaluated the heat generation of five different commercial lithium-ion battery cells in charging/discharging modes at normal operation conditions. Figure1(a,b) shows the typical charge and discharge voltage profiles versus capacity. Cell types B, C and D show similar voltage profile; however, the voltage profile of cell type A is slightly different from those of the first three cells. Cell type E has very different voltage profile than others. Figure 2 shows comparison of heat generation profiles of same cells. The three cells B, C, and D have similar heat generation profiles. These cells showed the lowest heat generation profiles comparing to other two cell types. Cell type E has the highest heat generation profile. For the five cell types, the heat generation is increased sharply at the end of each discharge, which was mainly due to the dominance of the irreversible heat over the reversible heat generation. The obtained results will be further discussed in more details during the presentation.

Unmanned Aerial Vehicles and Artificial Intelligence based Inspection for Power Assets

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The rise of renewable energy demand worldwide leads to the enormous scale construction of renewable energy plants such as solar that span a vast area. This installation needs an effective and efficient way of performing asset inspections. Drones can access areas that are hard and dangerous to reach. Furthermore, it can also cover a large area at a cost-effective price. UAVs with highly-advanced sensors and AI to improve the efficiency in managing and streamlining the inspection and maintenance work is notonly to Photovoltaic but also all industries. This paper will compare the advantages of drones versus conventional methods in PV plant inspection. Equipped with advanced IoT devices e.g. thermal imaging, the capabilities of drones increase significantly. Analysis on how much time will be reduced in a solar sector inspection via thermal imaging vs time taken to identify overheating and faulty solar panels will be detailed. With AI, the entire process becomes faster. The method of acquiring data from the sensors, which is an autonomous process and then analyzed by AI, will be described. The accuracy of AI detection being at 90% or better, where it has the capability of detecting defects on the assets autonomously, will be presented. How AI can autonomously generate a comprehensive report upon completing its mission will be described. This capability helps the asset owners to make informed decisions at the earliest sign of potential problems, hence reducing or eliminating the delays in making decisions to such extend that can cause damages to the assets.

Rational Design and Post-Synthetic Functionalization of Porous Metal-Organic Frameworks (Porous-MOFs) for Carbon Capture and Utilization

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The occurrence of an extreme concentration of carbon dioxide (CO_2) in the atmosphere needs to be removed with appropriate techniques including bring CO2 emissions at minimal level sources such as industrial plants through carbon capture technologies, storage and conversion of the captured CO2 into non-polluting value-added products such as fuels, cement and other useful organics. The efficient and viable techniques for CO2 capture are highly required and the existing technologies and methods involve the chemical reactions that absorb CO2, but they have many drawbacks.1 Since last two decades to establish porous type functionalized MOFs as the most sought-after class of new-generation materials. One of the primary challenges that plague the translation of porous MOFs into porous materials suitable for market use is their water-influenced degradation, hydrolytic instability, and moisture sensitivity.3 Hydrophobic MOFs offer one of the most promising solutions which can enable these porous materials to control their functionalization driven chemical and physical properties even under extremely humid conditions that materials should necessarily provide the efficient applications. In this contribution, our presentation will focus on the state-of-the-art rational design, synthesis of porous MOFs, and their post-synthetic functionalization of porous MOF-derivatives. These newly functionalized porous MOFs are characterized by analytical and spectroscopic methods. A brief overview of the structure-property correlation aspects in each of these promising hydrophobic MOFs will be covered by validating outputs of molecular modeling along with experimental outcomes.

Computational insights on the reaction of methanol, methyl mercaptan in Zeolites

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There are many techniques to produce olefins and aromatics (benzene, toluene and xylene) most of which have methane as feedstock or through Fischer-Tropsch (FT) process. With the recent fuel price fluctuations; it became crucial to develop processes for direct and indirect conversion of methane into value-added products to increase the benefit of the natural gas reserves. One of the promising technologies and mostly investigated for methane conversion to olefins and aromatics is called oxidative coupling of methane (OCM). It works by the combustion of methane with pure oxygen or air. In this talk, we will introduce a new technology based on a non-oxidative coupling of methane utilizing sulfur as radical for methane conversion to added-valuable products, specifically olefins and aromatics, as well as to remove toxic impurities (H2S). Aided by Density functional theory (DFT) calculations, we will give insights on the reaction of methanol, methyl mercaptan and H2S molecules with clusters representing the reactive site of the cavity Zeolite catalysts. We will also report on the results of reactive force field molecular dynamics simulations on large periodic Zeolites systems. Finally, we will discuss the interplay between the reactivity of the catalyst and its geometrical properties such as pore size, morphology and the access to the active sites.

A Hybrid Machine Learning Framework for Analyzing Solar PV Adoption

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From the economic and environmental perspective, the use of solar energy for the production of electricity will yield significant savings of fossil fuels used for electricity production. For oil and gas rich countries, these savings can be repurposed for additional trade on the international gas market, used to develop a downstream industry based on gas-to-solid value-added products, or left untapped to extend the lifetime of the country's natural gas reserves and lower extraction costs. For countries, which rely, heavily of oil and gas imports for energy productions, the use of solar energy would help reduce trade costs and increase energy independence. In either case, the use of solar energy in place of fossil fuels to generate electricity would lead to significant reduction in CO2 emissions. To keep up with the complexity of decision making in the adoption and selection of renewable energy strategies, it is necessary to combine MCDA with simulation approaches that capture the dynamic aspect of alternative energy strategies. The approach described in this paper proposes to do so by using a Bayesian approach to MCDA to analyze simulation data generated via Agent-Based Modeling (ABM). The figures in the attached file describe some experimental results obtained when applying machine learning techniques to analyze solar PV adoption.

Connection reliability for environmental remote sensing applications in Qatar

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Remotely located ground-based measurements are needed in several environmental applications to monitor parameters continuously or during a field measurement campaign. For these applications, wireless data transmission is mainly used to collect and process the measured data. In this work, we evaluate the connectivity from a local cellular providers to transmit the data from a network of solar stations to a central server. 6-month of data obtained from twice-a-week visits to 13 solar monitoring stations (Figure 1) distributed throughout the State of Qatar was investigated. The data was analyzed in terms of the intensity of the signal strength reported by the data logger at the site as well as the lag in receiving the collected solar data at our server in the Education City (Doha). No correlation was found between the strength of the signal and the number of days of delay. For instance, Alkaraana station is located in a rural area and has a signal mostly at 100% intensity. On the other hand, Al Khor station is located near residential areas and reports less than 50% signal most of the time. However, several factors have been reported in previous studies that would impact the reliability of the signal, such as failure in GPRS communication, and equipment failure; among others. To this end, long-term data collection is required in order to implement a data flagging system to identify, differentiate and quantify different types of errors.

Qatar Seawater Characteristics; an Observatory Approach

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Qatar surface area is 11,651 km2 including several small islands in the Arabian Gulf with 99% dependency on desalinated water, and 1% derived from ground water. In order to achieve one of the Qatar National Vision 2030 and National Development Strategies, this study aims to characterize and observe the seawater (SW) resources in Qatar, estimating the heavy metals intake and the risk from different pathways of water consumption, measuring the physical parameters, and naturally occurring radioactive isotopes in SW. Total of 154 samples were collected from 81 locations across Qatar covering all seashores during the period from September 2018 until December 2020. The samples were collected at three depth levels from surface water as the follow 1, 4 and 10 meters. In addition, at different distances, 1km from seashore border of Qatar up to 6 kms. The samples were collected on two steps 1) from the surface by hand and 2) using Niskin bottle for collecting at 4 and 10 m depth. The samples were analyzed for (electric conductivity, pH, TDS, Turbidity, anions and cations, heavy metal trace elements and radioactivity elements) using IC-thermo scientific-Dionexx ICS-5000, ICP-OES, ICP-SFMS and high-resolution gamma-ray spectrometry. It was observed that, the seawater salinity peaked in the west and south-east area of Qatar with 80.8 mS/cm, where the water flow is laminar. In addition, the heavy metal and NORMs concentrations were mostly below the potential hazard limit. The complete SW atlas characteristics will be presented in the conference with insights about the critical parameters.

Emissions and Energy Consumption: An Environmental Perspective in Middle East

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Traditionally relying on available natural resources, nations worldwide are facing the endeavor to provide enough energy to industry and society by utilizing environmentally-friendly energy sources. Even fossil fuel-dependent countries in the Middle East are currently searching by diversifying energy generation as the rest of the developed and industrialized world. Consequently, this will reduce the heavy reliance on the combustion of fossil fuels for power generation. Currently, the region is among the biggest producers of carbon dioxide (CO2) per capita. In such context, several gulf cooperation council (GCC) countries have launched nationwide programs in the so-called Middle East 2030 vision to emphasize alternative green energy sources such as solar and wind. An environmental perspective in this work aims to highlight the growth of energy consumption in the Middle East and its impacts on CO2 emissions. Then, we discuss the Kaya identity, an index that compares economic development and emissions to benchmark higher and lower CO2 emitters worldwide using regression analysis on population, gross domestic product per capita, energy intensity, and carbon intensity. The results show that the countries with the higher release of CO2 by the Kaya identity index count on economic expansion with minimal environmental concerns. In contrast, the lower CO2 polluters formulate strategies to maximize the energy mix and flourish their economy by considering the environmental impacts of CO2 emissions. Although Middle East countries are pushing national programs to reduce CO2 emissions, they are still figuring amongst the highest emitters in absolute numbers, carbon intensity, and the Kaya identity.

Sustainable Liquid Natural Gas (LNG) Value Chain: Towards the Energy Transition

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Although liquid natural gas (LNG) is considered a fossil fuel, its utilization must increase in the next decades by its reduced carbon content (mostly in the form of CH4) and higher efficiency during the combustion in comparison with coal and crude-oil distillates. The energy transition from heavy fossil fuels to renewables will depend on LNG in an initial stage since solar, wind, biofuels, nuclear, or any kind of renewable energy cannot supply the current and the long-period demands of industry and society. However, measures to obtain a sustainable value chain for the expansion of the production, processing, transportation, and utilization of LNG can be reached. First, the megaproject investments to enlarge the assets must follow a precision engineering management and optimal capacities and networks of the equipment installations. Second, for the better operation of such assets, it is mandatory a wide optimization of the units and segments of the value chain, mainly in the natural gas conditioning (treatment), separation in its pure components, and finally in the liquefaction. In the latter, huge expenditure of electricity is demanded to reduce the pressure of the mix refrigerant stream that once depressurized takes energy from the natural gas, transforming it to its liquid phase. Solar panel installations may be a viable alternative to cope with the huge demands of electricity in the compressors. Additionally, losses of boil-off gas during the LNG shipping can be reduced by an optimal operation or totally mitigated by using LNG as a propulsion fuel for the vessels.

Qatar Groundwater Characteristics, an Observatory Approach

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Groundwater (GW) is the main source of water for irrigation in the Qatari farms, where Qatar has more than 8,500 wells. This study presents a most recent overview of the status of Qatari GW characteristics compared to the comprehensive study conducted by Schlumberger Water Services (SWS) in 2009. Total of 87 samples were collected during the period from August 2020 until June 2021. The samples were analyzed for (electric conductivity, pH, TDS, Turbidity, anions and cations, heavy metal trace elements and radioactivity elements) using IC-5000, ICP-OES, ICP-SFMS and HRGRS. It was observed that, the pH values were within the standards set by the WHO, USEPA and Qatar guidelines for drinking water, while the total dissolved solids (TDS) values exceeded peaking at 22,650 mg/l. The level of Boron, Molybdenum and Lithium were exceeded the standards as well. The concentrations of boron in some samples exceeded Qatar and WHO drinking water guideline of 2.4 mg/L (WHO, 2011; KAHRAMAA, 2014). Moreover, the comparison of the results from this work to Schlumberger's results have shown that quality of the Qatari GW is deteriorating due to the extreme over pumping and the low recharge rate. The results from this work can help in better understanding and managing the GW resource in Qatar, which is extensively used in agriculture, in order to extend its presence as a strategic, clean and vibrant resource for water for the country. The complete GW atlas characteristics will be presented in the conference with insights about the critical parameters.

Magnesium carbonates as efficient materials for heavy metal removal in water: synthesis, morphological analysis, and spectroscopic characterization

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Magnesium carbonates can be found naturally as mineral rocks on Earth but they can also be produced by chemical reactions. They are widely used in industry for their applications in construction and pharmaceutics. Recently, magnesium carbonates have also been adopted as efficient adsorbents for the removal of pollutants from water. To date, the work conducted about this topic is somehow limited and there is still a lack of comprehensive understanding of the adsorption mechanism, as well as of a detailed estimationofremovalefficiency. In this work, we investigate the heavy metal removal efficiency of two magnesium carbonates, prepared via carbonation of magnesium chloride aqueous solution, specifically nesquehonite and non-indexed magnesium carbonate. The surface morphology and thermal stability of the yielded solids were characterised by SEM microscopy, FT-IR and XRD spectroscopy, and TGA analysis. The prepared materials have been adopted for the removal of copper (II), iron (III), and cobalt (II) ions from water. This part was conducted by employing UV-Vis spectrophotometry in order to investigate the metal removal efficiency (%R) upon adsorption. The removal of copper and iron ions achieved the highest values, which exceeded 98%, while the maximum %R obtained for cobalt ions reached 86%. In all the cases, the non-indexed magnesium carbonate outperformed the removal efficiency of nesquehonite. Here we demonstrate that magnesium carbonate can effectively remove various pollutants in water, like heavy metal ions, and thus it could be suitable for water treatment applications in industry.

Evaluation of sugarcane bagasse as a carbon source for the growth of garden soil yeast

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Biodiesel is considered a "carbon neutral" fuel, as any carbon dioxide released from its burning was previously captured from the atmosphere during the growth of the vegetative crop. This study evaluates lipid production by oleaginous yeast from agro-industrial waste, sugarcane bagasse which is ultimately used for biodiesel production. The isolates was cultivated in sugarcane bagasse media and then stained with the Sudan Black to check lipid-producing capability. Lipid accumulation in microorganisms has been well studied. The maximum lipid contents obtained from industrial effluent I4 and grassy soil G4 which is 93.03g/l and 87.07g/l, respectively. The dry mass concentration of I4 and G4 is 9.33g/l and 8.67g/l and optical density of same isolates were shown significant and maximum results up to 1.85 and 1.82 respectively. This study estimates lipid production requires a medium with an excess of sugars or agro-industrial based carbohydrates such as xylose, glucose, fructose etc. under limited nitrogen contents.

Development of a novel multi-physics model for plasmonic Schottky solar cell and beyond for light-harvesting toward high optoelectronic performance

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Solar cells under advanced light management configurations have engaged extensive attention owing to their capacity in achieving cost-effective solar energy utilization. However, in these devices, thermal effects such as self-heating and light-induced heating which may constrain the output performance dramatically. In the specific scheme of plasmon-enhanced solar cells, metal nanoparticles associated with the local surface plasmon resonance (LSP), aiming at triggering a highly confined electric field and large scattering cross-sections (σ), are associated with parasitic ohmic losses that consequently undergo local temperature rising, thereby altering the photoelectric conversion efficiency and impact the stability of solar cells. Modeling of plasmonic solar cells (PSC) is critical for operating conditions optimization of optical-electrical-thermal performance. For this purpose, a novel multi-physics model for plasmonic Schottky solar cell (PSSC), decorated with gold nanoparticles (Au-NPs) onto a thin silicon absorber, is developed. Notably, the modeling framework presented here unique as no multi-scale multi-physics model is available for coupling optical, electrical, and thermal response of PSSC, simultaneously. For optimal electrical performance, parametric analysis is conducted for variable system sizes, namely (3×3, 5×5, 7×7), and radii of NP varying from 10 to 150 nm. Total spectral heat absorbed is obtained by integrating total spectral heating from 300 nm to 1200 nm. The optimum performance for a device, with 70 nm radius and 5x5 NPs array, revealed a maximum short circuit current gain of about 47 % compared to bare silicon solar cell. However, this electrical boost is opposed by significant thermal gains in NPs, up to 182.5 %.

Solar Radiation Mapping Using GIS based Interpolation

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Solar radiation resource assessment is essential for identifying the solar radiation potential on earth surface. Apart from other factors such as availability of land and slope of the location, knowing the amount of solar radiation falling on that location is the major part for identifying the suitable site for installation of solar PV and solar thermal plant. Generally, solar radiation distribution on land surface is represented by GIS mapping. This study is carried out to create solar radiation maps for QATAR. The common methods used to create solar maps include spatial interpolation or extrapolation of time series of ground measured solar data, if available with optimal distribution and proper maintenance of ground stations. When ground observations are not available, satellite-derived solar data are used instead. The spatial distribution of ground solar radiation measurement station is comprehensive in Qatar hence, to test the hypothesis, EB-Kriging, one of the interpolation method is used here to prepare solar potential maps of Qatar and evaluation is carried out on the basis of leave–one–out cross-validation method. For the 13 points locations of the ground stations, Global Horizontal Irradiance (GHI) monthly average values are retrieved from ground measurements and from HelioClim-3 solar radiation database. Maps are prepared using EB-Kriging technique. The NRMSE is 3.16% and 1.5% for satellite and ground data respectively. However, Helioclim-3 data shows NRMSE of 8.79% when compared with ground observations. It is concluded that the proposed kriging method is valuable for solar radiation mapping.

Novel insights into the nanoadsorption mechanisms of crystal violet using nano-hazelnut shell from aqueous solution

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This paper discusses the nanoadsorption mechanisms of crystal violet (CV) using a nano-hazelnut shell (nano-HS) from an aqueous solution. The effect of various factors such as pH, temperature, and initial CV concentration on the adsorption process was also evaluated. The physical and chemical characterizations of hazelnut shells (HS) and nano-HS were studied using Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), and transmission electron microscope (TEM). Various functional groups including –OH, C—O, C–H, and C–O were identified that are facilitated the CV sorption onto the adsorbents. Additionally, the SEM revealed the adsorbents as a heterogeneous structure with deep cavities and high porosity, which is thought to play a vital role in capturing and binding the CV ions onto the surface of the adsorbent. The optimum pH in this study was reported to be 10. While Langmuir isotherm was identified as the best-suited model to describe the adsorption process, with a 93% and 96% correlation coefficient for HS and nano-HS, respectively. 181.82 mg/g was the maximum adsorption capacity for HS and 294.12 mg/g for nano-HS at 45 ◦C. Additionally, the positive value of changes in enthalpy for HS (21.912 kJ/mol) indicated the reaction was endothermic while the negative value (47.541 kJ/mol) for nano-HS signifies that the CV adsorption onto was an exothermic reaction. The Gibbs free energy was found to increase with smaller nanoparticle sizes. On the other hand, the effects of particle size on the enthalpy and the entropy were increased.