Research Institute of Sciences and Engineering
Office of the Vice Chancellor for Research & Graduate Studies
University of Sharjah

Issue No. 3 Academic Year: 2020/2021

Introduction

The purpose of this circular is to highlight the joint research collaboration between researchers in the Research Institute of Sciences & Engineering (RISE) at the University of Sharjah (UoS) and professionals from the Sharjah Electricity, Water and gas Authority (SEWA). In this circular, the following projects are highlighted:

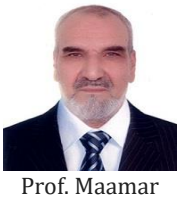
- Grey-water Reuse Policies and Practice in Sharjah
- Circulation Modeling near Al-Hamriyah Lagoon
- Spatiotemporal Analysis of Groundwater in Sharjah
- Solar Absorption Air Conditioning System in Sharjah
- Hybrid PV-thermal collector
- Demand Side Management Using Hybrid Power Systems
- Techno-Economic and Environmental Analysis of Drinkable Air Systems Under Hot and Humid Weather Conditions in Sharjah

Previously, a research chair position in the name of SEWA was established at UoS to support research and educational activities related to energy, water and environmental protection. As an addendum to the agreement and following discussions, a number of projects were agreed between the two parties in the areas of water and energy. The coordinators of collaboration and the chair position from the two parties are:

1. Prof. Abdallah Shanableh, from UoS
2. Eng. Mayyada AlBardan, from SEWA

H.E. Prof. Hamid Al-Naimiy, Chancellor of UoS

H.E. Saeed Sultan Al Suwaidi, Chairman of SEWA



Prof. Maamar Bettayeb, Vice Chancellor for Research & Graduate Studies, UoS

Eng. Mayyada Al Bardan

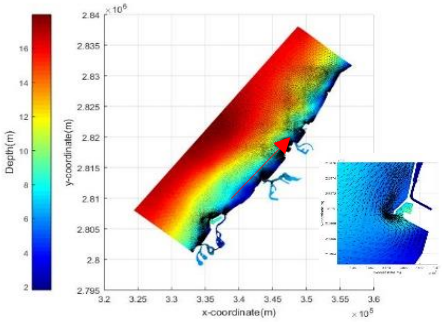
Prof. Abdallah Shanableh

Joint UoS and SEWA Projects
Circulation and Water Quality Modelling in and Around the Al-Hamriyah Lagoon (Sharjah)
Spatio-Temporal Analysis of Ground Water in Sharjah
Greywater Reuse in Sharjah - Policies and Practice
Solar Powered Absorption Chiller Air Conditioning System
Hybrid PV-Thermal Collector
Demand Side Management Using Hybrid Power Systems
Techno-Economic and Environmental Analysis of Drinkable Air Systems Under Hot and Humid Weather Conditions in Sharjah

Circulation and Water Quality Modelling in and Around the Al-Hamriyah Lagoon (Sharjah)

Dr. Mohsin Siddique (PI), UoS

Hamriyah desalination and power plant is located on the coastline along Al-Hamriyah City in the Emirates of Sharjah. To supply water for the plant, an intake structure inside a purpose-build lagoon, called Hamriyah Lagoon. Hamriyah lagoon is connected to the Arabian Gulf where the water is exchanged between the lagoon and the Gulf. The plant has been reported to experience biological fouling related issues. A recent autopsy of membrane sample, that is included in the Hydronations SWC5 reverse osmosis (RO) system of plant, confirmed the presence of foulant layer. A joint team from the University of Sharjah (UoS) and SEWA was established to develop a comprehensive 2D hydrodynamic and water quality model using Delft3D software to understand the hydrodynamics and water quality in/around the Hamriyah lagoon with the goal to identify the causes of biological fouling and make recommendations that could improve the plant operation.



Flexible mesh (unstructured) of study area.

Project Outcomes to Date:

Publication

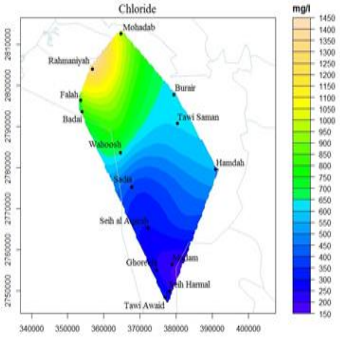
- ✓ Hydrodynamic and water quality modeling of Sharjah-Ajman coastline: A case study of circulation around Hamriyah Power and Desalination plant seawater intake (in preparation)

Acknowledgment:
This work is supported by a special UoS/SEWA Collaboration Grant # (19020401127-SEWA).

Spatio-temporal Analysis of Ground Water in Sharjah

Dr. Abdallah Gokhan Yilmaz (PI), UoS

Groundwater is an essential source of water in Sharjah, which is located in one of the most water-stressed regions in the world. Sharjah is highly dependent on desalination and groundwater to satisfy rapidly increasing water demand. Therefore, a joint team from the University of Sharjah (UoS) and SEWA was established to analyze groundwater level and quality for sustainable management of groundwater resources. Comprehensive analysis of available groundwater data provides information on Spatio-temporal changes in groundwater level and quality, leading to a better understanding of groundwater problems in the region. Given the fact that groundwater is a key resource for freshwater supply in the UAE and Sharjah Emirate, the outcome of this research is anticipated to contribute to sustainable groundwater management in Sharjah. Therefore, this project aligns with SEWA's strategic water management plan for the upcoming years.



Chloride spatial analysis map in 2017

Project Outcomes to Date:

Publications

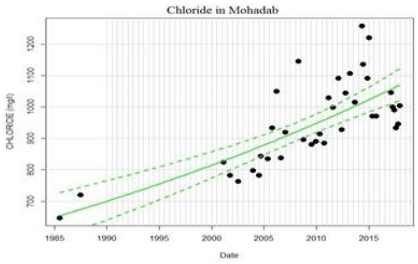
- ✓ Yilmaz, A. G., Shanableh, A., Al-Ruzouq, R. I., & Kayemah, N. (2020). Spatio-Temporal Trend Analysis of Groundwater Levels in Sharjah, UAE. International Journal of Environmental Science and Development, 11(1).
- ✓ Kayemah, N., Al-Ruzouq, R., Shanableh, A., & Yilmaz, A. G. Evaluation of Groundwater quality Using Groundwater Quality Index (GWQI) in Sharjah, UAE. E3S Web of Conferences. (Accepted).

- ✓ Yilmaz, A. G., Shanableh, A., Al-Ruzouq, R. I., Idris A., & Kayemah, N. (2020). Spatio-Temporal Trend Analysis of Groundwater Quality Data in Sharjah, UAE. Water, (revised submission is under review).

Training of MSc Students

MSc Thesis "Development of Groundwater Quality Index Considering Hydro-chemical Factors and Spatial Variations in Sharjah, UAE", Student: Eng. Naseraldin Kayemah

Acknowledgment:
This work is supported by a special UoS/SEWA Collaboration Grant # (19020401122-SEWA).



Graphical illustration of trends in chloride at Mohadab well field

Grey-water Reuse in Sharjah - Policies and Practice

Sharjah is highly dependent on desalination for water supply in urban areas, which comes at significant financial and environmental costs. Therefore, reducing the demand for water is a strategic objective of the Sharjah Electricity, Water and Gas Authority (SEWA). Residential water conservation and greywater recycling (GWR) are potentially feasible options for reducing water demand and wastewater generation. In 2004, SEWA became the first authority in the region to demand greywater reuse from large consumers, such as shopping centers, government buildings, and hotels. The program however faced some difficulties related to policies, technologies, and implementation. A joint team from the University of Sharjah (UoS) and SEWA was established to assess the Sharjah's GWR program, including policies, technologies, and implementation, and propose appropriate modifications and improvements.

Prof. Abdallah Shanableh (PI), UoS

Greywater Treatment System Installed in UoS students' Dorm

Project Outcomes to Date:

Publications

- ✓ "Greywater reuse policies and practice in the city of Sharjah, United Arab Emirates." In Proceedings: 10th Int. Conf. on Water Sensitive Urban Design (WSUD 2018), pp. 321, Perth, Western Australia
- ✓ "Greywater reuse experience in Sharjah, United Arab Emirates: feasibility, challenges and opportunities." Desalination and Water Treatment, V. 179 (2020): 211-222.
- ✓ "Feasibility and Impact of Greywater Recycling in Four Types of Buildings in Sharjah, United Arab Emirates." 2020 3rd International Conference on Environment and Ocean Engineering (ICEOE 2020) (Accepted).
- ✓ Shanableh et al. (2021), Assessment and Reform of Greywater Reuse Policies and Practice in Sharjah. Water Policy Journal, doi: https://doi.org/10.2166/wp.2021.205

Revised Greywater Reuse Policy Proposal for Sharjah:

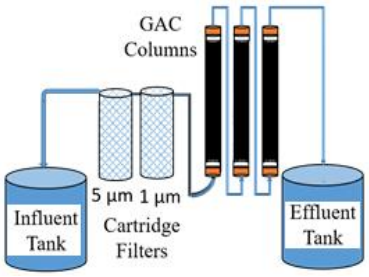
- ✓ Proposal for revised grey-water policies in Sharjah

Training of MSc Students

- ✓ MSc Thesis "Appropriate Greywater Treatment Technologies for Sharjah", Student: Eng. Adel Tayara

Installation of Pilot-Scale Greywater System

- ✓ Installation of a 1 m^3/d pilot-scale grey-water treatment system in the students' dorms in UoS



Experimental Greywater Treatment System Assessed in UoS Laboratories

Acknowledgment:
This work is supported by a special UoS/SEWA Collaboration Grant # (18020401116-SEWA).

Solar Powered Absorption Chiller Air Conditioning System

Dr. Chaouki Ghenai (PI), UoS

Future energy demand in the UAE will increase due to population growth, economic activities and high consumption rates. This is not sustainable in the long term. Based on the latest estimates from the UAE Ministry of Energy, there is 9% increase annually of the demand of energy in the UAE. The UAE's energy sector is undergoing a major transformation targeting diversification of UAE's energy mix – increase the penetration of renewable (solar) and nuclear energy in the energy mix and the deployment and intensification of energy efficiency efforts. The development of sustained energy efficiency strategy will help to slow the growth of energy consumption. The energy consumption in UAE buildings mainly in air conditioning accounts for about 60-70% of the total energy of the building. The challenge is to design and build houses and buildings of low energy consumption that suits the gulf environment in general and UAE in particular. The UAE weather is a challenge for building designer because of the high temperatures and high humidity in summer. The main objective of the proposed research study is to design a solar thermal absorption cooling system with 10 tones capacity in Sharjah. The study will include (1) simulation and modeling analysis to optimize the solar cooling system; (2) set up and test the performance of the system under Sharjah weather conditions; and (3) determine the conditions to achieve and maintain cooling conditions (temperature, humidity, cleanliness and distribution) to meet the requirement of the conditioned space.

Solar Air Conditioning System Installed in the roof of W12 Central Laboratory

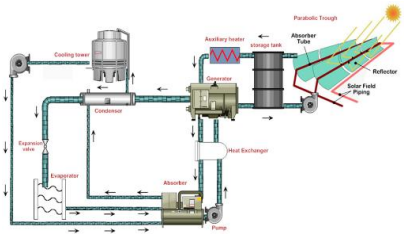
Project Outcomes to Date:

Publications

- ✓ "O Rejeb, C Ghenai, M Bettayeb, Modeling and simulation analysis of solar absorption chiller driven by nanofluid-based parabolic trough collectors (PTC) under hot climatic conditions, Case Studies in Thermal Engineering, Volume 19, June 2020.
- ✓ " C Ghenai, O Rejeb, M Bettayeb, Performance of Solar Lithium Bromide Water Absorption Air-Conditioning System for a Conference Hall in Hot Desert Climates, IEEE, 2019.
- ✓ Ghenai and T. Salameh, Sustainable Air Conditioning Systems, Book, ISBN 978-1-78923-301-8, Publisher: Intech, 2018.
- ✓ C. Ghenai, O. Rejeb, and M. Bettayeb, Performance of Solar Lithium Bromide Water Absorption Air-Conditioning System for a Conference Hall in Hot Desert Climates, International Conference on Modeling and Simulation and Optimization, Bahrain, April 2019.

Installation of Pilot-Scale Solar Powered Absorption Air Conditioning System

- ✓ Installation of solar PTC (30 parabolic troughs), 10 tones cooling capacity (150 m^2) in the roof of W12 building, University of Sharjah.



Experimental Set Up – Solar Powered Absorption Chiller Air Conditioning System

Acknowledgment:
This work is supported by a special UoS/SEWA Collaboration Grant Ref. (V.C.R.G./R. 1374/2017).

Hybrid PV-thermal collector

Dr. Ahmed Amine Hachicha (PI) UoS

Following the strategic vision of the UAE towards implementing alternative sources of energy, the study of hybrid PV-thermal collector may help to increase the penetration of renewable energy and harness more solar energy for water heating and electricity applications. Hybrid PV-thermal collector is a promising technology that combines both technologies: PV and solar thermal collector in one compact design to produce electricity and hot water at the same time. In this project, the main purpose is to explore the maximum

potential of this solution under UAE conditions using different cooling strategies. Therefore, a unique all in one installation that includes various cooling strategies (front/back cooling, nanofluids, PCM) has been designed using an innovative hybrid PV-thermal collector. The project involves the study of dust effect and predict the soiling losses in PV technology which is considered one of the major challenges of implementing such technology under UAE weather conditions.

Project Outcomes to Date:

Publications

- ✓ Hachicha, A.A., Al-Sawafta, I. and Said, Z., 2019. Impact of dust on the performance of solar photovoltaic (PV) systems under United Arab Emirates weather conditions. Renewable Energy, 141, pp.287-297
- ✓ Hachicha, A.A., Al-Sawafta, I. and Hamadou, D.B., 2019. Numerical and experimental investigations of dust effect on CSP performance under United Arab Emirates weather conditions. Renewable Energy, 143, pp.263-276.
- ✓ Said, Z., Arora, S. and Bellos, E., 2018. A review on performance and environmental effects of conventional and nanofluid-based thermal photovoltaics. Renewable and Sustainable Energy Reviews, 94, pp.302-316.
- ✓ Gupta, M., Singh, V., Kumar, S., Kumar, S., Dilbaghi, N. and Said, Z., 2018. Up to date review on the synthesis and thermophysical properties of hybrid nanofluids. Journal of cleaner production, 190, pp.169-192.

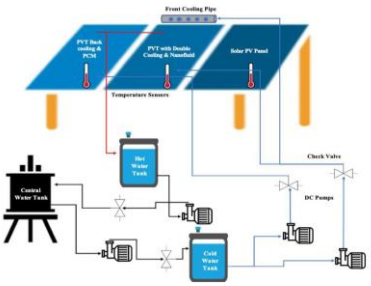
Senior design projects at UOS related to the project:

- ✓ Evaluation of an innovative PV-Thermal collector under UAE weather conditions. Hamdan Mohamed, Ali Alkhoori and Majid Almehiri.
- ✓ Energy and Exergy efficiency of a photovoltaic thermal system (PVT) using industrial grade MWCNTs based nanofluids. Mariam Salim, Aya Majeed and Kholood Khalili.
- ✓ The Effect of Dust on Solar Systems and Dust Mitigation Methods. Israa Al-Sawafta, Deema Emadaldin and Zainab Al Hashimi.

Installation of an innovative Hybrid-PV thermal collector using different cooling strategies

Installation 3 DualSun Hybrid PV-thermal collectors using different cooling strategies (front/back cooling, nanofluids and PCM) including an immersed coil heat exchanger for nanofluids and a cooling unit to maintain a continuous operation of the system.

Hybrid PV thermal collector installed on the rooftop of W 12 at UOS



Experimental setup of hybrid PV-thermal collector with different cooling strategies

Acknowledgment:
This work is supported by a special UoS/SEWA Collaboration Grant # (1702040683-P).

Demand Side Management using Stand-Alone Hybrid Power Systems

The location of Sharjah is closed to equator region, this make the Emirate of Sharjah has high potential of solar energy during the year. The solar energy can be used for many applications depend on the conversion of solar energy to thermal energy or electrical energy as in solar heater, solar cooler, concentrated solar power plant (CSP) and photovoltaic. There for the hybrid system used in UAE must include at least one of these applications for solar energy work together with another nomination type of renewable resource. In this study, the simulation will perform for similar condition load in Sharjah,

Dr. Tareq Salameh (PI), UoS

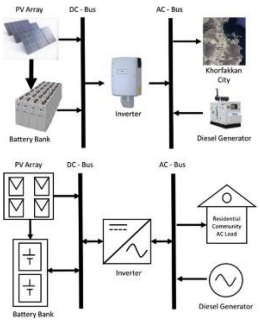
where the weather data and load will consider in order to know how the hybrid system will cover the energy demand and reduce the energy cost and carbon foot print.

Project Outcomes to Date:

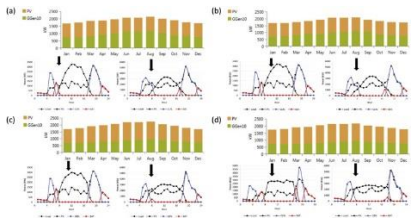
Publications

- ✓ Tareq Salameh, Chaouki Ghenai, Adel Merabet, Malek Alkasrawi, Techno-economy optimization of integrated stand-alone hybrid solar PV tracking and diesel generator system for Khorfakkan in UAE, Energy Journal, Energy Volume 190, 1 January 2020, 116475.
- ✓ Tareq Salameh, Mohammad Ali Abdelkareem, A.G. Olabi, Enas Taha Sayed, Monadhil Al-Chaderchi, Hegazy Rezk, Integrated standalone hybrid solar PV, fuel cell and diesel generator power system for battery or supercapacitor storage systems in Khorfakkan, United Arab Emirates, International Journal of Hydrogen Energy, Available online 15 September 2020.
- ✓ An Effective Energy Management Strategy for AC/DC Hybrid Microgrid
- ✓ (Under Review)

Acknowledgment:
This work is supported by a special UoS/SEWA Collaboration Grant # (1702040681-P).



Proposed HES for the city of Khorfakkan, UAE



Monthly and daily average power outputs of HES for all proposed cases: (a) fixed, (b) CHA, (c) CVA, (d) dual-axis tracking.

Techno-Economic and Environmental Analysis of Drinkable Air Systems Under Hot and Humid Weather Conditions in Sharjah

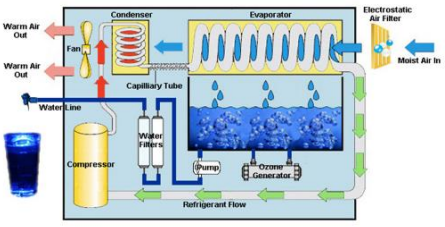
The University of Sharjah (UoS), Sharjah Electricity and Water Authority (SEWA), and Drinkable Air Company are proposing to develop a collaborative research project on the performance and optimization of Drinkable Air units (water production from humid air) under Sharjah weather conditions. The amount and quality of water production; the energy consumed by the system; the design, performance and optimization of renewable and clean energy system (solar PV) for drinkable air system, forecasting of the water production using training data and Sharjah input weather conditions, and economic (cost of the water production) and environmental analysis will be investigated in this study.

The main objective of the research study is to test the performance (quality and quantity of water production, specific energy consumption kWh/m^3) of the C3, C8, and C60 drinkable air systems under Sharjah weather conditions and to develop forecasting model for water production.

The project goal is to develop sustainable system to produce fresh and clean drinking water from humid air using renewable and clean power system (water-energy nexus).

Dr. Chaouki Ghenai (PI), UoS

Prof. Abdallah Shanableh (PI), UoS



Schematic of the Drinkable Air System

Project Outcomes to Date:

- ✓ Preliminary testing of the C3 and C8 units at the UoS humidity testing chamber.
- ✓ Visit of SEWA chairman to the UoS and presentation of the project in Sharjah TV – Akhbar Adar.

Acknowledgment:
This work is supported by a special UoS/SEWA Collaboration Grant # (18020401117-SEWA).