Theme 6-2: Renewable Energy and Power Systems - 2023

Title	Name of the PI	List the Names of the Co-Is	Department	Abstract	Starting Date	Ending Date	Funding	Amount of Funding
MRAC Based Battery Energy Management and Cascaded FOPI Motor Controllers for the Electric Vehicle Traction System Energy Optimization	Habib ur Rehman	Shayok Mokhapadya	ELE	The energy consumption optimization of the electric vehicle (EV) traction system for improving the EV drive range per charge and sensorless controller design for reducing the EV cost and maintenance are the two main goals of this project. The first goal of energy optimization will be achieved by setting up two objectives; (i) the electric vehicle (EV) traction system energy optimization at the motor drive level, (ii) electric vehicle (EV) traction system energy optimization at the battery bank level. The second goal of EV traction system cost and maintenance reduction will be achieved by the third objective of this project that is a sensorless controller design for accurate motor/vehicle speed estimation. The first objective of energy optimization will be achieved by designing an efficient cascaded fractional order proportional integral (FOPI) based motor drive system which is expected to consume lesser power than the PI controller does. Conventionally, the field oriented control, which is widely opted for the EV motor control has two cascaded PI controllers incorporated in it. Based on the literature review and our previous findings about the performance of FOPI controller for speed regulation of a field-oriented induction motor drive system, we predict that FOPI controller will reduce the energy consumption when deployed for both the speed and current regulators. Therefore, this work will replace both PI controllers with the FOPI controllers and investigate the motor drive system energy consumption. The second objective of battery energy consumption optimization will be realized by designing a model reference adaptive controller (MRAC) to track a desired SOC discharge profile with minimal compromise on the speed control performance. For the third major objective of this work, a modified adaptive function based on the Nassbaum function will be designed for the flux and speed estimation of the induction motor. The performance of proposed estimators will be investigate for the wide speed range sensorless control of induction motor specifically the low speed estimation. The work suggested in this proposal will be evaluated through computer simulations and the actual implementation on the EV traction system set up in our Electric Machines and Power Electronics Lab.	06/01/2002	10/03/2023	FRG	348940
Employing Earth Water Heat Exchanger to reduce Power Consumption of Air-conditioning System	Mohammad Hamdan	Bassam A. Abu-Nabah; Mousa Attom; Abdul Hai Alami	MCE	Reducing energy consumption is becoming one of the main concerns for human existence. More than 60 percent of the electricity consumed in UAE during summer season is used to run air-conditioning systems. This proposal aims to reduce air-conditioning power consumption using earth water heat exchanger (EWHE). EWHE is a viable technology that can cut air-conditioning power consumption by half. EWHE utilizes the geothermal cooling capacity of underground soil during summer time. Currently many engineers are considering the use of EWHE for new construction projects or as retrofit for existing ones. Hence, a feasibility study for implementing this technology in UAE is needed. This study will explore the benefits of implementing EWHE in UAE. EWHE is made up of a single tube (or multiple parallel tubes) through which a fluid is circulated. By placing the earth tube sufficiently deep below the surface, the circulated fluid is cooled down in the summer and heated up in the winter since ground temperature always lags the surrounding temperature. The underground temperature almost stays constant around the year with smaller fluctuation temperature swing during the season compared to the ambient temperature.	01/06/2018	31/05/2020	FRG	146000
Maximizing Bifacial Photovoltaic Performance under GCC Soiling Conditions	Mohammad Hamdan	Bassam Abu Nabah	MCE	The project aims to analyze the impact of dust accumulation on bifacial photovoltaic (PV) panels. The project aims to identify the main factors affecting solar photovoltaic farm in Sharjah such as bifacial PV orientation, soil albedo and dust characteristics (material, distribution and frequency over a period of one year). The dust will be collected within Sharjah city and analyzed on a weekly bases to characterize the dust based on material, distribution, rate of accumulation, level of severity on PV, relation of dust type to weather conditions and dust stickiness to surface. The study will test the impact of dust on bifacial photovoltaic panel and on optimum tilt angle which is expected to show a major difference when compared to traditional mono-facial photovoltaic. Bifacial modules harvest solar energy from both sides of the panel. Bifacial PV panels are fabricated with a transparent back sheet or dual tempered glass unlike the opaque back sheet that used on the traditional mono facial solar panel. Bifacial modules expose both the front and backside of the solar cells to solar energy, hence the study will examine bifacial PV panels under different orientation angles to determine optimum anlage for maximum energy harvesting and minimum dust accumulation. As shown in figure 1, bifacial PV panels allow light to transmit across the PV panels which get reflected off the ground and can be collected from the other side of the PV panel.	01/06/2020	31/05/2022	FRG	133000
Developing a Novel Cooling System to Improve Photovoltaic Performance Using Loop Heat Pipe (LHP) and Metal Foam (MF) Infused with Phase Change Material (PCM)	Mohammad Hamdan	Bassam A. Abu-Nabah; Frank Gerner	MCE	Overheating of photovoltaic (PV) cells is a major issue that causes deterioration of power generation and reduces the lifespan of PV panels. To resolve the PV cell overheating issue, this work proposes a novel design to cool PV panels using loop heat pipe (LHP), metal foam (MF) and phase change material (PCM). For simplicity, the novel proposed design is abbreviated as LHP-MF-PCM cooling system. LHP is an effective cooling device that transfers heat from high temperature region to low temperature region with a minute temperature difference. LHP ability to transfer heat exceeds the ability of many high thermal conductive materials such as copper. MF is an effective way to conduct heat through a low thermal conductivity material. PCM is an excellent thermal storage technology that can remove large amount of thermal load with a minute temperature difference. A hybrid cooling system that combines LHP, MF and PCM offers an innovative way to cool PV panels. The proposal aims to build four test setups to quantify the ability of LHP-MF-PCM cooling system in cooling a PV panel. The four test setups are (1) PV panel with natural air cooling, (2) PV panel with PCM, (3) PV panel with MF infused with PCM, and finally, (4) PV panel with LHP and MF infused with PCM. Different PCM's will be evaluated to decide on the appropriateness of the PCM to be used in solar panel cooling applications. In addition, a mathematical model will be developed to predict the cooling performance and to estimate the amount of PCM needed in each experimental setup. An effective way of cooling a PV panel can improve the panel energy convergent efficiency, as well as extend the life expectancy of a PV panel. The proposed system offers a viable prospect to produce a passive cooling system that is capable of increasing solar power production while extending its service life.	01/06/2023	31/05/2026	FRG	592,550
Turbocharger Based Turbojet Engine	Mohammad Hamdan	Ali Younes	MCE	Our objective is to make a turbocharger-based turbojet engine to be available for research and testing in AUS with thrust capability of 200N. We noticed that there are no jet engines available on campus and we think that having one will add many benefits in terms of education and research. Especially that, other universities (UAEU, KU), have a turbojet engine for educational purposes. To achieve our objective, we are planning the following tasks: •Researching turbojet engines and turbochargers. •Integrating a suitable turbocharger in place of the conventional axial compressor-turbine in a typical turbojet engine. •Calculating the appropriate various parameters affecting a turbojet engine (i.e. Pressure ratios, mass flow rate, etc.…). •Running CFD simulation for the engine once the dimensions are finalized. •Having controllable fuel pump for testing different air-fuel ratios and different kinds of fuels for research purposes. •Designing a converging nozzle to achieve a maximum jet of Mach 1 (sonic).	12/12/2022	31/05/2023	URG	6000
A novel bioenergy system utilizing desalination reject brine for carbon capture and enhanced hydrogen production	Yassir Makkawi	Ondrej Masek (University of Edinburgh)	CHBE	The Gulf countries have among the highest carbon emissions per capita (~30 t/y) making it essential to introduce clean renewable energies. A significant fraction of these emissions is associated with desalination, which is vital to maintaining freshwater supplies and general daily life in the region. Due to geographical location and arid nature, the potentials of renewable energies from wind or conventional biomass in the Gulf region are limited. However, the latter can provide drop-in substitutes for conventional gas and transport fuels if a suitable biomass source can be identified. This project proposes an entirely novel approach to bioenergy production, taking advantage of the natural environment that encompasses all the Gulf region. The abundant solid organic waste and waste generated in desalination plants are utilized to develop a novel closed-loop thermochemical conversion (pyrolysis) system with CO2 capture. The proposed concept involves the utilization of seawater reject brine from desalination and locally available organic matter and wastes, namely food waste, date palm waste, sewage sludge, and halophyte Salicornia, for sustainable production of liquid biofuel, biochar and H2-rich-gas, thus making coastal arid and semi-arid regions potentially promising for modern bioenergy technology. The proposed project will benefit from the PI's recent work on the characterization and pyrolysis of some of the organic waste in the UEA and the existence of the experimental facilities and supporting instruments in the AUS labs. The preliminary results indicate high potentials of the identified feedstocks, and thus, this will constitute a great opportunity for further investigation, as proposed in this project. In the long term, the outcomes of this project are expected to contribute to the Gulf economies, moving them towards sustainable energy and water supplies with decreasing reliance on fossil fuels. Finally, this project will culminate with a series of seminars and workshops bringing together researchers and national and regional stakeholders to discuss the project outcomes and their beneficial environmental and economic impacts for future Gulf and worldwide economies.	01/06/2023	31/05/2025	FRG	709,300
Production of Acidic Biochar for Soil Application- Phase II	Yassir Makkawi	Mohamed Abdallah (University of Sharjah), Fatin Samara (AUS), Mahmoud Awad (AUS)	CHBE	This proposal is in reply to the recent call by Emirates Global Aluminum (EGA), a major aluminum manufacturing company based in the United Arab Emirates (UAE), to study the economic, environmental, and energy balance of converting local organic waste into biochar, bio-oil and biogas using thermochemical conversion (pyrolysis). The ultimate goal is to utilize the biochar in the EGA's bauxite-residue-based soil (Turba). This proposal builds on the recently completed study (Phase I) on the production of acidic biochar. In this proposal (Phase II), it is proposed to consider co-feeding, namely food waste with sewage sludge as a primary feedstock due to their proven advantages for the production of biochar with characteristics suitable for the intended application. The proposed tasks include, but not limited to, the following: •Extensive experimental campaign for the optimization of biochar production. •Life cycle assessment and the associated data collection to utilize the biosolids to produce neutral-acidic biochar. •Provide cost estimates for building a biochar plant in the UAE using a combination of biosolids as feedstock. •Provide sufficient quantities of optimized biochar for direct demonstration trials in local sandy soils and prototypes of EGA's bauxite-residue-based soil (Turba). •Demonstrate the ability of the bio-oil and gas to sustain the drying and pyrolysis processes by assessing the energy content and performance of the products as fuels. The proposed project duration is 32 months with a total budget of AED 1,542,051 (Including Indirect Cost and UAE required contract VAT). Due to the multidisciplinary nature of the proposed work, the project team will include expertise from chemical engineering (AUS), analytical chemistry (AUS) and civil and environmental engineering (AUS and UOS), in addition to UK-based experts to advise in bio-oil energy assessment (Aston University) and biochar interaction with soil (Edinburgh University). The project management will solely lie with the principal investigator from the AUS.	01/04/2022	03/12/2024	External	1,600,000
A Novel Bioenergy System for Marginal Environments	Yassir Makkawi	Mohamed Gadalla (AUS), Yehya Elsayed (AUS), Dionysia-Angeliki Lyra (ICBA), Amani Al-Othman (AUS), Ondřej Mašek (UoE-extranal)	CHBE	This project aims at developing a novel biomass conversion process using a renewable and sustainable energy source. The project falls within the AUS "Bioscience and Bioengineering research institute (BBRI)" research track on "Biomass and Biofuels". The concept involves the utilization of concentrated solar power (CSP) in delivering the energy demand of an intensive biomass conversion process to high quality biofuels (hydrogen-rich gas and bio-oil) and biochar. The biomass materials to be investigated will include Salicornia and food waste. The former is a type of halophytes that has great potentials as a feedstock for biofuel and has been field tested at large scale under the harsh desert environment in the UAE*. The latter is radially available everywhere and is in particular posing a major concern in the UAE where 38% of the food prepared daily goes into waste. While the biofuels produced can be used for electricity generation via hydrogen fuel cells, gas/steam turbines and internal combustion engines, the process by-product, which is biochar, can be highly useful in enhancing the desert soil in the UAE (fertilizer). The overall proposed concept will be built on a recent paper** and two patented concepts by the PI¥ on integrated solar thermal biomass conversion, CO2 capture and fuels upgrade. The proposed waste-to-energy conversion (WtE) concept is expected to be highly competitive to existing biomass thermal conversion methods, with a factor close to 50% improved in the overall efficiency with added advantages of addressing the environmental problems associated with waste disposal. If realized, this will revolutionize processes for thermal conversion of biomass, particularly in marginal environments of high salinity and solar radiation, such as in the Middle East and North Africa	01/06/2019	30/05/2022	FRG	700,000
Production of Acidic Biochar for Soil Application	Yassir Makkawi	Mahmoud Awad, Yehya Elsayed, Raffaell Ocone (HWU-external), Onderj Masek (UoE-external), Noha Hussein, Adil Tamimi,	CHBE	In this proposal, we aim to identify suitable local feedstocks (waste biomass) for the production of a functionalized biochar to be used in contaminated soil and soil enhancement in the UAE. This application is in reply to the recent call made by Emirates Global Aluminum (EGA), a major aluminum manufacturing company based in the United Arab Emirates (UAE). The anticipated project outcomes aim thought to benefit the EGA plan in converting their process waste (bauxite reside) into soil using biochar as amendment as well as helping the UAE in achieving the 2021 vision for waste minimization. We propose to carry out the main experimental work in the American University of Sharjah (AUS) labs using an advanced biomass pyrolysis reactor and a range of state-of-art instrumentation and techniques for biochar analysis. It is proposed to use a relatively mature biomass pyrolysis technology with innovative pre, post and in-situ biomass treatment methods in order to produce a biochar with the desired quality. It is also proposed to generate data, for the first time in the UAE, correlating the selected biomass feedstocks, the pyrolysis operating conditions and the biochar quality. Another unique feature of proposal is the potential of scaling-up the proposed biochar production method and to operate in a sustainable fashion; this will help the EGA in achieving its ultimate goal of becoming the world's first alumina producer that converts its entire bauxite residue into a valuable product. The proposed project duration is 24 months with a total budget of $189,230. The project consortium will include expertise from chemical engineering, chemistry, industrial engineering and civil engineering, including two world recognized experts in biochar from the UK Center of Biochar Resrech (UKCBR) and UK-Canada biochar network. The project management will solely lie with the principal investigator from the AUS.	01/05/2018	30/04/2020	External	650,000
Enhancement of CNG ICE Using Hydrogen From Photovoltaic-Powered Electrolysis	Mohammad Hamdan	Hadj Kerrouchi	MCE	The objective of this project is to produce hydrogen from water electrolysis unit when powered by photovoltaic panel. The produced hydrogen will be used as supporting fuel in a compressed natural gas (CNG) engine. The energy sector is still highly dependent on coal, oil, and gas. Unfortunately, these sources are causing too much damage to the environment starting from pollution, acid rains, global warming. There are mainly two effective energy generation methods that have less negative impact to the environment. Either by adopting renewable energy systems, or by improving efficiency of energy production [1]. In this project we are attempting to improve the efficiency of a compressed natural gas (CNG) vehicles by integrating PV powered Alkaline electrolyser. CNG taxi started service in UAE in 2010 and currently more than 11,000 taxi are operating in UAE roads [2]. The proposal aims to fix flexible photovoltaic (PV) panels at the roof of a car. The electric power PV converts the radiation coming from the sun to electricity, which used to chemically splitting water to hydrogen and oxygen. Using hydrogen produced from the electrolytic cell along with CNG leads to less use of the fuel and hence less pollutants emitted to the air. We have chosen CNG to be the working fluid instead of gasoline and diesel because it can form a homogeneous mixture with hydrogen and enhance the combustion process. There are many factors and reasons why we considered working on this topic. First, improving a more sustainable technology that has minimal effect on the environment. Moreover, the gradual increase of fuel prices nowadays, especially after COVID 19 pandemic make use of hydrogen more feasible than before. Finally, and most importantly, the expected project doesn't require major retrofits in engine's design, considering that the automotive industry is moving towards electric powered vehicles. The best solution currently is to improve the engines' efficiencies to make more economical and reduce pollution emissions.	29/11/2022	10/06/2023	URG	8000