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Volume 10, Issue 4, November 2018

SET 2019, 20 - 22 August 2019
Kuala Lumpur, Malaysia
Call for Papers

SET2019, the 18th International Conference on Sustainable Energy Technologies, will be held in Kuala Lumpur, Malaysia, on 20th to 22nd August 2019. The conference will be hosted by Universiti Sains Malaysia and will be held in a convention centre close to 4/5 star hotels, malls, restaurants, and bars.

Kuala Lumpur (KL) is the capital of Malaysia and is one of the fastest growing metropolitan regions in South-East Asia in both population and economic development. It has many interesting attractions such as Petronas Twin Towers, Merdeka Square, Chinatown, KL Tower and much more.

Topic areas for SET2019 cover Energy Technologies and Renewables; Energy Storage and Conversion; Low Carbon Buildings and Sustainable Cities; and Policies and Management. Go to www.set2019.org/topics for more information. Selected papers will be published in a number of international journals.

Papers should be submitted via EasyChair - a link can be found on the SET2019 website: www.set2019.org/submission-registration/submissions-2/

You could also submit your research projects to the 4th WSSET Innovation Awards (please see www.wsset.org/innovation-award-2019). Winners will be announced at the SET2019 Conference gala dinner.

All WSSET members will receive a 20% discount on the conference registration fees. Postgraduate students can also apply for a conference registration grant which will be awarded to up to 4 students. More information can be found here: www.set2019.org/submission-registration/student-travel-grant/

www.set2019.org

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Deep Farms to Revolutionise World’s Food Production

Academics at the University of Nottingham, UK have patented a new concept that would see food production in deep farms in cities. The revolutionary ideas are being promoted by University of Nottingham academics Professor Saffa Riffat, Fellow of the European Academy of Sciences and President of the World Society of Sustainable Technologies, and Professor Yijun Yuan, Marie Curie Research Fellow.

Most of food we eat is transported by train, sea and air contributing to large CO2 emissions. For each one calorie of food we eat 10 calories of crude oil are used. Projections show that feeding a world population of about 9 billion people in 2050 would require overall food production to be increased by some 70 percent between now and 2050.

Land area for traditional farming is limited and increased food supply will require more intensive methods of crop production. Deep farming technology would allow crop production all-year-round. Up to 10 crop cycles per year could be achieved compared to 1-2 cycles for conventional agriculture. Put another way, 1 indoor acre is equivalent to 4-6 outdoor acres or more, depending on the crop.

Deep Farms would eliminate the use of mechanical ploughs and other farming machinery, thus reducing the burning of fossil fuels that cause climate change. Furthermore, as Deep Farms could be located close to urban centres, CO2 emission due to transportation of crops would be reduced. This is particularly important as the proportion of people living in cities continues to rise. Over the last 20 years, the percentage of people who live in cities globally has increased from 20% to nearly 50%. Cost-effective deep shafts for intensive crop planting would be constructed using new drilling techniques as well as exploiting existing coal mine shafts, mines and tunnels, many now abandoned.

A variety of crops could be grown using hydroponic planters (plant roots fed with nutrient-rich water) or aeroponics (growing plants in an air or mist environment). LED units would enable photosynthesis in the absence of sunlight. Groundwater could be used directly or water could be condensed from ambient air in hot/humid desert climates. A major benefit of this approach is that crop production is largely unaffected by climatic or seasonal factors - one of the greatest limitations of conventional farming methods. Furthermore, being enclosed units isolated from each other, plant diseases and pests can be readily controlled with little no application of chemical biocides.

Many crops are now being grown in greenhouses and while this provides a controllable growth environment, greenhouses are heavy energy consumers. Vertical farms are a relatively recent adaptation of the traditional greenhouse and are suitable for use in cities, as their tall glass structures provide high crop yields on a small land area.

However, vertical farming systems are expensive to manufacture and install, and require a large amount of water and energy for heating and cooling. They are also vulnerable to extreme weather conditions, wars and terrorism.

Cont.
Newly constructed Deep Farms could be created as well as redundant mine shafts and tunnels could be utilised for crop production. In the UK, for example, there are over 150,000 redundant coal mine shafts.

Carbon dioxide is required for plant photosynthesis and Deep Farms are well suited for carbon capture from ambient air. The CO2 could be released to achieve the concentration levels required by plants.

Use of carbon capture systems has the added benefit of reducing CO2 concentration in the environment, as additional carbon is adsorbed in materials in the ground space. Advanced control systems including sensors and remote controls could be used to monitor crop production. Automated systems such as robots could be used for crop planting and harvesting. Electricity generated from renewable sources and off-peak power could be used to power the LED lighting for plant photosynthesis.

Deep Farms are not strongly affected by the seasons or climates, and are resistant to natural disasters, extreme weather, pests and diseases, man-made accidents and industrial pollution. In fact, the ground environment is naturally suited to the growth of plants.

Plants can thrive in an essentially closed environment with less oxygen and enriched levels of CO2 and water. So in terms of the rationality of the biological chain and the biological space, some crops are best located underground, leaving the ground surface for human and animal activities.

Deep Farms have many benefits including:

• Easily constructed using drilling machines and controlled explosion methods
• Effective use of abandoned mine shafts
• Can use absorption materials to capture CO2 from ambient
• Reduced dependency on cultivated land, climate and surface water resources
• More efficient utilization of natural resources in crop production
• Improved security of crop production and reduced impact of natural and man-made factors
• Higher yields and greater cost efficiency
• Improved control over quality and food safety
• Removal of seasonal restrictions allowing production of crops all year round
• Can be used in areas with poor natural weather conditions, e.g., cold climates, and areas with low solar insolation
• Crops can be produced in desert areas, dry and water-deficient areas
• Impact of human conflict on crop production is reduced
• Crops can be grown close to highly populated areas

It is estimated that a small Deep Farm can produce 80 tonnes of food per annum. Some of the crops can be ready for harvesting within 2-3 weeks. The amount of energy it would require is equivalent to that consumed by 3 UK homes.

Crops suited to deep farming methods include:

• Lettuces and leafy greens, such as kale and spinach
• Herbs, e.g., basil, cutting celery, chives, mint and parsley
• Roots e.g., carrots and onions
• Vegetables e.g., peppers, eggplants and cucumbers
• Fruits e.g., strawberries and different types of mushrooms

Deep Farms could be installed at various locations to create a ‘Deep Farming City’ as shown in Figure 1. This would facilitate the supply of a wide range of fresh crops to the local population.

For more information contact Prof Saffa Riffat:
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Single-layer fuel cell

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Fuel cell is a promising clean energy technology. Of the many fuel cell types available, polymer fuel cells (PEM) and solid-oxide fuel cells (SOFC) are closest to commercialization. A PEM typically operates well below 100 °C and has found interest in mobile applications, where the SOFC needs a high temperature to operate and would be best suited for stationary applications, such as power generation or auxiliary power units. SOFCs, though reaching conversion efficiencies up to 60%, still suffer from materials problems due to the high temperatures involved in the range 800-1000 °C.

The key component of a fuel cell is the ionic conductor, or electrolyte. In the case of SOFC, yttria stabilized zirconia (YSZ) has traditionally been used, which requires a high temperature to reach adequate ionic conductivity and good performance. To lower the operational temperature of SOFC and also mitigate the severe material durability problems associated, we have developed an entirely new path for preparing a fuel cell based on a solid conductor.

The material also enables to build a so-called single-component fuel cell, which differs from the 3-layer traditional fuel cell that all functionalities of a fuel cell can be achieved with a 1-layer structure.

Using a homogenous mixture of the mixed oxide semiconducting and ionic material and putting a current collector on both sides of this layer forms a fuel cell device. Depending on which side the fuel or oxidant is fed, will determine which side functions as the + or the – pole. Such a single-layer structure is potentially much easier to manufacture than present fuel cells and could open up ways for easy mass production.

The physical principle of the single-layer fuel cell is based on forming a junction through inside the fuel cell through the oxides used (heterostructures), which prevents short-circuiting and forces the electrons (current) to move through an external circuit. The oxide energy bands are aligned at the junction helping to realize charge separation and redox reactions. The electron-ion coupling effect enhances ionic conductivity and reduces the activation energy, all contributing to excellent performance. All this results in improved fuel cell performance.

Our novel fuel cell innovation is based on combining oxides (semiconducting materials) with ionic conducting material, for example a mixture of LiZnNi with samarium doped ceria (SDC). This material not only enables to lower the operational temperature down to 550 °C, but also produces a record-high ionic conductivity producing power densities beyond 1 Wcm-2.

Various new functional semiconductor-ionic materials and junction devices showing outstanding fuel-to-electricity conversion have been developed and demonstrated in laboratory scale. Next phase of work will include scaling-up of the single-layer fuel cell technology and improving its long-term stability, among others.

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The EfficientGeoTech project aims to develop a novel Ground Source Heat Pump (GSHP) package that reduces the UKs reliance on fossil fuels for space heating.

GSHPs are efficient in utilising electric power for space heating, however their widespread use is limited mostly by their high costs, mainly due to installation costs, which can be up to £1000 per kW. Furthermore, the lack of public knowledge about this type of system restricts their use further.

This project aims to tackle these two key issues by developing a system that has 90% lower installation costs whilst also improving public awareness of the technology.

This is achieved by designing a system that allows for the replacement of large scale drilling equipment with hand held alternatives, reducing cost and making it possible to apply the technology in hard to access locations.

In addition, methods of improving the heat transfer rate of the soil have been investigated. Two approaches have been used for this, one being the inclusion of small, conductive particles into the ground, and the other using electro-osmosis.

Laboratory testing found that the thermal conductivity of the soil could be improved by 168% by the inclusion of graphite particles. Furthermore, the utilisation of low voltage electro-osmosis has been shown to double the thermal conductivity of the soil as a result of increasing its water content.

In 2019, this technology is set to be trialled in a new housing development in Nottinghamshire.

**Figure 1:** The system removes the need for large drilling equipment

**Figure 2** Heat pump output improvements using different enhancement methods

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To make use of waste heat potential used in thermal systems utilized to improve electricity energy production technology through thermophotovoltaic methods

Zafer UTLU

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What we aim in this project is to make use of waste heat potential used in thermal systems utilized in transportation and residential sector to improve electricity energy production technology through thermophotovoltaic (TPV) methods and to increase the use of developed technology in order to produce electricity from waste heat. Therefore, we aim to contribute both to technology and economic improvement by expanding the utilization of TPVs in the areas making use of waste heat.

An intense amount of energy is used to produce thermal energy in industry, transportation, electricity production and residential sector where approximately 40 to 50 percent of the energy used in the thermal systems of these sectors is emitted to environment through heat loss from surfaces and stack gas. This emitted heat has low (32-230 °C), medium (232-440°C) and high (440-932 °C) temperature ranges. There are many technologies developed to make use of this waste heat. In all of these technologies the thermal energy of the waste heat is transferred into waste heat conversion device through heat transmission and the radiation energy found in waste heat is emitted to the environment without any conversion. The project we offer is to improve the technology to produce electricity by making use of the radiation in waste heat.

The systems converting the radiation energy into electric energy are known as Termophotovoltaic (TPV) technology. TPV systems are also the static energy converters. They transform the infra red black body radiation into electricity. TPV systems are more efficient and provide higher output energy intensity due to low band energy gap and the short distance between the TPV diode and the transmitter comparing to the photovoltaic (PV) systems.

Considering the potential level of waste heat, the current TPV technology is suitable for high temperatures only. We propose in this project to research the use of technological development and to improve a new technology to make TPVs usable in low, medium and high temperature stages. Another feature that makes the proposed project original is that we aim to investigate the possibilities of applying the TPVs to radiation processes occuring in industry, residential sector, cycle plants and transportation.

The project was carried out in four stages: preliminary research, application of existing technology, theoretical modeling and new technology production. In the first stage, the researches of the applications using TPV technology have been determined based on one-to-one observations, not as a literature review. It is determined what can be done to improve the existing technology.

In the second stage, the current status and potential of the electricity production by using waste heat with low, medium and high temperature values in the industry, transportation, housing and conversion sectors were investigated. In addition, the applicability of existing systems to specified sectors was also investigated.

Continued...
In the third stage, the information and findings obtained in the second stage were taken into consideration and theoretical models were created for a new TPV technology.

In the fourth stage, studies have been carried out to create a new product with the theoretical modeling. Unlike the current technology in these studies, each temperature stage and the applicability of each sector has been put forward.

In this study GaSb cells have been selected for TPV modelling. The band spacing of these cells is suitable for study. The GaSb cells are connected in series and placed on the inner surface of the cooling system. Figure 1 is a schematic representation of the TPV system. Exhaust gas is thrown out of the system. The photons emitted from the selective emitter come to the optical filter by radiation, and are reflected to the selective emitter, which filters the low-energy photons. Photons, which have an appropriate band gap in terms of energy, reach the photovoltaic cell. In a photovoltaic cell, thermal energy turns into electrical energy. This Electrical energy is direct current. The inverter converts the direct current (DC) to alternating current (AC). The coolant attached to the system maintains the temperature of the cell by reducing the overheating of the photovoltaic cell. Both the cooling system and the filter prevent the cell from overheating.

In this project, thermophotovoltaic system applied on low, medium and high temperatures GaSb cell was really analyzed and data were obtained. Efficiencies of GaSb cell for low, medium and high temperature are shown Figure 2 and Figure 3. The optimum energy efficiencies obtained as a result of the prototype result on the industrial system are 21.57% for high temperature, 14.45% for low and medium temperatures.

When cell temperature is increased, energy efficiency is reduced. As the temperature of the cell decreases, the energy efficiency increases. As the temperature of the cell increases, the band gap decreases, and the TPV decreases the open circuit voltage of the cell.

In addition, the filling factor and efficiency are reduced due to increased cell temperature.

Compared to the ideal and ideal analysis, the highest open circuit voltage has been 0.464 V at the 3000 K radiation temperature in the theoretical (ideal) analysis, but this value decreased to 0.4459 V at 3000 K radiation temperature for the highest open circuit voltage. To determine the application efficiency and using rate of current TPV technology in industry, transportation, When this technology is commonly used in industrial plants using radiation system, the plants will meet their needs from this system therefore there will be economical gain.

Figure 2: Energy efficiencies for high temperatures
Figure 3: Energy efficiencies for low and medium temperatures
**WSSET News and Information**

**Professor Saffa Riffat, Fellow of the European Academy of Sciences.**

Professor Saffa Riffat, President of the World Society of Sustainable Energy Technologies, has been elected as a Fellow of the European Academy of Sciences for his outstanding contribution to science and technology. Professor Riffat received the award from Professor Rodrigo Martins, President of the European Academy of Sciences during the Academy workshop held in Bielefeld, Germany on 18-20 October 2018, see image below.

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**5th TESSe2b Workshop in Association with WSSET**

**University of Nottingham**

**24th January 2019**

**Workshop on**


*Enquiries to: Celia Berry (Event Secretary) - celiaberry2@nottingham.ac.uk*
International workshop on
“Solar Powered Net-Zero Energy Built Environment for Eco-Cities”

13th December 2018, 9:30 A.M to 5:00 P.M
Venue: Department of Mechanical engineering,
IIT Madras, Chennai

Energy from alternative sources is the matter of great concern in the current scenario of societal progression. Renewable energy systems especially driven by solar energy are most promising and sustainable for the emerging eco-cities. As buildings constitute major part of an urban sprawl, the need for smart eco-cities that are sensitive to use the latest technological developments is paramount. Hence, a one-day workshop session on “Solar Powered Net-Zero Energy Built Environment for Eco-Cities” is being organized for middle level practicing engineers, managers from industry and personnel from teaching and R&D institutions to enable them to use these technologies effectively towards efficient consumption of energy, so as to build sustainable eco-cities of the future.

OUTLINE OF THE WORKSHOP

- Solar energy conversion
- Solar PV and thermal technologies
- Eco-Cities conceptual understanding
- Design and integration of solar energy systems
- Technologies for Net Zero Energy Buildings (NZEB)
- Sustainable buildings, architecture and materials

SPEAKERS from India & Canada:
- Dr. K. Srinivas Reddy, IIT Madras
- Dr. Bala Pesala, CSIR-CEERI
- Dr. B. Nageswara Rao, IIT Madras
- Dr. Ashutosh Bagchi, Concordia University, Canada

About Organizing Institutes

- IIT Madras, India is one of the premier institutes in India that embark on latest technological innovation ideas and knowledge sharing in its best possible ways and means.
- CEERI Chennai, India (regional centre of CEERI, Pilani), is a pioneering institution focusing on development and commercialization of various renewable energy technologies
- Concordia University Montreal, Canada brings out the next generation ideas to reality and aims at creating a sustainable environment through its academic programs.
- WSSET is a non-profit organization which has played an important role in promoting sustainable development & technologies worldwide.

The workshop is funded through DST & IC-IMPACT joint program

In association with

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The International Journal of Low-Carbon Technologies (IJLCT), which recently received an inaugural Impact Factor of 0.837 with indexing in the WOS and the JCR, offers a 25% discount to the APC (article processing charge) for WSSET members wishing to publish a paper in IJLCT (open access). This will cost WSSET members £638 as opposed to the full charge of £850. Authors will need to state that they are WSSET members when paying.

Please visit www.ijlct.oxfordjournals.org to submit your articles.

Also in conjunction with Future Cities and Environment (FCaE), WSSET have agreed a £25 discount to the APC (article processing charge) for WSSET members wishing to publish a paper in FCaE (open access). This will cost WSSET members £475 compared to the full charge of £500. Authors will need declare their membership details to the editorial team when it comes to payment before publication.

Please visit www.futurecitiesandenvironment.com to submit your articles.

Renewable Bioresources is an Open Access (Gold OA), peer reviewed, international online publishing journal, which aims to publish premier papers on all the related areas of advanced research carried in its field. Renewable Bioresources emphasizes the advanced applications of biotechnology to improve biological ecosystems through renewable energy derived from biological sources.

Please visit www.hoajonline.com/renewablebioresources to submit your articles.
All WSSET members are kindly invited to submit articles for publication in future WSSET newsletters. Articles can be on a range of topics surrounding the word of sustainable energy technologies. With nearly 2000 members, the WSSET newsletter provides a great opportunity to publicise new ideas, technologies or products – all free of charge!

Articles should be no more than 400-500 words and one or two photographs would be very much appreciated. Submissions should be emailed to secretary@wsset.org

Furthermore please contact secretary@wsset.org regarding any conferences, seminars or symposiums relating to topics of sustainable energy technologies that you wish to be advertised in the newsletter.

Once again, thank you for your continued support to WSSET.