Volume 8, Issue 1, Newsletter July 2016

WSSET World Society of Sustainable Energy Technologies NEWSLETTER

Featured WSSET article

Inside this issue:

The 15th International Conference on Sustainable Energy Technologies (SET2016)

19th – 22nd July 2016, Singapore

The 15th International Conference on Sustainable Energy Technologies (SET2016) will take place in Singapore from 19th to 22nd July 2016, hosted by the National University of Singapore (NUS), in collaboration with the World Society of Sustainable Energy Technologies (WSSET), American Institute of Chemical Engineers Singapore Local Section (AIChE SLS), and Campus for Research Excellence and Technological Enterprise programme (E2S2-CREATE). SET2016 is a multi-disciplinary, peer-reviewed international conference on sustainable energy sources and technologies. This scientific meeting aims to provide a platform to gather scientists, industrialists and politicians around the world for the exchange of latest technical information, the dissemination of high-quality research results, the presentation of recent advances and new developments in the area of sustainable energy, and the debate and shaping of future directions and priorities for better environment, sustainable development and energy security.

Major topics in SET2016, include (but not limited to):

Heating and cooling systems
CO_2 capture, storage, and utilization
Sustainable urban systems and infrastructure
Energy saving in buildings
Gasification and pyrolysis
Hydrogen and fuel cell technologies
Strategies for energy demand and use optimization
Smart-grid
Biomass processing
Sustainable consumption and production

All papers are peer reviewed before being accepted for presentation at the conference and published in the conference proceedings. Full manuscripts of selected papers will be published in special issues of the following prestigious international journals: Applied Energy, Energy, Low-Carbon Technologies, International Journal of Refrigeration, and Renewable Bio-resources. SET2016 is honoured to have eight distinguished keynote speakers from all over the world. SET2016 will also hold a workshop on biochar and gasification technologies.

Singapore is a bustling cosmopolitan city that offers a world-class living environment, with a landscape populated by high-rise buildings and gardens. One interesting facet you'll discover about Singapore is a ubiquitous collage of cultures, where people of different ethnicities and beliefs coexist. Singapore is the perfect meeting location for SET2016, as Singapore is a highly-urbanised city with limited energy resources and hence "energy sustainability" is highly required for Singapore. Please use the following link for more information - http://set2016.chbe.nus.edu.sg/

Latest news from WSSET

WSSET innovation awards – Prof. Saffa Riffat

Industrial expansion, commissioning of new power plants and expansion of transport systems are changing our climate due to the emission of large quantities of carbon dioxide into the atmosphere. If greenhouse gas emissions are not brought under control, climate change will accelerate with devastating impact on civilisation. Urgent action is required if we are to avert the threat this poses to humans and the world's ecology.

The 2015 United Nations Climate Change Conference held in Paris negotiated a global agreement on reducing climate change. The organisation committee has agreed to set a goal of limiting global warming to less than 2°C compared to pre-industrial level.

Sustainable development and innovative energy solutions are crucial to reducing climate change. The WSSET Innovation Awards recognise the achievements of private individuals and organisations in new sustainable technologies and encourage the wider application of these new developments. The WSSET Awards include innovations in the following categories:

- Renewable energy systems (e.g., solar, wind and biomass)
- Power generation technologies (e.g., CHP systems, fuel cells and anaerobic digestion plants)
- Energy efficiency (e.g., heat pumps and hybrid solar/gas systems)
- Low carbon buildings and future cities (e.g., low/zero carbon buildings, sustainable cities)
- Water treatment and desalination (e.g., solar water desalination)
- Sustainable materials (e.g., innovative composite materials and aerogels)
- Waste management and water recycling (e.g., households and construction waste management)
- Agri-food technologies (e.g., innovative greenhouses and food drying)

Please visit http://www.wsset.org/innovation-awards/ for a downloadable WSSET Innovation Award application form. You will need to provide a brief: project summary, project status, description of innovation, what makes your innovation distinctive, advantages/benefits of your innovation and innovation ownership.

The Awards will be assessed by a panel of judges from academic institutions, industry and Government departments. The First Round Awards will be presented at the 2016 Sustainable Energy Technologies (SET2016) conference. A certificate and plaque will be awarded to the winners. The Awards will be widely publicised through WSSET website, newsletters and the media.

***First round* WSSET Innovation Awards deadline of entries - Tuesday 31st May 2016**

The first round awards will be presented at SET2016, and an article will feature in the next WSSET newsletter. The second round of WSSET Innovation Awards will open on 1st March 2017.

WSSET magazine of sustainable technologies and products – Prof. Saffa Riffat

WSSET Magazine of Sustainable Technologies and Products provides a platform for information and promotion of innovative technologies and products. In addition, the magazine provides information about new inventions and patents which could be exploited by industry. The areas covered by the magazine include: renewable energy systems, power generation technologies, energy efficiency and much more.

The authors will need to provide information including: name of the technology/product/invention, brief description, benefits (environmental, cost, etc.), 1-2 images, funding/support, case study examples, contact details, website link.

See WSSET website for more details | send all applications to: secretary@wsset.org

Articles WSSET recommends

An innovative hybrid membrane dehumidifier (MD) - Indirect evaporative cooling (IEC) technology for all-weather air-conditioning without compressors - Chua Kian Jon Ernest

In tropical climates, air conditioning consumes up to 35% of the total electrical production of a country. In the department of Mechanical Engineering – National University of Singapore, an innovative patented technology has been developed to, firstly, dehumidify moist intake air using a novel membrane, followed by sensible cooling of the dehumidified air by a multiple-pass of indirect evaporative cooling (IEC). A nano-woven membrane dehumidifier (MD) is employed – see Fig.1. It comprises several substrate-supported layers of enhanced hydrophilic polymer, and it is formulated using a patented processes. The membrane can selectively sieve out water vapour molecules at high flux without the need of a thermal regeneration process seen in conventional desiccant system and thus it is a highly energy efficient process. To achieve a high flux of vapour separation at a vapour-to-air selectivity, a mild vacuum is applied across the membrane surfaces. The energy needed to maintain the vacuum is relatively low in comparison to mechanical chillers. The hybrid processes of dehumidifying the moist air prior to indirect evaporative cooling (MD-IEC cycle) is the key to cooling without the need of harmful HCFC refrigerants and the use of compressors in all weather.

The IEC comprises multiple-pairs of dry and wet channels, where in each generic dry and wet channel pair the dehumidified air flowing in the dry channel is cooled laterally by an evaporative cooling process of the wet channel. To achieve effective cooling in the generic stage, a fraction of the dry air (usually < 2.5%) is purged into the wet channel forming a counter flow heat exchange.

Fig 1 - breakthrough composite polymer membrane air dehumidifier

The IEC process differs from the conventional "swarm coolers" as it exploits the evaporative potential of dehumidified air, approaching the dew point of every stage instead of the ambient wet-bulb temperature. Hence, the hybrid MD-IEC cooler can provide the product air at the desired comfort conditions, namely the dry bulb temperature T_{db} < 18°C and absolute humidity ω < 14 g/kg of dry air. As no compressor is used, the MD-IEC electricity consumption is much lower than a conventional mechanical vapour compression system, resulting in a saving of 50% of the kW per Refrigeration-ton (Rton).

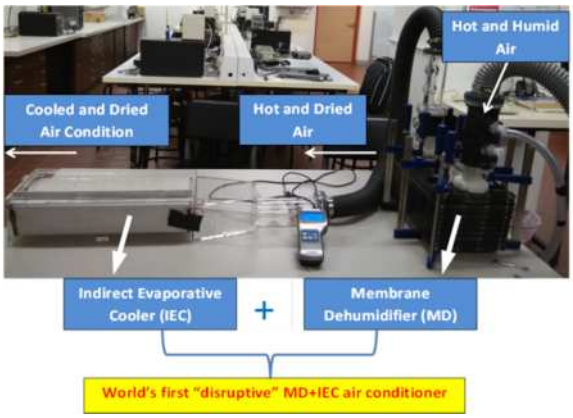


Fig 2 - Working prototype of the hybrid MD IEC technology

Owing to the innovative design of MD-IEC system, the electricity consumption of the hybrid system is low, typically less than 0.4 kW/Rton compared 0.8 kW/Rton for a mechanical vapour compression system. The major electricity consumption in MD-IEC system emanates from the parasitic power of fans to move the air through the system and the vacuum pump that extracts water vapour into the air-cooled condenser. Although the IEC uses water for evaporative cooling, its water footprint is much lower than mechanical vapour compression chillers. The patented MD-IEC cooling technology is game-changing, the system reduces carbon and water footprints, whilst still providing provide thermal comfort in built environment applications. See Fig. 2 for a photograph of the working prototype hybrid MD IEC.

This technology is strategically poised to improve energy efficiency of cooling in the residential, commercial and industries sectors. Additionally, the membrane dehumidifier has great potential for confined spaces, where removing moisture from moist air is critical for human comfort and sustainable operation of delicate equipment.

For more information please contact: Chua Kian Jon Ernest, National University of Singapore, mpeckje@nus.edu.sg

Articles WSSET recommends

Novel Photo-electrochemical Reactors for Sustainable Hydrogen Production

Dr. Ibrahim Dincer

Work is heating up this summer in the Clean Energy Research Laboratory (CERL) at University of Ontario Institute of Technology (UOIT) in Oshawa, Canada, with cutting edge research and experimental testing of the newest generation of the UOIT-developed continuous-type solar photoelectrochemical (PEC) reactor for sustainable hydrogen production. The system integrates a solar concentrating Fresnel lens and spectrum-splitting mirror apparatus with the PEC reactor and a photovoltaic (PV) module for simultaneous hydrogen and electricity production from a fully renewable energy source – sunlight. Under the supervision of Dr. Ibrahim Dincer, Professor of Mechanical Engineering, there are multiple groups working on sustainable energy technologies, ranging from renewable energy technologies to hydrogen production technologies. In one of the groups, PhD students Yusuf Bicer and Janette Hogerwaard are working with local and international summer students; André Felipe Vitorio Sprotte of Universidade Federal de Santa Catarina in Brazil, Ghassan Chehade of UOIT, and Said Boztepe of Bahcesehir University in Turkey to conduct experimental studies with the PEC hydrogen production system.

The experimental system consists of mainly a PEC reactor, light source, power source and optical tools. To maximize utilization of incident solar insolation (light source), concentrated sunlight is split via a dielectric mirror into upper and lower spectrum, with lower energy wavelengths directed onto the PV module and high energy wavelengths directed onto the photo-active surface area of the PEC reactor. The PEC membrane is treated with catalyst material to promote both electricity and hydrogen production on the photo-active surface via incident photons. This allows the PEC system to operate independently of an external power source for hydrogen production in the presence of sunlight, and for PV electricity to be stored for night and/or low-light system operation.

The in-house designed and built PEC reactor, shown in Fig 1, aims to maximize the utilization of solar energy. The proton exchange membrane (PEM) is sandwiched between custom-designed cathode and anode plates, which provide structural support and ensure proper contact of the membrane electrode assembly.

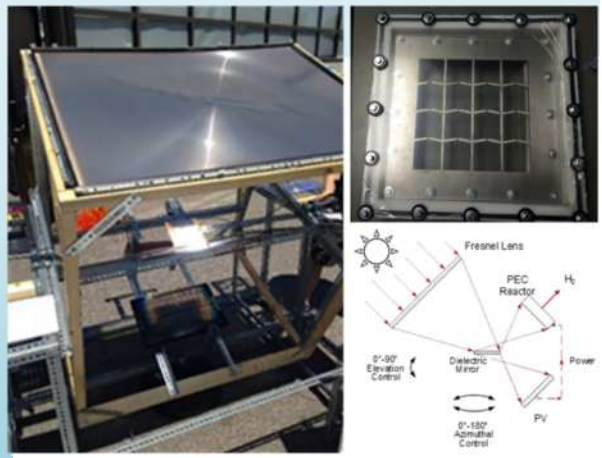


Fig 1 - The experimental set-up (left) is tested under concentrated sunlight. The system integrates the PEC reactor (top right) with a Fresnel lens solar concentrating apparatus, spectrum-splitting dielectric mirror, and PV module (schematically - bottom right)

Catalyst material is deposited onto the light-exposed areas of the cathode plate and membrane to enhance photo-activity and increase photocatalytic hydrogen production. When integrated with the solar concentrator set-up, PV generated electricity provides a power supply to the reactor to produce hydrogen via electrolysis. During this phase of the experimental work, Dr. Dincer's research team, assisted by undergraduate summer students, are investigating the effect of varying light intensity and other environmental conditions (i.e., temperature) on the hydrogen production performance of the PEC reactor system, and the PV cell efficiency. Furthermore, the losses caused by transmittance and reflectance of the materials within the system are determined, and thermodynamic analyses of the processes are conducted. The efficiencies for each light conversion process are determined together with overall efficiency and comparatively assessed for concentrated and non-concentrated light conditions. By using solar concentrator and PEC process integrated to current photovoltaic power plants, the intermittence issue of solar energy could be overcome, and solar energy can be stored in the form of chemical medium as hydrogen. The next phase of the experimental work by the research group will address the challenge of hydrogen storage by integrating fuel synthesis reactors for chemical storage or direct use as clean and sustainable fuels that can be utilized in current transportation and power plant applications, such as ammonia, methanol, or various biofuels.

For more information please contact: Dr. Ibrahim Dincer, Vice President for WSSET North America Ibrahim.Dincer@uoit.ca

Articles WSSET recommends

A pico-hydro generation system for low-head low-flow water sources - Mohd Farriz Basar

Pico-hydro generation systems with a capacity of less than 5kW promote the cheapest opportunity for off-grid electrical generation. However, there are many unexploited opportunities for the generation of electricity using pico-hydro power technologies. The majority of available hydro turbines are made for high-head and high-flow water conditions. There is a research gap that appears at the low-head and low-flow scale. This area of interest has not been widely discussed and explored. This situation has provided the motivation to develop a novel approach to a low-head, low-flow pico-hydro system, focusing on turbine design. An innovative method and non-regulated design are needed for the generation of power in these low source areas.

This project introduces a simple pico-hydro generation system embedded with a simple reaction turbine known as a Z-blade turbine. Small streams are good enough for the innovative system to operate efficiently. The pico-hydro system generally relies on the natural flow of rivers and streams. It is capable of producing power at low water heads (minimum 5m) and low flow rates (minimum 2L/sec). It is able to utilise a smaller volume of flowing water without the need to build large reservoirs. Thus, the pico-hydro system is considered to be economically feasible because it only requires a small investment but is capable of achieving a considerable power output. Besides that, the operation of the system is not affected during drought season. During times when the water level falls below the designated level other hydro systems may have to shut down, the novel pico-hydro system can still operate. The pico-hydro system, shown in Fig. 1, will consistently operate and generate electricity even in critical (low-flow) situations.

Fig 1 – Pico-hydro generation system at small stream

The innovative pico-hydro system has a simple geometrical design and fabrication process. Due to its simple design, no high-tech manufacturing machinery or expert workers are required. Using locally available materials it costs very little to manufacture a Z-blade turbine and the complete system it is developed by means of a simple process that requires only basic knowledge of piping systems. The turbine blades are made using standard plumbing pipes and fittings.

The system is also easily transported and its installation is straightforward. The Z-blade turbine, which was developed in 2014, is the latest version of the simple reaction type turbine.

This project is a collaboration between two Malaysian Public Universities, namely the Universiti Teknikal Malaysia Melaka (UTeM) and Universiti Kebangsaan Malaysia (UKM). This project has also secured two research grants from the Ministry of Higher Education Malaysia. Furthermore, this project has been nominated in the "High Impact Program (HIP)" organized by the Malaysian Foundation for Innovation, where the objective is to nurture scientific innovation for community usage especially in East Malaysia.

For more information please contact: Mohd Farriz Basar, Faculty of Engineering Technology (FTK), Universiti Teknikal Malaysia Melaka, Malaysia, mfarriz@utem.edu.my

Articles WSSET recommends

Concentrator photovoltaic systems - development and progress at HBUT

Hui Lv[1, 2], Jun Liao[1,2], Qinghua Lv[1,2], Benyuan Chen[1,2]

In previous work, we have built three sets of rooftop solar concentrator photovoltaic systems. In accomplishing that, the concentrator optics, solar cell modules, the dual-axis tracking linkage and automatic control system have been verified to be applicable and reliable. Several solutions to improve the system are currently underway, including enhancement of solar modules movement homogeneity, improvement of tracking scheme flexibility, reliability of real-time measurement and monitoring system. The concentrator photovoltaic system needed long term testing and data acquisition, with several system design iterations to reach a system efficiency of over 33%. In this article we propose a novel combined heat and power (co-generation) dish-type solar concentrator photovoltaic system. An initial proof-of-concept prototype has been built, with a parabolic dish diameter of 1800mm and concentration ratio of 450X. Using this set-up the tracking linkage, cooling system, control scheme and emergency protection system have been tested. The peak power output can reach 800W, and the heat recovered by the cooling system under this condition can reach 900W. The system output may be improved with optimisation of a second optical element and an appropriate heat exchanger devise. A system with a much larger solar concentrator dish is in progress. The larger system is designed to generate 2.5kW electricity and 2kW heat.

Based on the dish-type structure mentioned above, we have developed a novel beam splitting concentrator photovoltaic system. With the solar spectrum split by a dichroic reflector, incoming sunlight is separated and projected to two different receivers with different band-gap materials. A suitable solar cell combination can then be selected so that the system's absorbing band covers the whole solar spectrum. The most often used combination is a three-junction GaInP/GaAs/Ge solar cell matched to a Si solar cell, which is adopted to achieve current matching between sub-cells of the three-junctions and enhance overall output

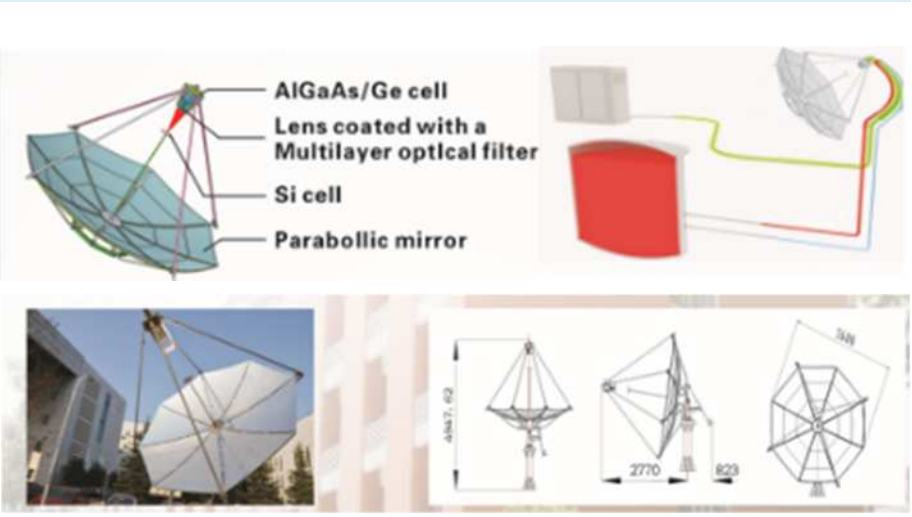


Fig 1 – Concentrator photovoltaic systems

Taking the QE/IPCE of the different solar cells into consideration, the total optical-to-electrical conversion efficiency of the system can be simulated. Using these simulation results an appropriate spectrum splitting scheme and corresponding solar cell receiver combination can be designed in order to maximise total efficiency. For several combinations of typical solar cells we have shown that the resulting experimental system efficiencies verified our theoretical estimations. Due to high efficiency, this system can be used in various situations where both electricity and thermal power are required, such as: rooftops, hotels, resorts and industrial process heat etc. In addition, this system can be constructed to be an experimental platform for research into suitable materials for concentrative solar energy utilisation. Spectrum splitting is more than just about getting higher efficiencies. In some applications, a part of the solar spectrum may be designed for certain usage, such as particular kinds of plant growth, where the other parts of the spectrum may be designed for PV usage – this can be referred to as "spectrum management". Beam splitting photovoltaic systems could be used for PV farming / PV greenhouses, and ecological restoration in desert areas. The potential of our system and the forthcoming challenges are exciting. Several related projects are now underway.

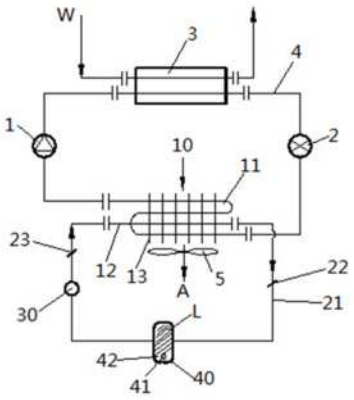
For more information please contact corresponding author: Hui Lv, [1]Hubei Collaborative Innovation Center for High-efficiency Utilization of Solar Energy, Hubei University of Technology, Wuhan 430068, P. R. China, lvh@aovenergy.com

[2]School of Science, Hubei University of Technology, Wuhan 430068, P. R. China

Articles WSSET recommends

An efficient continuous heat pump system – Yijun Yuan

The heating efficiency of a heat pump air conditioning system is severely reduced when the evaporator becomes frosted. In this work, a defrost evaporator is presented – Fig 1. The defrost evaporator consists of refrigerant pipes and thermal fluid pipes, connected with fins. The thermal fluid pipes are connected to a thermal storage system and heating element. Under frosted evaporator conditions, the defrost evaporator heat pump system turns on a thermal fluid pump and the heated fluid is used to defrost the evaporator, thus improving heat pump performance. Under the 'no-frost' condition, the defrost evaporator operates in the same way as a normal evaporator.



1	Compressor	21	Thermal fluid pipe
2	Throttle	22, 23	Valve
3	Condenser	30	Pump
4	Brass pipe	40	Thermal storage system
5	Fan	41	Heater
10	Defrost evaporator	42	Tank
11	Freon pipe	L	Thermal fluid
12	Thermal fluid pipe	A	Air
13	Fin		

Fig 1 – Heat pump defrost evaporator system

The power consumption of the heater in the thermal storage system is small, thus it can work continuously to provide the heat for defrosting. The described defrost evaporator uses a special structure to enhance heat transfer and thus improve the defrosting process.

Testing results

- Heating capacity of heat pump prototype: 15kW
- Environment temperature during testing: 0°C
- Thermal storage system heating element: 500W
- Volume of heated water: 5L
- Volumetric flow of heat pump: 20L/min
- Defrosting happens every 30-60 minutes and each defrost cycle takes 0.5 - 1 minutes

For more information please contact: Yijun Yuan, ISAW Technology Corporation, yuanyijunc@msn.com

Seminars WSSET recommends

Seminar and Exhibition Technologies on Energy Efficiency Buildings -Taiwan and EU countries – *26 October 2016, Albert Hall Conference Centre, Nottingham, UK*

The main objective of this seminar is to set up a cooperation platform between Taiwan and European countries to exchange the technology on energy efficiency in buildings among these countries as well as the cooperation between academic and industry. It is expected to sign some international cooperation projects and technical transfers after this seminar. An information database for energy efficiency in buildings will be established after this seminar to keep on promoting the cooperation between Taiwan and EU countries on the technology of energy efficiency buildings and the cooperation among academic organisations and industrial companies. In additions, it is most significant that we will introduce the outstanding exist research output from NEP-I and NEP-II of Taiwan to EU countries in this seminar to exhibit the technologies on energy efficiency buildings of Taiwan. As well, we will also invite some EU companies to present their technologies on energy efficiency buildings in this seminar for technical exchange. Exhibition of related technologies is also held in this seminar. We deeply welcome all the related companies in EU to attend this seminar to exchange the technologies on energy efficiency buildings and industry.

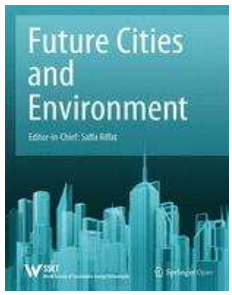
For more information please visit - http://web.ntust.edu.tw/~young/nep2/nep2.htm

Alternatively please contact Saffa Riffat – saffa.riffat@nottingham.ac.uk or Benson Lau - Benson.Lau@nottingham.ac.uk

Journals WSSET recommends - Future Cities & Environment

Along with the successful ***International Journal of Low Carbon Technologies*** (http://ijlct.oxfordjournals.org/), Professor Saffa Riffat would like to invite you to submit articles to his newest Journal from Springer publishers: ***Future Cities & Environment*** *http://www.futurecitiesenviro.com/*

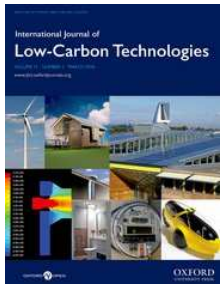
Scope of the journal - Future Cities and Environment publishes high quality multi-disciplinary research which aims to reduce the environmental impact of cities. Considering research in the areas of transport, urban planning, architecture and design, and energy and infrastructure, it publishes fundamental and applied research, critical reviews and case studies. This includes experimental development, demonstration and computer modelling. Future Cities & Environment is an open access journal. Articles related to the topics of Future Cities & Environment are all welcome, and should be submitted using the above link.



WSSET exclusive offer – IJLCT

Exclusive article processing charges for WSSET members

WSSET in conjunction with the International Journal of Low-Carbon Technologies (IJLCT) are introducing a 50% discount to the APC (article processing charge) for WSSET members wishing to publish a paper in IJLCT (open access). This would cost WSSET members £375 as opposed to the full charge of £750. The authors will need to quote they are WSSET members when it comes to payment. Please visit: http://ijlct.oxfordjournals.org/



Contributing to WSSET newsletters and e-bulletins

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 over 1000 active 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 secretay@wsset.org

Furthermore please contact secretay@wsset.org regarding any conferences, seminar or symposiums relating to topics of sustainable energy technologies that wished to be advertised in the newsletter.

Once again WSSET wishes to thank the continued support of its members.

Donations are welcomed and greatly appreciated!
We would like to remind our members that WSSET is a non-profit organisation, hence providing free membership. We would not be able to play a significant role in consolidating practical partnerships between academic and industrial organisations without the help of our members.
Whether you would like to get more involved or contribute financially, please get in touch with us at secretary@wsset.org.