WSSET
World Society of Sustainable Energy Technologies

NEWSLETTER

Volume 12, Issue 4, August 2020

Inside this issue

New Awards Competition

~selected entries can win cash prizes~

WSSET are pleased to announce that we have a number of new awards, some with cash prizes, open for young members - PhD students and new researchers - to apply for. All award winners will receive an Award Certificate and will be invited to participate in the SET 2021 conference in Istanbul, Turkey. Please note the deadline dates as there will be no extensions to these. For more information on each award and restrictions on entrants, visit the WSSET Awards page at https://www.wsset.org/news-events/awards

President’s Prize – deadline 1st November 2020

The President of WSSET is offering a cash prize of £1,000 for a research project or idea related to helping the fight against COVID-19. **This competition is open ONLY to PhD students or young researchers up to 30 years old.** Projects and ideas related to minimising the impact of COVID-19 in hospitals, healthcare centres and buildings include but are not limited to:

- Innovative and efficient personal protective equipment/mask design;
- Technologies including heating ventilation and air conditioning (HVAC) systems;
- Indoor air quality devices;
- Filtration systems;
- Novel design/modelling for natural-ventilated buildings.

WSSET Terry Payne Awards

Professor Terry Payne is sponsoring two awards, both being open only to members from developing countries. A list of eligible countries is available on the WSSET website.

Young Researchers or PhD Students in Developing Countries

There are two prizes of £500 available here. The Award recognises the research innovation that our young members in these countries are carrying out. Applicants must be currently registered students or up to 4 years after completing PhD. Evidence of student registration must be submitted.

Best Research by Female Scientist in Developing Countries

Prize money of £750. This Award acknowledges the extraordinary work that our female members are carrying out in developing countries.

Deadline for submissions for both Awards: **21st March 2021**

More next page

WSSET Terry Payne Awards, *cont.*

Topics for submissions for both of the Terry Payne Awards can be from any of the following areas:

- 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).

Future Cities and Environment – Open Competition for PhD Review Papers

Future Cities and Environment journal is launching a competition to find the two best Review Papers from current PhD students, aiming for publication in early 2021. Selected papers will be published open access, with the Article Processing Charge (APC) being 100% waived. All submissions will be sent for external peer review, with the best two papers being selected by a panel from the Editorial Board. *Future Cities and Environment* is widely indexed, with **Scopus** currently providing a CiteScore of 0.9. Topics for review include:

- Sustainable and resilient cities;
- Sustainable urban systems and infrastructure;
- Green and sustainable buildings and materials;
- Energy efficiency in buildings;
- Smart and responsive buildings;
- Energy demand and use optimization;
- Waste management and recycling;
- Energy and carbon savings incentive;
- Energy and environment policies.

Deadline: **1st November 2020**

WSSET PCM Products Award – Best PhD Student Project in Energy Storage

The successful candidate for this Award will receive prize money of £500. The Award recognises research innovation in thermal energy storage systems.

Deadline for submissions: **21st March 2021**

Topics on thermal energy storage systems can include, but are not limited to:

- Phase change material storage;
- Thermochemical energy storage;
- Sensible heat storage, seasonal/long terms storage;
- Integrated energy storage, solar/renewable energy storage;
- Hybrid energy storage;
- Ice storage and passive cooling storage;
- Energy storage for building applications (homes, commercial and industrial).

WSSET Online Lecture Series

July saw the launch of the WSSET online lecture series. ***Professor Li Shao*** from the University of Reading, UK, kicked off with Thermal Performance of Urban Trees: recent findings.

If you missed the lecture, you can view it on the WSSET YouTube channel here: https://www.youtube.com/channel/UCVXz7KvDrLBTjV32znbJhJw

There will be 2 lectures in August by: ***Professor Srinivas Reddy*** (India) and ***Professor Hongxing Yang*** (Hong Kong). More information will follow and for details and updates please visit: https://www.wsset.org/news-events/press-releases

You can also find out what's happening at WSSET by following us on social media @UoNWSSET and @WSSET_

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On the development of daytime radiative cooling materials

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Overheating in cities exacerbates energy problems, worsens thermal comfort conditions, brings health problems to vulnerable people, and causes tremendous economic losses [1]. Daytime radiative cooling is a passive cooling technique and is a broadly researched topic with very high potential. To have effective radiative cooling, a material needs to have a high reflectance in solar wavelength to minimize the absorption of solar radiation, and high emittance in 8-13um to maximize the heat output as the transparent atmospheric window is located here, as shown in Figure 1.

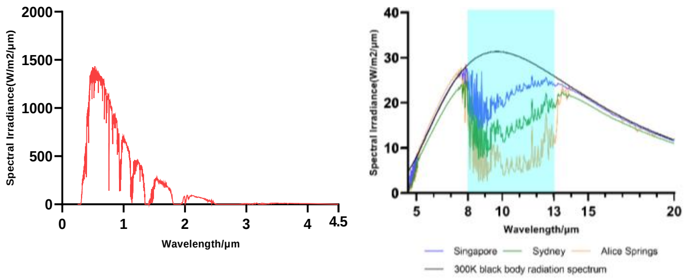

Figure 1: Incoming solar radiation and atmospheric radiation spectra in Singapore, Sydney and Alice Springs, as well as the black body radiation spectrum of a material having the temperature of 300k.

Nighttime sub-ambient performance has long been reported. But daytime sub-ambient cooling has only been reported significantly in recent years as nanotechnology and photonic structures have developed [2]. In 2014, a photonic radiative cooler was tested in Stanford, California [3]. It was a photonic structure fabricated by using electron beam evaporation on top of a silicon wafer. When exposed to solar radiation over 850 W/m2, its surface temperature reached 4.9°C lower than that of the ambient. Using a thin polyethylene cover layer as a convection shield, its cooling capacity at ambient air temperature was 40.1 W/m2. Similarly, in winter at Stanford, direct shading devices and vacuum chambers were used to eliminate non-radiative heat transfer [4]. When the photonic surface was exposed to air, it presented a maximum 42°C sub-ambient temperature when solar radiation reached its peak.

However, the high cost and the inability of photonic structures to perform scalable manufacturing greatly limits their large-scale application in practice. The latest advances in low-cost and scalable radiative coolers, such as the implementation of common polymers, sprays or paints, have shown a very promising image in real-world large-scale applications and can make significantly long-term cost savings. Increasingly, more scalable polymers are being tested and proved to be potential emitter for radiative cooling purposes, like polyvinylidene fluoride (PVDF) [5], poly(methyl methacrylate) (PMMA) [5], polymethylpentene (TPX) [6], polytetrafluoroethylene (PTFE) [7], etc. In 2017, a hybrid structure consisting of silica spheres distributed in the TPX matrix was produced by scalability. The basic emitter and reflector are shown in Figure 2. On a sunny day in Cave Creek, Arizona, under direct sunlight, it was proved to have a cooling capacity of 93 W/m2 [8].

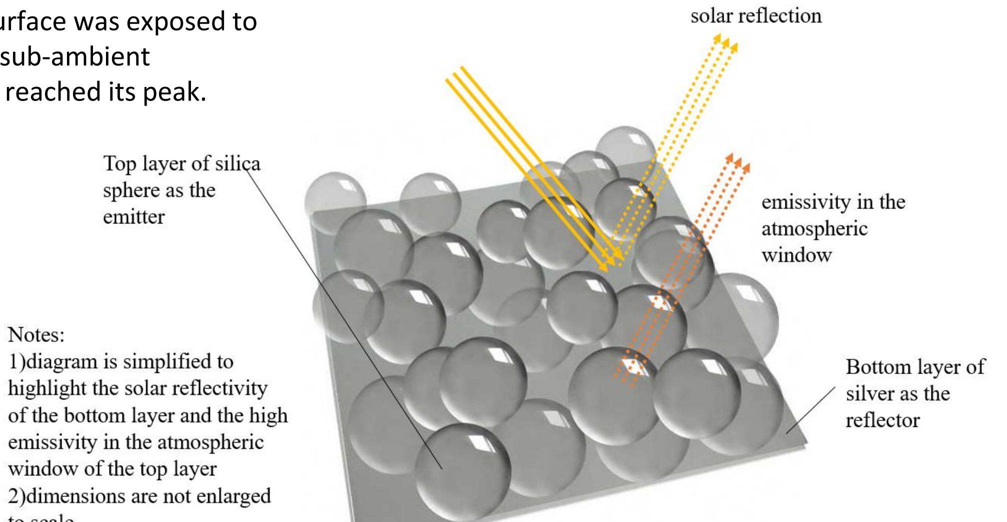

Figure 2: Basic emitter and reflector in [8].

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Increasing the resilience to the health impacts of extreme weather on elderly people under future climate change

Professor Edward Ng

Chinese University of Hong Kong, Hong Kong, China

Extreme hot weather is expected to be more frequent and intense in Hong Kong under future climate change. The impacts will be exacerbated due to the presence of the urban heat island phenomenon in our high-density city. In particular, elderly people are more vulnerable to the impacts of extreme hot weather because of their decline in physiological functions and their behaviour and response. As such, plans for "mitigation" and "adaptation" actions are urgently needed.

Numerous studies have proved that excess mortality and morbidity are associated with extreme hot weather. It is important for different sectors of the society to take necessary actions. However, there are three issues to be addressed for successful responses, including (a) lack of data for understanding the extreme hot weather in our city; (b) lack of evidence-based mitigation action plans; and (c) lack of evidence-based adaptation response plan.

This project aims to contribute by: (1) downscaling global climate data to the urban scale for weather information services and health impact assessment; (2) developing a mitigation action plan with better urban planning and building design under extreme weather; and (3) developing an adaptation response plan for supporting services to increase the resilience of elderly people to extreme weather. This study will provide a methodological framework for incorporating the scientific knowledge of extreme weather and its associated impacts on the elderly health and well-being into a comprehensive plan for response actions.

The findings of the study will help the Hong Kong Observatory transform the current simple weather information system into a more comprehensive one that is capable of reflecting timely conditions of different districts.

Guidance will be developed for urban planners, architects, developers and other professionals in the field to help the industry fully unleash its potential in building towards a sustainable and healthy city under the vision of Hong Kong 2030+. They will fill the current knowledge and awareness gap in the industry.

Current services will be improved by incorporating information provided by the new weather warning system. Housing protocols will be developed to better cater to the elderly's need under extreme weather. Social workers and volunteers will be trained to take better care of the elderly under such conditions.

The project is led by the project director, Prof. Edward Ng and conducted by a multidisciplinary team composed of architects, scientists, psychologists, building science specialists and health practitioners.

The project lasts for three years from 2019 to 2021. It is funded by the Research Impact Fund of the University Grants Committee. The funding amount is approximately GBP 1 million.

The project team is looking for contributions from colleagues who are interested in this project to share knowledge and experiences.

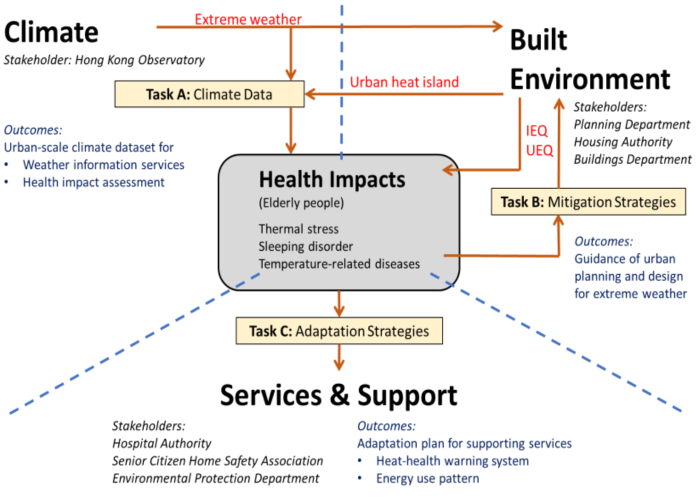

Figure 2: Methodological framework of the project

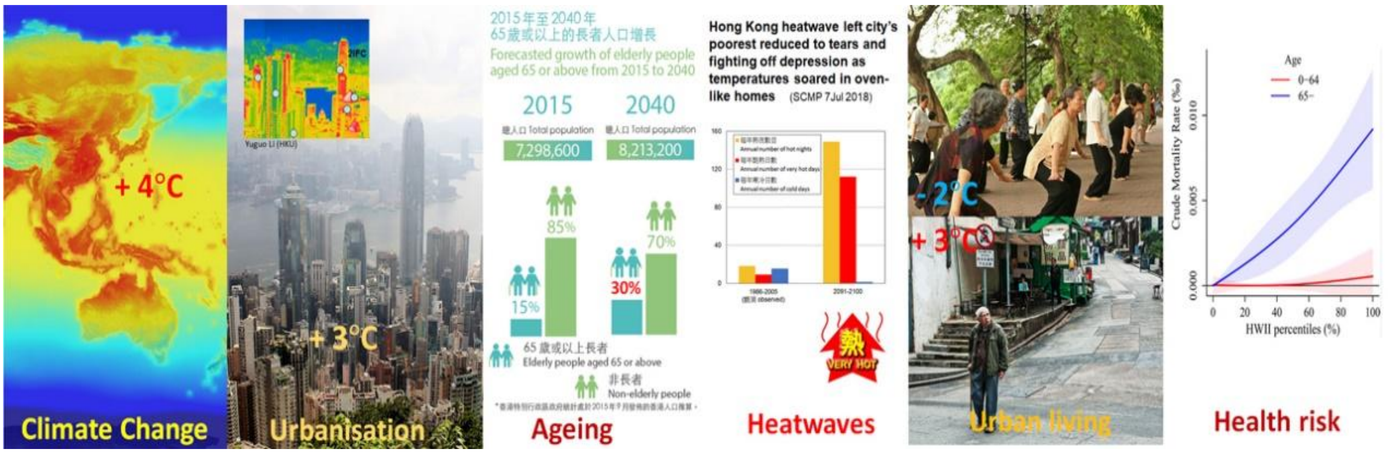

Figure 1: The context and issues of the project

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Photovoltaic thermal (PV/T) collectors with SiC-Paraffin and SiC-H_2O nanofluid

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Photovoltaic thermal (PV/T) is mutually beneficial for the PV element, and solar thermal element of the collector. PV is cooled and hence can produce more electricity, while solar thermal can yield thermal energy in the same area. The development in PV/T collectors is done through improving the process of heat transfer between PV and thermal absorber attached to it. To enhance the heat transfer, some authors propose new design configurations, while others utilize different construction, and operating material. Nanofluid's have been used as coolants for PV/T collectors, while Phase Change Material (PCM) have been used to thermally regulate the temperature of PV modules; due to their high latent heat. However, issues of PCM such as low thermal conductivity calls for innovation in these two approaches.

This project proposes a novel design of PV/T collectors which utilizes nano enhanced PCM and nanofluids to improve its heat transfer (Figure 1). The ability to recover from heat storage and release cycles is amplified when employing nanoparticles into PCM. Hence, the proposed PV/T is a PV module attached to a nano-PCM filled tank. Copper pipes, emerged in the nano-PCM layer, carry nanofluid for heat extraction. In this way, more heat is utilized from the PV/T collector. The proposed system requires a heat exchanger, nanofluid tank and a pump.

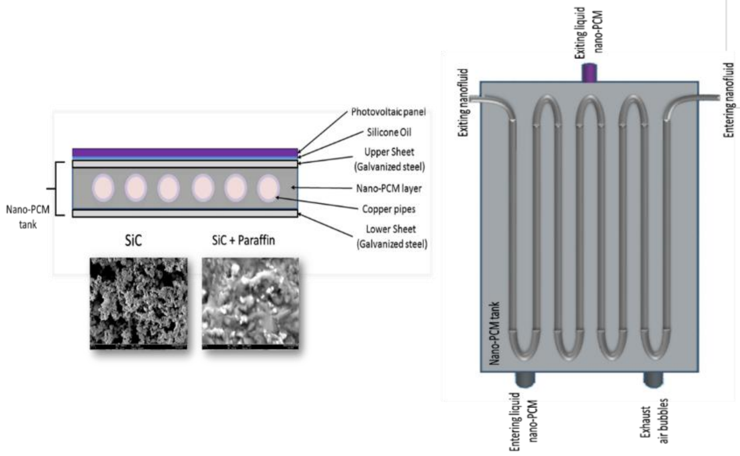

Figure 1: Schematics of the PV/T with nano-PCM and nanofluids

A 3% volume fraction of Silicon Carbide (SiC) nanoparticles were used to prepare the nanofluids, while 0.1% was used to prepare the SiC-Paraffin. Paraffin was used due to being cheaper than its alternatives, and readily available in the market. The mixing was done using two-step method, and tests of thermo-physical properties were done using thermal analyzer, density meter and rheometer (viscometer). The system was tested in UKM's green park outdoor laboratory in Bangi-Malaysia. The experiments were done from 8 AM to 7 PM. The measurement was recorded using various sensors and a data acquisition system. The sensors included rotameter, thermocouples, pyranometer, and IV tracer for measurement of mass flow rate, temperature, solar irradiance and PV current-voltage curves, respectively.

At a mass flowrate of 0.017 kg/s, the nanofluid and nano-PCM based PV/T collector exhibits superior performance over conventional PV, water-based PV/T, and PV/T with PCM and water as coolant. During peak solar irradiance the PV/T achieves a thermal efficiency of 72% and an increase in electrical power of 47.06% compared to the typical PV module. The thermal efficiency peaks at around 2 PM local time; attributed to charging of nano-PCM and time taken for release. On the other hand, the electrical efficiency remains high due to continuous transfer of heat between PV and nano-PCM tank.

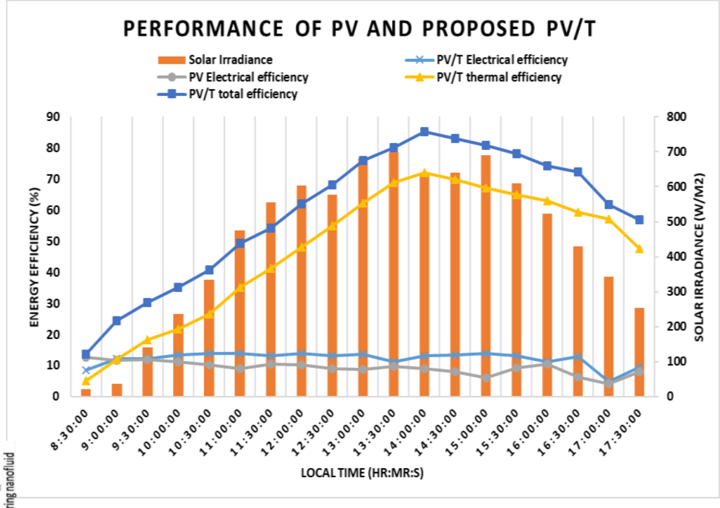

Figure 2: Thermal, Electrical and total Energy of PV/T collector in outdoors conditions

The capabilities of PV/T collectors with nanofluids and nano-PCM show massive potential for development and applications in different fields where electricity and thermal energy are needed. Throughout the continuous experimentation, the proposed PV/T system remains to produce higher than its counterparts.

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Energy and fuels from sunlight and solid waste

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Solar gasification uses highly concentrated solar radiation as a source of high-temperature process heat to drive the gasification processes. In general, improving the heat value of the product syngas, the steam/CO2 mixture serves as the gasification agent of carbonaceous feedstock. Thus, solar energy in an amount equal to the enthalpy change of the endothermic reactions. Conversion performance of thermochemical gasification of solid waste can be significantly improved, accompanied by solar energy stored as a fuel carrier.

In this project, we are evaluating the potential of the hybrid solar/autothermal gasification technology with various reactors. We will specifically investigate the following aspects:

1) To study the coupling of thermal radiative transport with gasification reaction kinetics;

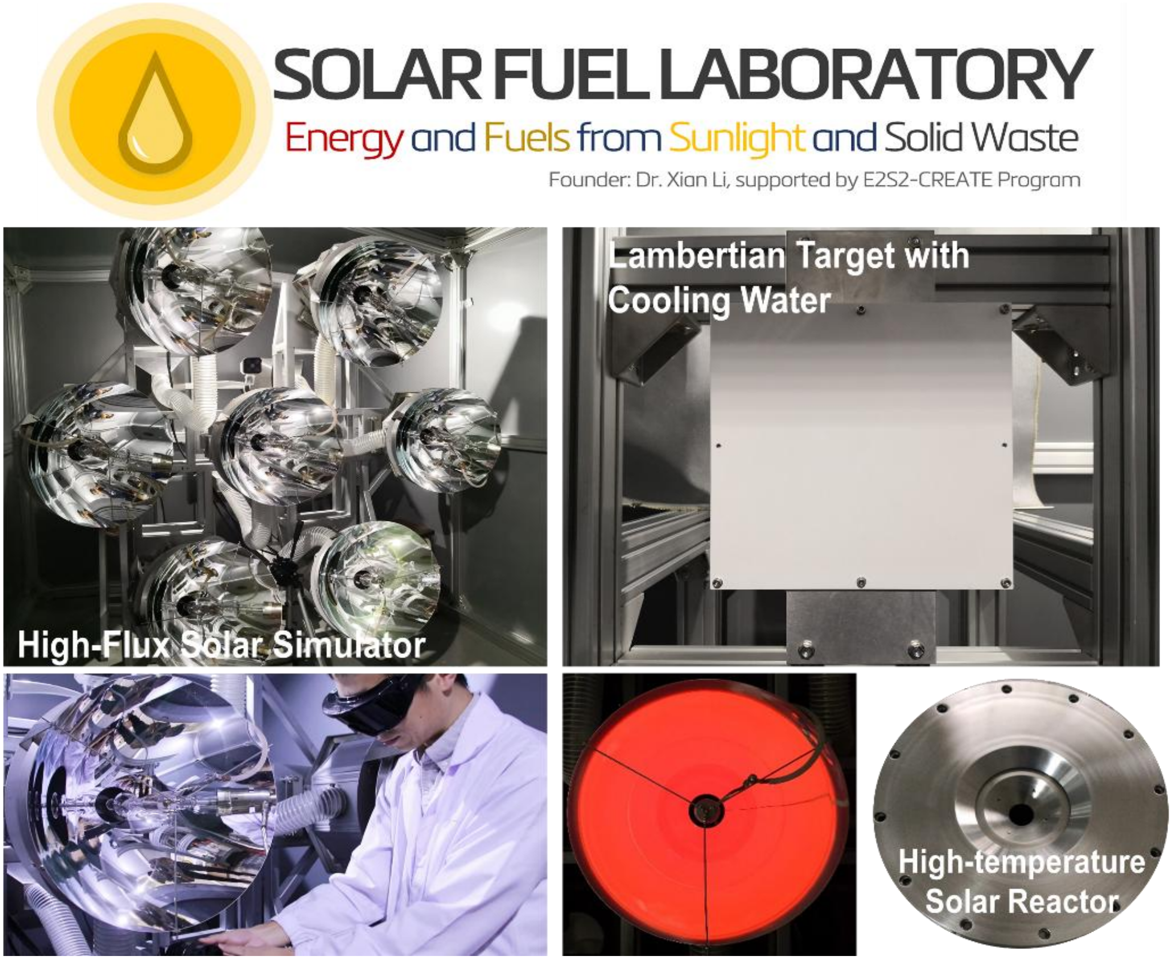
2) To analyse the variations of optical properties, species composition, and phases with respect to chemical reactions;

3) To explore the transient radiation exchange inside particle/gas suspensions, and various thermochemical processes such as thermal cracking, reforming, decomposition, and reduction processes;

4) To optimize thermodynamically the system-level matching and control problem assisted by the advanced optimization technologies. The successful implementation of the hybrid solar/autothermal gasification will form a potential and promising technical reserve.

E2S2-CREATE programme has launched Singapore's first and Southeast Asia's largest high-flux solar simulator (28 kWe) that is able to supply ~12 kWth radiative power, associated with a peak concentration of >7000 suns and an average concentration of >3500 suns at the target region with a diameter of 4 cm. Two high-temperature solar reactors have been developed for 900-1000 °C and 1300-1500 °C solar gasification of solid waste by using the configurations of internally circulating fluidized bed and directly irradiated fixed bed, respectively.

Research on Energy and Fuels from Sunlight and Solid Waste is supported by the National Research Foundation Singapore, under its Campus for Research Excellence and Technological Enterprise (CREATE) programme (E2S2-CREATE).



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Low temperature waste heat recovery with heat pump and related technologies

Professor Ruzhu Wang

Shanghai Jiao Tong University

Waste heat recovery is of great significance for energy saving and emission control purposes, and heat pumps are among the best options for low temperature waste heat recovery. However, its wide application is still restricted by two aspects: 1) the limited efficiency, temperature lift and capacity of current heat pumps, and 2) mismatch between waste heat source and demand.

In this project, both vapour compression and absorption heat pumps with large capacity and high-efficiency were developed and demonstrated. Additionally, network utilization of waste heat was proposed for optimized waste heat recovery. The major achievements were:

1. Development and demonstration of a 10 MW Centrifugal vapour compression heat pump in a steel manufacturer in Anshan, China. The waste heat with temperature of 32°C was upgraded to 62°C for residential heating in which the heating capacity was 10 MW (Figure 1). The unique compressor design and double compressor configuration ensured a high COP of 6.93. The heat pump system replaced the original fossil fuel burner and had a short payback period of 1.7 years. The successful demonstration project has enabled another 5 Centrifugal vapour compression heat pumps to be put into use for winter heating in Anshan.

Figure 1: 10MW Centrifugal heat pump

2. Development and demonstration of 50 MW absorption heat pump. Double-section LiBr-water absorption heat pumps were developed and applied in a CHP plant in Lanzhou, China. The original heating was supply by the low pressure extracted steam from a Rankine cycle, which was inefficient. Our project used the absorption heat pump driven by the extracted steam (0.24 MPa) to recover the waste heat of the Rankine cycle (34.63°C from the cooling water tower), and the heat pump could heat the water from 45.94°C to 81.34°C for district heating. The real measured heating capacity was 63.57 MW for one heat pump unit (Figure 2). Due to the unique double-section design, the absorption heat pump could achieve COP of 1.77. This project has a payback period of 3.7 years.

Figure 2: 5 units absorption heat pump (50 MW each)

3. Concept and demonstration of network utilization for waste heat. Waste heat recovery often encounters the issue of mismatch between waste heat source and user demand in spatial, temporal and energy grade degrees. To achieve better utilization of waste heat, the concept of network utilization of waste heat was proposed (Figure 3), which includes the cooling, heating, power, storage, and transportation from waste heat. Technology matching and heat exchange network optimization were integrated together to achieve the optimized utilization of waste heat. A book edited by Prof. Ruzhu Wang will be published by Science Press in China. This method was used in a waste heat recovery network optimization project with cooling capacity of 5 MW in Jurong Island, Singapore, and ensured a payback period of ~2 years.

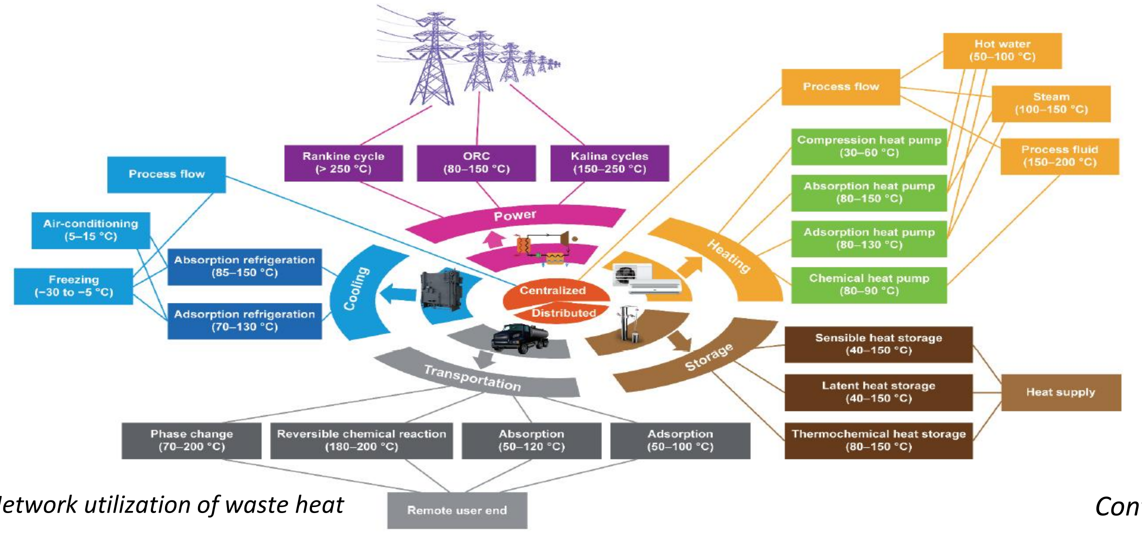

Figure 3: Network utilization of waste heat

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4. Development and demonstration of a high temperature vapour compression heat pump with water as refrigerant. Industrial heating demands typically have higher temperatures than domestic ones. However, conventional vapour compression heat pumps cannot work efficiently under high temperature conditions. In this project, we developed the first vapour compression heat pump with water as refrigerant in China (Figure 4). The heat pump unit was able to lift waste heat from ~80°C to ~115/130°C with COP of 5.7/3.5. This was further cascaded with an air-source heat pump to make an air-source heat pump steam generator. A 180-kW prototype was developed and demonstrated for the steam supply of wine production in Jinan, China.

Figure 4: Water vapor compression heat pump.

5. Development and demonstration of phase change heat storage. To tackle the spatial and temporal mismatch between waste heat and demand, heat storage with PCM is necessary to keep the original energy grade. A series of PCM heat storage plants were developed. Expanded graphite was used to yield PCM with high thermal conductivity. A PCM-based heat supply system with $2MWh_t$ storage capacity was demonstrated in Bejing, China (Figure 5). The system was driven by off-peak electricity, which ensured a short payback period of 2.8 years.

Figure 5: A 2 MWh PCM thermal storage

This research was supported by the National Key R&D Program of China (No. 2016YFB0601200).

WSSET News and Information

5th WSSET Innovation Awards 2021
Deadline for submissions: 31st March 2021

Following the postponement of SET2020, the WSSET Innovation Awards were postponed for a year as well. 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. Innovative ideas are welcome in any of the following areas:

- Renewable energy systems
- Power generation technologies
- Energy efficiency
- Low carbon buildings and future cities
- Water treatment and desalination
- Sustainable materials
- Waste management and water recycling
- Agri-food technologies

To enter and download an application form, go to https://www.wsset.org/news-events/awards/innovation-awards
Winners will be announced at the SET2021 gala dinner in August.

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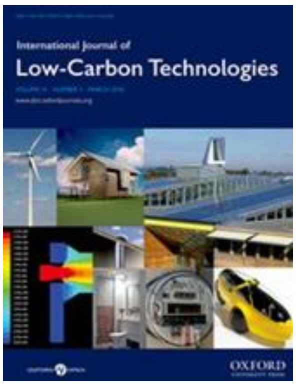
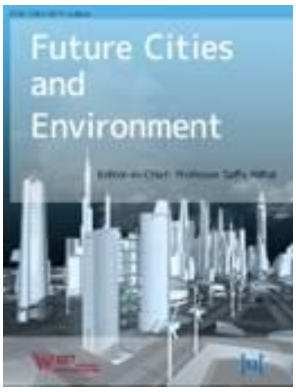


WSSET exclusive offer – IJLCT

The International Journal of Low-Carbon Technologies (IJLCT), whose Impact Factor has increased to 1.054 with indexing in the WOS and the JCR, offers a 20% discount to the APC (article processing charge) for WSSET members wishing to publish a paper in IJLCT (open access). This will cost WSSET members £915 (€1099) as opposed to the full charge of £1144 (€1373). Authors will need to state that they are WSSET members when paying.

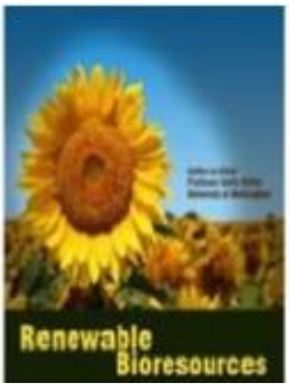
Please visit www.ijlct.oxfordjournals.org to submit your articles.



WSSET exclusive offer - FCE

Also in conjunction with Future Cities and Environment (FCE), WSSET have agreed a £25 discount to the APC (article processing charge) for WSSET members wishing to publish a paper in FCE (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.



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If you no longer wish to be a member of WSSET or you want to unsubscribe from emails, please unsubscribe here.

Thanks

Donations are welcome 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

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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 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.