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SPECIAL ANNOUNCEMENT:
We extend our best wishes for a speedy recovery to Lord Prescott, our new Honorary President, following a stroke.

He was admitted to Hull Royal Infirmary on Friday 21st June but is recovering well. Unfortunately, this means that he will not now be attending SET2019 but we hope to see him at future events.

SET 2019: Time to Register!

The deadline for abstract registration has passed but late submissions may still be considered, go to the SET2019 website: www.set2019.org/submission-registration/submissions-2

If you have submitted an abstract, please submit your full paper quickly as it will still have to be peer-reviewed and comments returned. Revised manuscripts must be submitted by 30th July.

Delegates should register and pay as soon as possible but of course, you don’t have to be presenting a paper in order to attend. SET2019 welcomes attendees who are not presenting too. Remember that all WSSET members receive a 20% discount on the conference registration fees and students will receive an even greater discount.

<table>
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<tr>
<th>Deadline Date</th>
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<tr>
<td>14th July 2019</td>
<td>Full Manuscript Submission</td>
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<td>15th July 2019</td>
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<td>Registration and Payment Deadline for ONLY Conference Attendance – without Paper/Poster Presentation</td>
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Salt impregnated porous concrete for thermochemical heat storage applications in buildings

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Recently due to pollution, expense and depletion of fossil sourced energies, thermal energy storage (TES) systems and technologies are considered to undertake a vital portion in supply of clean, inexpensive and sustainable thermal energy. Thermochemical heat storage (THS) systems offer higher thermal storage density in comparison with the conventional sensible heat storage (SHS) systems and latent heat storage (LHS) systems. Unlike the other TES technologies, THS systems are not widely available in markets and still under development and research stage. The materials used in THS systems can exploit required charging energy from any renewable source and discharge the required thermal energy in electricity consumption peak time or at the time needed by consumer to heat the living space. In case of solar assisted THS systems, in summer, due to longer availability of solar energy, THS materials can be charged and stored and can be used in period of less availability of solar energy of winter.

In addition, THS systems could be utilized for storage of off-peak electricity also the electricity generated by photovoltaic panels in the form of thermal energy. This could allow achieving energy supply-demand balance also reduction of fossil fuel usage in building space heating applications. Thermochemical heat storage is considered as a promising technology to enhance the utilization of energy sources due to its high energy storage density and long term heat storage potential. However, further development of such systems depends on the development of new advanced sorption materials.

In this study, a novel composite sorbent that consists of aerated porous concrete (APC) and calcium chloride (CaCl$_2$) is investigated. Besides, vermiculite – calcium chloride (V–CaCl$_2$) and Zeolite were also employed in the developed reactor for performance comparison. The temperature variations of air also cumulative thermal energy and exergy outputs from the system during the discharging cycles are presented in Figure 1.

According to the testing results, average energy storage density (over three repeating cycles) of the system operating with APC-CaCl$_2$, V–CaCl$_2$ and Zeolite were found 186.9, 174.2 and 182.6 kWh/m$^3$ respectively. Between the charging and discharging cycles, materials were charged at 90 °C and the hydro-cyclic (ratio of the amount of moisture removed to the amount of moisture adsorbed) efficiencies for APC-CaCl$_2$, V–CaCl$_2$ and Zeolite were obtained as 81%, 79% and 33% respectively. The views of the tested materials before and after discharging are shown in Figure 2. Performed research demonstrated that the APC-CaCl$_2$ composite could be a potential THS material for building integrated thermal energy storage applications. However further research is required for optimizing its pore volume, structural stability and thermal properties.

![Figure 1: Temperature variations of air (left) and energy-exergy output from the THS (right) during the cyclic discharging tests of APC-CaCl$_2$, V–CaCl$_2$ and Zeolite](image1)

![Figure 2: View of the tested materials (a) after charging and (b) after discharging.](image2)
A Domino-Like Snow Removal System for Roof PV Panels Array

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In Canada, as also in northern areas of Europe and China, there are long periods each year when the daily average temperature stays below 0°C. PV (photovoltaic) power generation systems deployed on the roof will often not be able to generate electricity, because snow covering the solar panels won’t melt without external help. The traditional snow removal method is a manual snow sweeping or spraying of snow melting agents. These manual methods are not only time-consuming and labor-intensive, but also costly, and can easily damage the photovoltaic panels. Due to the erratic snowfall in the winter climate, frequent artificial snow clearing is difficult to achieve. Figure 1 shows a typical snow-covered house. Because of the above problems, the efficiency of photovoltaic power generation systems in the countries like Canada has been seriously degraded; otherwise the PV popularization may increase significantly.

Figure 1: Typically, a Canadian house roof covered by snow may last for several months every year

A novel PV power generation system which realizes a Domino like snow removal technique by PV self-heat-generation is proposed by a USTC R&D group. It can solve the snow problem on the photovoltaic panel without external power supply or external labor. This idea is patent pending; it can be used not only for the snow removal of small-scale PV arrays for household, but also for the snow removal of large-scale PV power stations. We trust that this R&D work will be a great help to increase PV power generation efficiency in countries like Canada.

This system includes regular photovoltaic panels and one control box. The PV panels are separated into two types: Type I are placed on the roof, and Type II are placed vertically on the south side of the house as illustrated in Figure 2.

The vertically placed Type II photovoltaic panels won’t be covered by snow and provide the initial power source for snow removal (also known as no. 0 PV panels group). When the Type I photovoltaic panels are covered with snow, the control box detects that the voltage across the photovoltaic panels is reduced. Consequently the circuit connection is changed in a way, so that the no. 0 PV panel group is connected reversely to the two sides of the no. 1 PV panel group. The no. 1 PV panel group is energized in reverse, which will generate heat and melt the snow on it. After the snow slide down, the no. 0 and no. 1 PV panels groups will be used together as a power source, and the no. 2 PV panel group will be energized reversely to melt the snow on it. After that, no. 0, no. 1 and no. 2 PV panel group are used together as a power source, and so on. Like a domino effect, the snow melting speed will be faster and faster. After all the snow has melted, all the photovoltaic panels generate electricity again normally. In this way, a snow self-cleaning of the photovoltaic panels is realized. Figure 2 shows the work flow chart of the PV system.

Figure 2: The work flow chart of the PV system

The controller prototype has been completed, the USTC students are working on testing the system. They have to wait now until a winter season to finish a few houses in Canada with the domino snow melt system. The R&D group is looking for partners to do more demonstrations together.
Gravitational Energy Storage Using Soil Batteries (GravitySoilBatteries)

Saffa Riffat, Yijun Yuan

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The world’s requirement for electric power is growing rapidly and according to the International Energy Agency estimates, an additional 250 Gigawatts of power will be required annually between now and 2050. Renewable energy technologies including wind, solar, wave and tidal can provide clean energy but these technologies are intermittent, often producing power when grid utility or users don’t require them. With the growing use of renewables, peak power, able to provide the surge in power as needed, require the worldwide reserve capacity to be increased by up to 10% per year in order to handle peak power usage periods.

Existing grid-scale energy storage systems include batteries, compressed air storage, and pump storage hydropower (PSH) with PSH being the main player in grid-scale storage. The difficulties with PSH include siting, land/water usage, construction time and capital cost required prior to a facility can be deployed. The key challenges to providing a successful grid-scale storage are low capital and running costs, quick construction, high energy storage density, scalability, low maintenance requirements, and long lifetime. The gravity storage technology concept is similar pumped hydropower systems. In pumped hydro systems, water flows down via gravity from an upper reservoir to a lower reservoir, passing through a turbine/generator making power. Water is then pumped back up from the lower to the upper reservoir using electricity and the process is then repeated.

In gravity storage systems, a heavy weight block is moved from a lower point to an upper point which represents energy storage ‘charging’, and then, when needed, the mass returns from a higher to a lower point where the kinetic energy of the descending block powers a generator, ‘discharging’, creating electrical power when the grid requires. A simple way to illustrate the gravity storage concept is to use a person’s arm lifting and lowering a heavy object. The weight of the object tries to pull the arm down due to the force of gravity. As gravity pulls down on the object, it causes a rotational force at the shoulder joint. This force is torque and the muscles of the shoulder must then be activated to overcome this force in order to hold the weight from moving down. The rotational force at the shoulder can be represented by a pulley/motor-generator linked to a weight. The generation process occurs by moving the arm downwards while the charging process is accomplished by moving the arm upwards.

A new concept is proposed by University of Nottingham academics Professors Saffa Riffat (President of the World Society of Sustainable Technologies) and Yijun Yuan (EU Marie Curie Fellow Fellow), who filed a patent application in May 2019 claiming a novel gravity energy storage technology based on drums filled with soil.

Figure 1. GravitySoilBatteries, a) electricity generation process and b) electricity charging process

The basic concept of GravitySoilBatteries is shown in Figure 1. The technology uses storage cores (large drums filled with compacted soil) that could be shifted between lower and higher points. The soil for the storage device can be obtained locally by digging the ground to create deep channels for the system. The soil is also used as a filler for the central concrete support structure. Pulleys are mounted on the top of central concrete structure. The drums are fitted with axial shafts and bearings and are mounted on a metal frame similar to tarmac rollers. The drums could be then pulled on the sloped central concrete structure using cables and motor/generator. The motor/generator is mounted on the ground to provide a good stability and ease of maintenance. When heavy drums moved down, they release potential energy (i.e. electricity generation) to the main grid system. During the discharge phase, the drums are moved upward to store energy supplied by photovoltaic solar power or wind turbines, using power when not needed by the grid, storing the energy for later use.

GravitySoilBatteries can be used for a large-scale storage in conjunction with main grid systems. The technology is environmentally friendly and simple to construct. The estimate cost of GravitySoilBatteries is about $50/kWh or lower depending on the depth of the channels and height of the central support structure. The cost of PSH storage (without consider land cost) is about $200/kWh while the cost battery storage is about $400/kWh.

The energy storage capacity of GravitySoilBatteries for a small-scale storage could be 300kWh while for a high-scale storage could be 30,000kWh (or above) depending on the drum weight and stack height with an estimated system efficiency of approximately 85%. GravitySoilBatteries can be applied widely with simple siting and construction. For large-scale applications the GravitySoilBatteries system can be extended over several kilometres.

For more information, visit
https://www.youtube.com/watch?v=EZcZOjIvDOM
A High Efficiency, Low Cost and Building Integrated PVT System for Space Heating, Hot Water and Power Supply

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China has the largest solar thermal market in the world, with 45GWth installed as of 2013. Despite this, only 2.6% of China’s space heating, hot water and power demand in buildings is supplied using solar thermal systems.

This collaborative project, between Universities and businesses in the UK and in China, aims to tap into this market with a highly efficient and low cost PVT system.

The system aims to achieve 30% higher solar efficiency and 20% lower costs when compared to existing PVT systems. The system is also designed to be flexible so it can meet the demands of a specific building.

Four innovative technologies are employed to help the system meet its targets, these are a novel loop heat pipe; a novel PV/T panel; a highly efficient heat exchanger and storage unit and finally an internet based intelligent monitoring and control system.

The heat exchanger features a special triple tube design; this allows phase change materials (PCMs) to be included in the outermost tube. This enables excess heat to be stored during peak periods and discharged during periods of low solar availability using a technique known as peak shaving.

A hot thermal energy storage tank will be used in the centralised section of the design, where a PCM with a phase change region between 40~50°C will be utilised. Using intelligent control, this reserve of thermal energy can be used in a predictive way.

By using live weather data and predictions, energy can be stored in anticipation of periods of poor solar irradiance or fully utilised during sunny, warmer periods. This advanced control will offer a simple, easy-to-use interface to allow anybody to operate the system with confidence that their hot water needs are met.

Over the course of the project, methods of thermally enhancing the PCM were also investigated, using materials such as expanded graphite and aluminium. By using these thermal conductivity promoters, the traditional issues of organic PCM can be mitigated, with only a small drop in the overall latent heat capacity of the system.

These studies found that the freezing rate of the organic PCM can be increased by up to 167% with just a 4.5% drop in latent heat capacity, the melting rate also increases by 68% in this scenario.
Paraffin-sand mixture to enhance the underground thermal energy storage

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Nowadays, phase change materials (PCMs) play a key role in the thermal energy storage in form of latent heat in order to provide a realistic solution to increase the efficiency of the storage and use of energy in many domestic and industrial sectors. The CLIWAX project, funded by ERDF funds, aims to integrate PCMs in energy harvesting of multi-source heat pumps. In that, the underground thermal energy storage (UTES) integrates PCMs with shallow geothermal exchangers of the Flat-Panel type directly into the soil to exploit the additional thermal inertia of the phase change, increasing the performance in favour of a relevant reduction in the length of the exchanger and therefore in the cost of installing geothermal units.

The first step of this project involves the choice of the most suitable PCM by investigating its thermophysical behaviour in working conditions. Among the wide and various classes of PCMs we initially considered the paraffins (organic PCMs). Paraffins are the most widely used solid-liquid PCMs which possess high latent heat storage capacities over a narrow temperature range.

For a laboratory investigation, n-Octadecane (C18H38) with his well defined thermal, physical and chemical properties has been used as phase change material.

\[
\text{H}_3\text{C} \quad \begin{array}{c}
\text{CH}_2 \\
16 
\end{array} \quad \text{CH}_3 
\]

\[\text{n-Octadecane, } C_{18}H_{38}\]

<table>
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<th>Melting point (°C)</th>
<th>Heat latent (J/g)</th>
<th>Solid density (g/cm³)</th>
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<tr>
<td>28.0</td>
<td>244</td>
<td>0.776</td>
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Initially, the thermal behaviour in a time-temperature graph of pure n-Octadecane and of its mixture with dry sand has been observed and compared. Two small cylindrical containers with the same volume capacity have been used for the paraffin and the paraffin-sand mixture, respectively. In order to prepare the blend, an effective sand porosity was measured around 35%, and a ratio of 1:5 between the masses of the PCM and sand was used. Through the use of a heat bath two consecutive melting-solidification cycles in a temperature range of 23°C-33°C have been obtained, hence each cycle is characterized by solid-liquid-solid phase transitions. Only for the mixture sample, a similar analysis of sixteen cycles considering the same \(\Delta T\) in a programmed temperature ramp has been performed.

As depicted in the following graphs, during the heating process the paraffin-sand mix trend have a faster increase of the slope in comparison with the pure paraffin trend due to the thermal conductivity and heat capacity of the sand. Moreover, a constant supercooling phenomenon during the solidification process of each of the 16 cycles relative to the mixture sample has been noticed. Preliminary remarks, let us suppose that in this metastable condition the PCM (still composed exclusively of liquid phase) dissipates heat at the expense of the average kinetic energy of the molecules until the formation of the first crystalline germ. Preliminary results show that n-Octadecane seems to have a functional integration with sand and its thermophysical behaviour is not affected by variations during the time. Therefore, direct mixing of paraffin into the soil could be considered a solution for UTES. This type of PCM application will be the subject of further studies to verify its reliability and long-term performance, such as environmental issues.
IAQVEC 2019, Bari, Italy

The 10th International Conference on Indoor Air Quality, Ventilation and Energy Conservation in Buildings will take place on 5-7 September 2019 in Bari, Italy. The city of Bari, Puglia’s provincial capital, is on the Adriatic Sea, and is one of the finest destinations in southern Italy.

IAQVEC is a premier international conference series, held once every three years. The conference covers a wide range of key research areas with the goal of simultaneously improving indoor environmental quality (IEQ) and energy efficiency-enhancing wellbeing and sustainability. This year’s Conference theme is Healthy Nearly Zero Energy Buildings

Main topics:
- Ventilation strategies and measurement techniques
- IAQ and Indoor Environmental Quality
- HVAC systems
- Smart Technologies for ZEBs
- ZEBs: design and energy modelling

Abstract submissions have closed but you can still register to attend. For more information and to register, visit www.iaqvec2019.org

2019 International Seminar of the Department of Architecture, Université Badji Mokhtar, Annaba, Algeria: "Live the city, between yesterday and tomorrow"

The future of the world lies in cities and, according to the United Nations, by 2050 50% of the world's population will live there. Communities will have to adapt to new lifestyles, new spatial realities, and to the restriction of space and the excessive densification of cities.

The seminar "Living the city, between yesterday and tomorrow" runs from 24 to 26 November, 2019, and will address this issue from several angles. Our concerns, as actors in construction, are about transformations and emerging spatial realities.

The themes of the seminar will be:
- Taking charge of the city's past.
- Environment and urban living environment.
- City and mobility.
- Design and innovative techniques.
- The prospective city: stakes and challenges
**WSSET exclusive offer – IJLCT**

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](http://www.ijlct.oxfordjournals.org) to submit your articles.

**WSSET exclusive offer - FCaE**

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](http://www.futurecitiesandenvironment.com) to submit your articles.

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Please visit [www.hoajonline.com/renewablebioresources](http://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.