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DTA3/COFUND Programme Research Project Proforma

Page 1 – General Information

Project Code	UHEN07
Partner University	University of Hertfordshire
Faculty/School/Department/Research Centres	Engineering and Computer Science
First supervisor **Please provide name, email address (for UA use) and weblink**	Dr. Liang Li http://go.herts.ac.uk/Liang_Li
Second supervisor **Please provide name, email address (for UA use) and weblink**	Professor Yong Chen http://go.herts.ac.uk/yong_chen
Third supervisor **Please provide name, email address (for UA use) and weblink**	Dr. Hongwei Wu http://go.herts.ac.uk/hongwei_wu
Fourth (external) supervisor	
External/industrial supervisor	Professor Xiang Luo National Key Laboratory of Science and Technology on Aero Engines Aero-thermodynamics, Beihang University
Which of the supervisors listed above is an early-career-researcher	Dr. Liang Li
Contact details for project for informal applicant queries **Email address**	Dr. Liang Li Email: l.li30@herts.ac.uk
DTA Programme	DTA Energy
Project title	Design and Experimental Investigation of Solar powered energy storage and generation systems

Co-funded by the Horizon 2020 programme of the European Union

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 801604.

Page 2 – Project Description

Scientific Excellence (500 words)	Globally, the extensive consumption of fossil fuels in electric and thermal generation has been contributing increasingly to global warming and energy resource depletion. Considering the extraordinarily high energy consumption levels within the domestic application, the electric power and thermal energy consumed by domestic has been the source of considerable CO_2 emissions. There is a vast amount of domestic waste heat and relative renewable energies with temperature ranges of between 20℃ and 95℃, if this could be exploited through advanced technologies to be converted into electricity and useful heat, the result would be exceedingly significant. These technologies are based on energy storage and conversion systems with innovative thermodynamic cycles subject to heat source temperature ranges and appropriate working fluids. However, certain technical and practical issues need to be identified and solved before any such technology is put into practice for domestic application. Solar powered Combined energy Storage and Generation system (CSG) driven by phase change materials (PCM) and advanced power generation system has been discovered to be a promising thermodynamic process. This project will design and set up an advanced test rig of the CSG system with solar thermal energy with nanofluids as heat source and the state-of-the-art PCM as the energy storage materials for domestic application. The Nano and PCM technologies involved into CSG system is an innovative method to further increase the system efficiency and reduce the physical size. This project will significantly contribute towards achieving the target of over 8% of total electric power worldwide being generated from waste heat and renewable. Results obtained from the proposed project will improve the competitiveness of UK manufacturing within the energy sector by increasing technical knowledge with data within the UK.

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Aim (400 words)	**Clear aim and hypothesis:** The proposed project aims to investigate and understand, theoretically and experimentally, the usage of advanced CSG system with nanofluid and PCM as working fluid for renewable thermal energy recycling and power generation from heat source of a temperature range 20℃ to 95℃. Specific objectives are: Optimised design of all CSG system, with PCM energy storage system and advanced power generation system, for a range to low heat sources temperatures and heat recovery from solar thermal energy. Establish a multi-functional and high precision test rig for the solar powered energy storage system with nanofluids and PCM materials and heat source temperatures ranging from 20℃ to 95℃. Understand the complex heat recycling processes involved in renewable energy storage and power generation system and obtain valuable performance data through the use of advanced flow measurement technologies. Design detailed transient simulation models for each components and CSG system and validate the models with experimental results. Investigate the heat transfer and thermal behaviour of major components, particularly the energy storage heat exchanger with PCM and nanofluids in the CSG system, and system thermal and exergy efficiencies through experiment and simulation modelling. Prepare the operation specification for the CSG system. Demonstrate the advantages of the proposed system over conventional domestic boiler system ones through the use of a prototype. **Methodology and innovations:** The project will span three years and require the research activities of one PhD research student for three years to be funded by the H2020 Marie Curie project (COFUND). Industry partner will act in an advisory capacity and design of major components and manufacture while the academic partners (national and international universities) will carry out the research and development through the project. The project will comprise the following work packages:

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	Work Package 1: Design and construction of test facilities An experimental rig will be design and constructed for solar-CSG system driven by PCM materials and nanofluid. The system consists of a solar thermal panel, nanofluids pump, PCM heat exchangers and controls etc. Work Package 2: Experimental investigation Experiments will be performed in order to establish the effects of temperatures and performances of heat exchangers with nanofluids and PCM in CSG system and controls on the system. Work Package 3: Development of transient system and component models Work Package 4: Dissemination and Impact
Strategic Relevance (300 words)	This project will provide fundamental understanding into low grade renewable thermal energy recycling, storage and power generation with advanced thermodynamic cycles such as heat pump system and Brayton cycles etc. together with its associated design and control optimisation strategies. The research will enable end-users to maximise system efficiency and low greenhouse gas emissions compared to traditional heat and power generations by fossil fuels. The primary impact will be the knowledge transfer from University of Hertfordshire to the industry collaborator and academic partners. The second impact is University of Hertfordshire will lead dissemination activities to further R&D of energy storage and power generation solutions for additional applications. In addition, project results will be communicated through high-impact, peer-review journals and relative new academic research grant application (EPSRC new investigator and Royal Society Research Grant etc.). The third impact is University of Hertfordshire will lead knowledge transfer activities to UK and EU policy and legislation on the environment by a number of national and international networks and committees.
Interdisciplinary and fit with DTA3	This proposed project combines the research of energy storage and power generation system analysis, PCM measurement and renewable thermal energy recycling (solar thermal) etc. It strongly fits with the Energy DTA3 programme.

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Industrial Relevance (300 words) Detail external placement opportunities or collaborations available as part of the project	The PhD student will have the opportunity to do some research knowledge transfer activities about the solar powered supercritical Rankine cycle system with external supervisor in China. In addition, some experimental tests of heat sources and power generation systems (organic Rankine cycle system and transcritical Power generation system etc.) could be carried out in Brunel University London, South Wales University and relative industrial collaborators.
Economic and Societal Impact (300 words)	This project will significantly contribute towards achieving the target of over 8% of total electric power being generated from renewable and waste heat in worldwide. This project will address the major issue in which substituting energies mostly create low grate heat sources ranging roughly from 20°C to 95°C, in contrast to the high temperature water generated through national gas consumption. Thus, renewal of localised low temperature energy conversion systems with high efficiency energy storage system, using state-of-the-art working fluids, to replace the remote and conventional gas/ electrical water boiler will be developed. The research programme proposed here will build on the fundamental understanding of the solar powered low temperature CSG system and their design and control optimisation to provide maximum efficiency over a wide range of conditions. The project will also improve the completeness and capability of UK manufacturing within the energy sector by increasing technical knowledge and stimulating manufacturing capabilities within the UK. This will also provide training and employment opportunities in the UK energy and manufacture sectors. University of Hertfordshire will drive research objectives which will contribute to delivery high-impact, peer-review journals for REF 2021 and relative new academic research grant applications. In addition, University of Hertfordshire will lead knowledge transfer activities to UK and EU energy sectors by a number of national and international committees.

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Page 3 – Admission Requirements

Specific Admission Requirements Detail any subject specific degree qualifications or disciplines, relevant skills, experience	Applicants should have, or expect to achieve, at least a 2:1 Honours degree (or equivalent) in mechanical engineering or building services engineering or have an appropriate MSc qualification.
Minimum IELTS score	6.5

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