



## An Innovative Pathway for PhD research in Thermal Energy Storage

January 2017

Welcome to the Fourth INPATH-TES Newsletter, which includes the latest on INPATH-TES progress and development, profiles of recently graduated PhDs, news updates of conferences and seminars on TES, and a summary of participants of the project. An upcoming conference "The 3rd International Conference: Innovative Materials and Smart Technologies for Environmental Safety (IMST 2017)", organised by our partner in Riga Technical University, Latvia, will take a place on September 27 – 29, 2017. For further information and updates please check our website [www.inpathtes.eu](http://www.inpathtes.eu).

### INPATH-TES Update

The Fourth general meeting of the INPATH-TES project took place in Lleida, Spain on October 27 - 28, 2016. The meeting took place at the 'Aula Magna Saló Víctor Siurana', located in 'the rectorate building' at the University of Lleida. The board meeting was followed by the first Training Advisory Board (TAB) meeting where the chair of the TAB, Prof. Torsten Fransson, explained the main objectives of the meeting and the reviewing process of the learning material developed by the consortium.



INPATH-TES Consortium at University of Lleida, Spain during the 4th General Board Meeting, October 2016

### INPATH-TES in the 3rd UNI-SET Energy Clustering Event



Dr. Gabriel Zsembinszki, University of Lleida, presenting INPATH-TES project.

The 3<sup>rd</sup> UNI-SET Clustering Event took place on November 21 - 23, 2016; it was hosted by the University Politehnica of Bucharest, Romania. The event explored how European universities can further cooperate in research and education activities in the fields of energy system integration, smart systems and the role of energy consumers. The conference participants were offered insights into innovative programmes and approaches from a multidisciplinary perspective through examples, lessons learnt and other best practice. The overall goal of the event was to strengthen inter-university cooperation and thus the voice of universities in the development of energy policy at EU level. A presentation on INPATH-TES project was given by Dr. Gabriel Zsembinszki from the coordinating institution, University of Lleida. The project objectives, the main activities carried out so far, and the main challenges that were encountered were explained.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 657466





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### ***INPATH-TES in the European Researchers' Night 2016***

The objectives and activities of INPATH-TES were presented during the European Researchers' Night organized by the University of Calabria (Italy) in September 30<sup>th</sup>, 2016. The European Researchers' Night takes place every year all over Europe and neighbouring countries and is supported by the European Commission as part of the Marie Skłodowska-Curie Actions. The initiative was created with the objective to bring the general public beyond the research community, and in particular to the figure of the researcher, helping to increase the citizens' awareness of the importance that today covers the scientific research for the social and economic development of society. The INPATH-TES project was presented in two stands by posters, leaflets, and newsletters. The University of Calabria staff provided information about the project all the night by contacting students, public in general and potential stakeholders. The event attracted a high local and regional media interest and a radio interview about INPATH-TES was transmitted.



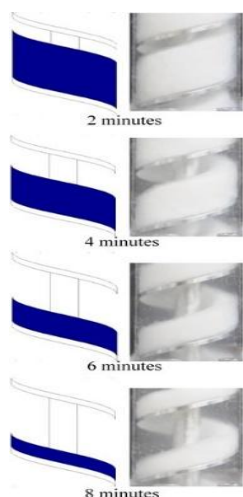
### ***Annex 30 – Thermal Energy Storage for Energy Management and CO<sub>2</sub> Mitigation***



As introduced in the previous newsletters, the main objective of Annex 30 is to encourage the implementation of thermal energy storage systems and evaluate their potential with respect to CO<sub>2</sub> mitigation and cost-effective thermal energy management. A recent workshop was held in Tokyo, Japan from October 17 – 19, 2016. This event brought together both research interests and Japanese industrial partners to discuss the integration of thermal energy storage systems into processes. The annex work will continue with the development of a methodology for process analysis for TES integration as well as further work on evaluation of TES systems in applications. An upcoming workshop is scheduled in Lleida, Spain on April 24 - 26, 2017. For more information, please contact the annex manager Duncan Gibb at [duncan.gibb@dlr.de](mailto:duncan.gibb@dlr.de) or visit the website at [www.eces-a30.org](http://www.eces-a30.org).

### ***Profiles of INPATH-TES Partners***

#### ***The Heat Transfer Laboratory (HTL)***



The Heat Transfer Laboratory (HTL) is based in the Department of Mechanical Engineering, Ben-Gurion University of the Negev and the team is lead by Prof. Gennady Ziskind, HTL research expertise encompasses complex experimentation and modeling for phase-change thermal energy storage and thermal management. Among widely-known contributions made by the Laboratory to the field of latent-heat thermal energy storage (LHTES), based on phase-change materials (PCM), one can mention full numerical modelling of solid-liquid phase change processes in basic geometries, like spherical and cylindrical containers and finned systems. More recently, the Laboratory has initiated a successful multi-year study of latent-heat storage units, demonstrating theoretically and experimentally novel ways for heat transfer enhancement in these systems. Among other recent activities, the HTL team has developed a novel theoretical model for solidification with super cooling and an original approach to thermal analysis and design of multi-PCM systems. HTL actively participates in numerous European and international activities in the field of thermal energy storage. For more information, please go to <http://in.bgu.ac.il/en/engn/me/Pages/meResearchLab.aspx>.





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### *Profiles of PhD Graduates*



Dr. Shuiquan Lan was awarded his PhD in June 2016 from Eindhoven University of Technology, The Netherlands. The title of his thesis was 'Grain-scale analysis of thermochemical heat storage materials'. In order to develop efficient thermochemical storage systems with sufficient thermal power, it is important to develop optimized TCM materials. For this, it's necessary to understand in detail the mass and heat transfer processes in the thermochemical material, both at grain scale and at packed bed scale. This thesis focuses on numerical and experimental analysis of the dehydration reaction kinetics at grain level. Subsequently, the results at grain level are used to simulate in detail the dehydration behavior in small powdery samples of salt hydrate grains in an air flow. The study focuses on the dehydration of lithium sulfate monohydrate ( $\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ ), which is used as a model material for salt hydrates. (Supervisors: Prof. Anton van Steenhoven, Prof. Herbert Zondag, Dr. Camilo Rindt).

Dr. Engin Küçükaltun was awarded his PhD in September 2016 from Çukurova University, Turkey. The title of his thesis was 'Synthesis of highly thermal conductive polyethylene terephthalate polymer to use as packaging material of phase change materials'. The objective was to synthesize Polyethylene Terephthalate (PET) polymer with enhanced thermal conductivity that could be utilized as packaging material in phase change material (PCM) applications for fast thermal response. Graphene and Polypyrrole are used as thermal conductivity enhancement additives via direct polymerization period of PET. The results revealed that it is possible to produce PET-Graphene composite easily during polymerization reaction. The thermal conductivity could be increased by 71% up to a value of  $0.48 \text{ W/m}\cdot\text{K}$  with only 1 % Graphene addition. (Supervisors: Prof. Halime Paksoy).



Dr. Cristina Prieto was awarded her PhD in September 2016 from University of Lleida, Spain. The title of her thesis was 'Advanced thermal energy storage research in demo plants for commercial systems'. Currently, commercial thermal storage technologies are direct and indirect molten salt storage and steam accumulators, being the first system the most widespread. Throughout this thesis, a process of analysis, study and optimization has been done in a thermal storage system with molten salt from its initial stage of development to a demonstration stage in order to be able to extrapolate the results to commercial designs, allowing the development of storage technologies more efficiently. This work helps to reduce costs and increase the efficiency in CSP plants with a clear objective: that solar electricity will be competitive with fossil plants in 2020. This research was involved with collaboration between three INPATH-TES partners University of Lleida, University of Barcelona and Abengoa Solar NT. (Supervisors: Prof. Luisa F. Cabeza and Dr. A. Inés Fernández).

Dr. Laia Miró was awarded her PhD in November 2016 from University of Lleida, Spain. The title of her thesis was 'Industrial waste heat: mapping, estimations and recovery by means of TES'. Current trends in energy supply and demand are economically, environmentally and socially unsustainable. In this energy context, the use of recovered waste heat provides an attractive opportunity to substitute primary energy consumption by a low-emission and low-cost energy carrier. Despite its potential, in the specific case of industrial waste heat (IWH), this potential is currently not only largely untapped, but also unaccounted. Thus, the aim of this PhD is to overcome some of the current technological and information barriers and to provide the literature and the researchers with more knowledge of the topic and supporting its widespread development. (Supervisor: Prof. Luisa F. Cabeza).







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