Innovative European initiative for education in Thermal Energy Storage at PhD level

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• Introduction to the project
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• Thermal energy storage (TES) bridges the gap between renewable production and energy use and is therefore an important part of a sustainable energy systems.

• TES can be implemented for a wide range of temperatures, energy and power requirements.

However, the lack of knowledge on TES is holding back implementation.

INPATH-TES enables implementation of TES by providing a framework to educate professionals both in academia and in industry.
Introduction to the project

• The training of skilled professionals in the field of TES (Thermal Energy Storage) technologies is of great importance.

• This was also confirmed by the European Commission (EC) SET-Plan Education and Training (E&T) Roadmap.

• The SET-Plan E&T Roadmap identified clear gaps and needs for more efficient PhD education in the area of thermal energy storage.
Introduction to the project

• Title and logo: INPATH-TES
  PhD on Innovation Pathways for TES

• Duration: 36 months
• Start: 1 May 2015
• Call: H2020-LCE-2014-2
• Type: Coordination and Support Action
• Coordinator - University of Lleida (SPAIN)
• Website: www.inpathtes.eu
Introduction to the project

• Main goal:
  – To create a network of universities and research institutes to **implement a joint PhD programme on TES technologies** at year 0+2 (2017)

• Specific objectives:
  – To develop at least **20 ECTS of basic common training**
  – To develop **4 basic common technology** PhD courses
  – To establish **one annual workshop** for PhD students
  – To aim at **graduating at least 28 PhD students every year** at year 0+6 (2021)
  – **To exchange at least 14 PhD students every year** between industry and academia
Introduction to the project

- INPATH-TES consortium: 22 partners, 14 countries
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The PhD programme

• A total of 14 courses are being developed by the consortium

• The PhD programme is built according to the following structure:
  – Course
    • Topics
      – Lessons
        » Learning activities: recorded videos, e-books, presentations, animations, diagrams, pictures and texts, assessment questions, access to remote lab exercises, interactive simulations, filmed study visits and online literatures

The PhD programme

• Basic common PhD courses
  – Course 1: *Research and PhD*
  – Course 2: *Introduction to thermal energy storage*
  – Course 3: *Thermal energy storage materials*
  – Course 4: *Testing and characterisation of thermal energy storage materials*
  – Course 5: *Heat and mass transfer and sizing of energy storage devices*
• Research management, dissemination, and communication courses ("soft skills")
  – Course 6: *Intellectual property and patenting ideas*
  – Course 7: *Idea to product development*
  – Course 8: *Dissemination and communication of R+D+I*
  – Course 9: *Funding of research and project management*
  – Course 10: *Management and entrepreneurship*
The PhD programme

• Common technology specialisation courses
  – Course 11: *Thermal energy storage applications for buildings*
  – Course 12: *Demand side management concepts and energy storage*
  – Course 13: *Large-scale and industrial energy storage*
  – Course 14: *Energy policy and market development*
The PhD programme

- The EIT/InnoEnergy pedagogical methodology is being implemented within an online platform
The PhD programme

Course 3: Thermal energy storage materials

Topic 4 - Micro and nano-scale modeling of TES materials

Lesson template

Learning activity - videos
The PhD programme

Introduction to kinetic theory

PDF Presentation

PhD on Innovation Pathways for TES

TU/e

Introduction to Kinetic Theory
H. Zhang, L. Salimi Parvaneh, S. V. Nedea, C. C. M. Rindt
December 2016

Contents

1. Kinetic Theory
2. Maxwell Distribution
3. Derived quantities for velocity
4. Mean free path length
5. Knudsen number
6. Transport properties of a perfect gases
   - Thermal conductivity
   - Dynamic viscosity

Assessment

Why do we need multiscale modeling of materials?
- The grand unified theory (GUT) is not well established
- Computational resource is limited
- Each model has its own assumptions and limitations and therefore can only be used at a specific time and length scale
- The physical phenomena may happen at multiple time and length scales

Sort the following models from the smallest to the largest scales
- Molecular dynamics
- Density functional theory for electronic structure
- Mesoscale models
- Continuum mechanics

Correct

Learning activity – PDF presentation

Learning activity - assessment

Energy Research Meet, 26 Jan. 2018
L. Salimi Parvaneh
Eindhoven University’s Role

• The Energy Technology and Fluid Dynamics group at Mechanical Engineering department provides lessons on “Micro and nanoscale modeling of TES materials” and a lesson on “Sorption and Chemical heat storage”.

• We are setting up co-tutelle agreements with UdL, UB, INSA and Ghent University.
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Main events

• Consortium meetings every 4 months

• Events for stakeholders and policy makers
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Main challenges

- Development of the programme
- The implementation of the programme in each country/institution
- Two levels of work: PhD programme and Master of Science (MSc) programme
- To ensure the continuity of the programme after EU funding ends
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Students have the possibility to do a PhD through *co-tutelles* between the participating universities

INPATH-TES label can be awarded if some requirements are fulfilled

External people from academia or companies may also take courses from the platform

Enrolments will be possible by filling up the form available on the project website and paying the fees

**Keep an eye on the project website!**

http://www.inpathtes.eu/
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Future expansion of the network

- The partners of the consortium will be the core of a future larger network of excellent R&D institutions from academia and industry.
- New members can join the network in the future as associate partners.
- Membership fees will be paid annually to make it sustainable after the end of EU funding.
- Core members will pay a reduced fee, but they will have some responsibilities, such as creating, updating, and reviewing the learning material.
Future expansion of the network

- Workshops for students, webinars, etc. will also be organised
- Although currently it is impossible, we still aim for a joint PhD programme in the future
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