INTERNATIONAL SUMMER SCHOOL

July 8-11, 2024

Electrochemical and Hydrogen Energy Storage for Mobility and Microgrids

Detailed final Program

FC LAB

femto-st SCIENCES & TECHNOLOGIES

DAY 1
Monday July 8th 2024- Morning

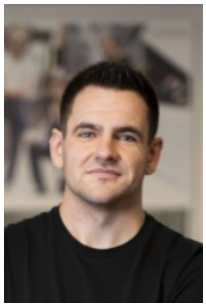
Conference 1

From second-life battery to certified product

Dr. Romain Tabusse, SWOOP ENERGY, France
romain.tabusse@outlook.fr

Abstract

This presentation will explore the journey of automotive second-life batteries towards their integration into safe and reliable products. We'll start with an introduction to second-life batteries, explaining their reuse after a first life in electric vehicles.
We will discuss the environmental and economic benefits, such as waste reduction and resource optimization, as well as the technical and regulatory challenges, including health assessment and safety risk management.
The presentation will describe the essential steps involved in transforming a second-life battery into a certified product: performance and safety testing, and integration into new energy systems. We'll look at certification protocols and industry standards.
Finally, we'll share concrete examples of successful projects illustrating the positive impact of second-life batteries in various sectors such as events, construction and the audiovisual industry.
This presentation aims to raise awareness of the potential of second-life batteries and the importance of certification for their successful integration into the circular economy.



Romain TABUSSE has a PhD degree in electrical engineering from University of Technology of Belfort-Montbéliard (UTBM) in France. He wrote his thesis on lithium-ion batteries, developing new characterization and accelerated aging methodologies on test benches for the automotive industry. He is now pursuing a career in industry as CTO of Swoop Energy, developing portable energy stations powered by second-life electric car batteries.

DAY 1
Monday July 8th 2024- Morning

Conference 2

Hydrogen storage solutions: challenges and focus of the MINCATEC Energy solution

Mr. Emmanuel BOUTELEUX
MINCATEC Energy, France
emmanuel.bouteleux@mincatec.com

Abstract

The presentation explains hydrogen storage technologies, and in particular solid-state hydrogen storage in metal hydrides developed by MINCATEC Energy. It exposes the possible uses of this technology in the decarbonization of industry and mobility.

A car enthusiast since childhood, **Emmanuel BOUTELEUX** is a graduate engineer from ESTACA. With a background in suspension engineering, he worked on test engineering and the development of thermal and hybrid powertrains. He went on to manage a BU at D2T, a strategic subsidiary of IFPEN.
He joined Mincatec in 2017 as Managing Director with new challenges based on more environmentally-friendly technologies and solutions. He has been involved from the start in developing the solid hydrogen storage solution with the creation of MINCATEC Energy in 2020.

DAY 1
Monday July 8th 2024- Morning

Conference 3

H2-ICE developments at TNO powertrains

Mr. Thomas Dankers
thomas.dankers@tno.nl

Abstract

TNO is a Dutch Research and Technology organisation who connects people and knowledge to create innovations that boost companies' competitiveness and sustainably increase well-being across society. TNO forms the bridge between the academia and the industrial world. The mobility unit of TNO, and specifically the Powertrains department located in Helmond, focusses on the heavy-duty industry with research topics in batteries, fuel cell solutions, modular energy management systems, automatic driving, and sustainable combustion engines (eg. H2-ICE). The focus of this presentation will be on the latter subject.
In our test facility in Helmond, it is possible to perform hydrogen internal combustion engine (H2-ICE) experiments on four heavy-duty single cylinders, as well under varying ambient conditions. In our H2-ICE research, TNO provides services into engine/combustion design, integration of cylinders on a multi-cylinder platform, and doing verification and certification tests.
The current focus of TNO regards H2-ICE concepts is in port-fuel injection spark ignited (PFI SI), low-pressure direct injection spark ignited (LP-DI SI), and high-pressure direct injection compression ignited (HPDI CI). Where Spark ignited H2-ICE engines achieve ultra-low NOx emissions, compression ignited H2-ICE engines excel in efficiency. Moreover, within the department, research is being done to combine both benefits, by adding new combustion techniques, such as lean-burn combustion or water-injection. To support these activities, CFD H2-ICE models have been developed to represent the combustion strategies. Overall, this forms a world leading research strategy in the topic of H2-ICE engines.

My name is **Thomas Dankers** and I work at TNO as a Scientist Innovator in the Powertrains department, fresh after graduation since March 2023. I am 25 years old and live in a small village in the south of the Netherlands. Furthermore, I love to spend my spare time outside, and doing sports as football or tennis. I studied Mechanical Engineering at the University of Technology of Eindhoven (TU/e). During my masters, I worked as an intern at the R&D Battery Research and Technology department at the Hilti Group in Liechtenstein, where I was involved in the assembly of experimental cells. Moreover, I did my graduation project in the topics of fuel cell diagnostics at the Powertrains department of TNO in Helmond. So after my graduation, I stayed at the powertrains group of TNO, and currently, I am mainly involved in the hydrogen topics related to PEM Fuel Cells in the heavy-duty sector. My work is related to modelling activities on fuel cells, but as well on higher level activities such as the integration of fuel cells in the maritime industry. However, my interests don't stop solely at fuel cells. So I keep a close eye to the developments in batteries, and H2-ICE combustion as well.

DAY 1
Monday July 8th 2024- Morning

Conference 4

Lithium-ion Battery Materials

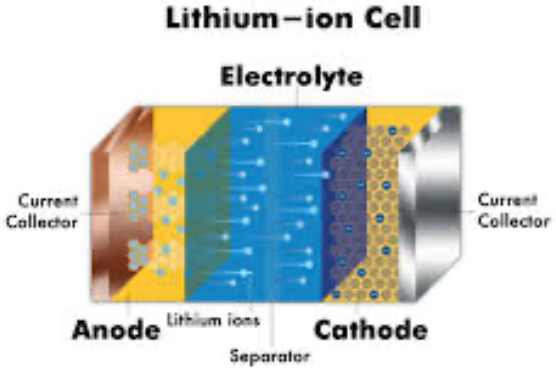
Prof. Ismael Saadoune, UM6P, Maroc
ismael.saadoune@um6p.ma

Abstract

The demand for lithium-ion batteries (LIBs) has surged dramatically in recent years, driven by their outstanding electrochemical performance and versatility in both stationary and portable electronic devices. This surge is a result of continuous innovation in the energy storage sector, which has seen significant shifts due to the widespread adoption of LIBs as a robust storage solution. According to a survey by the International Energy Agency, demand for LIBs increased by 700% from 2015 to 2021, reaching nearly 350 GWh annually.

Lithium-ion cell is composed of several key components, each playing a critical role in their function. These components include the anode, the cathode, the electrolyte.

While most anode materials consist of graphite, this course will provide an overview of the various cathode materials available in the market, beginning with $LiCoO_2$, the cathode material used in the first commercially available lithium-ion batteries introduced by Sony in 1991. The future challenge of this key technology for energy transition will be also presented.



Dr. Ismael Saadoune, a Full Professor at Mohammed VI Polytechnic University, completed his academic journey with a French PhD from the University of Bordeaux in 1992 and a Moroccan PhD from the University Cadi Ayyad UCA-Marrakech in 1996. His dual doctoral pursuits centered on advancing Active Materials for Lithium and Sodium-ion Batteries, offering promising solutions for energy storage challenges.

In 2002, Dr. Saadoune established the Laboratory of Materials and Environmental Chemistry, where he mentored over 100 graduate and 40 Master students. Guiding the research endeavors of 25 PhD candidates, all now active in industry or research laboratories, Dr. Saadoune has left an indelible mark on academic and industrial landscapes. As the principal investigator, he spearheaded 19 national and 23 international research projects on Battery Materials, demonstrating his commitment to advancing energy storage technologies. His contributions extend beyond academia, as he played pivotal roles in two European Master ERASMUS MUNDUS programs: 'Materials for Energy Storage and Conversion' and 'Functionalized Advanced Materials and Engineering'.

Dr. Saadoune's expertise has been sought after globally, with invitations to prestigious universities and research centers including Uppsala University (Sweden), Karlsruhe Institute of Technology (Germany), ICMM-CSIC (Spain), Jilin University (China), and Bordeaux University (France). His prolific academic output encompasses over 160 articles, conference papers, and project reports, underscoring his significant contributions to the field of electrochemical energy storage and conversion.

For more information, please visit the links :
GOOGLE SCHOLAR: https://scholar.google.fr/citations?user=zgCkaZwAAAAJ&hl=fr
ORCID ID: 0000-0003-1322-361X

DAY 1: Monday July 8th 2024 - Afternoon
DAY 2: Tuesday July 9th 2024 – Afternoon

Courses 1

Hydrogen storage

Dr. Djafar Chabane[*], Dr. Santiago SUAREZ[**]
[*]UTBM, CNRS, Institute FEMTO-ST, 90010 Belfort, France
[**]LAPLACE, CNRS, TOULUSE, France
djafar.chabane@utbm.fr, suarez@laplace.univ-tlse.fr

Abstract

Hydrogen storage is a critical technology for the advancement of clean energy applications, including transportation and electricity generation. This paper reviews the three main methods of hydrogen storage: high-pressure storage, liquid hydrogen storage, and solid hydrogen storage. High-pressure storage involves compressing gaseous hydrogen into tanks at pressures up to 700 bars, offering simplicity but posing safety and cost challenges. Liquid hydrogen storage, achieved by cooling hydrogen to -253°C, provides higher energy density but requires efficient thermal insulation and incurs high liquefaction costs. Solid hydrogen storage utilizes materials such as metal hydrides and nanoporous materials to absorb and release hydrogen, promising enhanced safety and storage density but needing further research for practical and economical solutions. The continued innovation and cost reduction in hydrogen storage technologies are essential for the widespread adoption of hydrogen as a sustainable energy carrier.

Dr. Djafar Chabane received his Bachelor's degree and Master's degree in Electrical Engineering from the University of Tizi-Ouzou, Algeria, in 2011. He then earned another Master's degree in Physics and Energy Engineering from the École Normale Supérieure de Cachan, France, in 2013, and completed his Ph.D. in Engineering Sciences at the University of Bourgogne Franche-Comté, France, in 2017. Since September 2020, he has been an Associate Professor at the University of Bourgogne Franche-Comté and UTBM, affiliated with the FEMTO-ST Institute and the FCLAB Research Center. His research focuses on fuel cells, green hydrogen production, and hydrogen storage in solid form, with an emphasis on developing energy management strategies and smart control approaches for transportation and stationary applications.

Santiago H. Suarez, obtained his electrical engineering degree from the National University of Tucuman (UNT) in Tucuman, Argentina in 2019. In the same year he obtained his master's degree in energy from the Université de Technologie de Belfort-Montbéliard (UTBM), France. He defended his doctoral thesis at the Université Bourgogne Franche-Comté (UBFC) on the energy management of a hydrogen system conformed by a fuel cell and a hydrogen storage system based on metal hydrides in 2022. In 2023, he became associate professor at the École Nationale Supérieure d'Electrotechnique, Electronique, Informatique, d'Hydraulique de Toulouse which is part of the Institut National Polytechnique de Toulouse (INP-T ENSEEIHT). His field of specialisation is the conception, technical-economic optimisation and management of multi-energy systems (electricity, hydrogen and heat/cold) in stationary and on-board applications. He carries out his work in the Laplace Laboratory at the Groupe Energie Electrique et Systemique (GENESYS).

DAY 1: Monday July 8th 2024 – Afternoon
DAY 2: Tuesday July 9th 2024 – Afternoon

Courses 2

Electrochemical Impedance Spectroscopy for electrochemical devices

Dr. Elodie Pahon
*UTBM, CNRS, Institute FEMTO-ST, 90010 Belfort, France

Abstract

This course is designed to present the electrochemical impedance spectroscopy (EIS) technique applied to electrochemical devices including batteries, fuel cells and water electrolyzers. The aim is to detail the general shape of the EIS based on simple electrical circuit representation. Models will be illustrated for each system and the main parameters that could be extracted from the EIS. Some examples of diagnostic of prognostics usages will also be developed.

Following the course, a practical work is proposed to build your model and fit it based on experimental data. A brief description of commercial device and settings will also be further explained.

Elodie Pahon received her M.S. degrees in electrical engineering from the University of Franche-Comté, France, in 2012 and the Ph.D. degree in engineering sciences from University of Franche-Comté, France, in 2015. She obtained the habilitation to conduct research (HDR), in 2023. Since 2019, she is an associate professor at University Technology Belfort Montbeliard (UTBM) and makes her research in FEMTO-ST Energy department (SHARPAC team) and FCLAB. Her current research focuses on the hydrogen systems durability and reliability by developing diagnostic, prognostic, and smart control approaches. She has been awarded by the Hydrogen Europe Research in the transport pillar, in 2018.

DAY 2
Tuesday July 9th 2024- Morning

Conference 5

Prognostics and Systems Health Management Beyond Deep Learning Techniques via Recurrent Expansion: Potential, Applications, and Prospects for Hydrogen and Energy Storage System

Prof. Mohamed BENBOUZID, IEEE Fellow
University of Brest, UMR CNRS 6027 IRDL, Brest, France
Mohamed.Benbouzid@univ-brest.fr

Abstract

Machine learning applications for prognosis and health management usually face data unavailability, complexity, and drift due to the massive and rapid evolution of data volume, velocity, and variety (3V). Advances in deep learning have brought many improvements in this area, providing generative modeling, nonlinear abstractions, and adaptive learning to meet these challenges. Deep learning aims to learn from representations that provide a coherent abstraction of the original feature space, enabling it to be more meaningful and less complex. However, the data complexity associated with various distortions, such as higher noise levels, remains challenging to overcome. In this context, recurrent expansion algorithms have recently been introduced to explore deeper representations than ordinary deep networks, enabling even better feature mapping. In contrast to traditional deep learning, where abstracting inputs extract meaningful representations, recurrent expansion merges entire deep networks into one, allowing inputs, maps, and estimated targets to be explored as primary sources of learning. These three sources of information provide additional knowledge about their interactions in a deep network. Furthermore, recurrent expansion provides the ability to investigate the estimated targets of multiple networks and learn significant features, improving its accuracy with each round. This keynote will provide a general overview of recurrent expansion, its main learning rules, variants, and prospective developments in this context. Case studies on electromechanical systems will be provided to illustrate the effectiveness of recurrent expansion prognosis.

Mohamed Benbouzid completed his Ph.D. in electrical at the National Polytechnic Institute of Grenoble, Grenoble, France, in 1994. He further earned his Habilitation à Diriger des Recherches degree from the University of Amiens, Amiens, France, in 2000.

Following the completion of his Ph.D., Dr. Benbouzid joined the University of Amiens, where he held the position of Associate Professor in electrical engineering. Since September 2004, he has been affiliated with the University of Brest, Brest, France, where he currently serves as a Full Professor in electrical engineering. Additionally, he holds the distinguished positions of a Distinguished Professor at the Shanghai Maritime University in Shanghai, China. Prof. Benbouzid primary research interests and expertise include control of electric machines, variable-speed drives for traction, propulsion, and renewable energy applications, and fault diagnosis of electric machines.

Prof. Benbouzid is an IEEE Fellow and a Fellow of the IET. He is the Editor-in-Chief of the International Journal on Energy Conversion and the Applied Sciences (MDPI) Section on Electrical, Electronics and Communications Engineering. He is a Subject Editor for the IET Renewable Power Generation.

DAY 2
Tuesday July 9th 2024- Morning

Conference 6

ENERGETIC European Project – The Potential of Energy Storage and Advanced Battery Management for a Sustainable Future in Europe

Dr. Daniela CHRENKO
UTBM, CNRS, Institute FEMTO-ST, FCLAB, 90010 Belfort, France

Abstract

Cost-effective energy storage is crucial to achieve the European Green Deal targets and improve the security of electricity supply in the EU, allowing greater flexibility in the grid and facilitating higher levels of renewable energy integration.
ENERGETIC project aims to develop the next generation BMS for optimizing batteries' systems utilization in the first (transport) and the second life (stationary) in a path towards more reliable, powerful, and safer operations. ENERGETIC project contributes to the field of translational enhanced sensing technologies, exploiting multiple Artificial Intelligence models.
The objectives of the project include:

1. To develop and embed low-cost sensors which provide new physical information to the BMS
2. To design a hardware abstraction layer platform
3. To develop multiphysics modelling tools to continuously assess the SoX and RUL of Li-battery
4. To develop AI bases models for explainable SoX prediction
5. To design an innovative, connected and smart DT based BMS
6. To make recommendations for future standard for predictive maintenance in the Cloud
7. To demonstrate and validate the ENERGETIC innovative smart DT based BMS
8. To facilitate the uptake and exploitation of ENERGETIC results by the academic community

The expected impact of the ENERGETIC project will contribute to the energy transition in the scientific, economic and societal domaine.
The presentation will cover an introduction to the project, the partners and the four main stages towards the achievement of the proposed objectives.

Daniela Chrenko obtained her PhD in 2008 on Energetic Macroscopic Representation (EMR) based model of a diesel driven fuel cell system, she was associate professor at University of Burgundy, France Higher Institute of Automobile and Transport UB ISAT from 2009-2016 and is now associate professor at Technical University of Belfort-Montbéliard, France (UTBM). She is associated director of the FEMTO-ST/Energie research department in charge of scientific seminaries and FCLABs coordinator for industrial training on hydrogen energy topics. Her research interests are system description of sustainable mobility systems including Batteries.

DAY 2
Tuesday July 9th 2024- Morning

Conference 7

Energy Storage Technologies Hydrogen-Based Multi-Source Electrical Systems: Architecture, Operation, and Energy Management

Dr. Ramzi SAIDI
Mincatec Energy – Belfort, France
ramzi.saidi@mincatec.com

Abstract

This presentation explores the integration of hydrogen-based multi-source electrical systems within microgrids, focusing on their architecture, operation, and energy management. We will discuss the design principles of these systems, emphasizing the role of hydrogen as a versatile energy carrier. Key aspects of system operation, including the coordination of various energy sources and the optimization of energy flow, will be covered. Additionally, we will examine energy management strategies aimed at enhancing the efficiency and reliability of microgrids. Attendees will gain insights into the potential of hydrogen technology to contribute to sustainable and resilient energy solutions.

Ramzi SAIDI is an engineer specializing in instrumentation and industrial maintenance, holding a degree from INSAT Tunisia, and a Ph.D. in Electrical Engineering from the University of Nantes, focusing on energy optimization in multi-source electrical systems.
Since 2019, Ramzi has been employed at Mincatec Energy, an innovative company specializing in hydrogen storage tanks using metal hydrides. Mincatec Energy provides comprehensive solutions integrating solar panels, batteries, fuel cells, electrolyzers, and hydrogen storage. Ramzi is responsible for technical definition of these solutions and the development of energy control and management programs."

DAY 2
Tuesday July 9th 2024- Morning

Conference 8

Mechanical behavior and damage of materials in low and high pression hydrogen tanks

Dr Anne Maynadier,
University of Franche Comté, CNRS, FEMTO ST Institute, Department of Applied Mechanics, Besançon, France

Abstract

Hydrogen is considered a good candidate as an energy carrier in the context of energy transition in response to the urgency of climate change. Safe, energy-efficient storage solutions are a prerequisite for the green nature of the hydrogen chain. The production of clean energy sources (solar, wind, hydro) is intermittent and rarely coincides with energy consumption needs. It is therefore essential to develop the safest, most efficient and most durable storage facilities possible.
Depending on the application and safety requirements, hydrogen can be stored in compressed gaseous form in hyperbaric tanks (typically between 200 and 700 bar), in liquid form at low temperatures (at temperatures below -252°C), or by chemical conversion to liquid ammonia (assuming a cracking decomposition process), or at a rather low pressure in solid form by reversible hydriding of intermetallic alloys (between 1 and 50 bar and 0 and 80°C). Whatever the chosen technology, storage or transportation of hydrogen as clean energy carrier necessitates the development of materials capable of withstanding these challenging conditions over a long period of time.
In this presentation, we will look at examples of work carried out at the FEMTO ST Institute department of Applied Mechanics on the mechanical behavior and aging problems of elastomers and polymers used in the manufacture of type IV hyperbaric tanks, as well as on the behavior and aging of powdered intermetallic alloys for the low-pressure solid-state storage of hydrogen.

Anne Maynadier studied in Mechanical Engineering and Materials Science at ENS Cachan (now ENS Paris Saclay). After a PhD thesis at LMT Cachan in 2012 on the thermodynamic modeling of Shape Memory Alloys and the development of coupled thermal and kinematic fields measurement techniques, she joined LAMCOS at INSA Lyon for 2 years to study the mechanical strength of silicon wafers in photovoltaic cells. In 2015, Anne Maynadier joined the FEMTO-ST Institute, in the Applied Mechanics Department, to work on the mechanics of materials used for hydrogen storage and transport. In the Mat'éco team (Materials for the Ecological transition), applications linked to hyperbaric storage in type IV tanks or storage in solid form by reversible hydriding of intermetallic alloys powders are explored. The research focus on the mechanical behavior and damage of granular media during absorption/desorption cycles.
The topics explored range from synthesis and optimization of storage properties by heat or mechanical treatments, to the study of decrepitation, development of in-situ observation benches and numerical simulations of hydride breathing and aging and the induced consequences on reservoir design.
As part of the PEPR Hydrogène Décarboné HYPERSTOCK project, A.Maynadier is also involved in research aimed at optimizing the barrier properties and durability of polymers used in Type IV hyperbaric tank liners with regard to their environmental impact.

DAY 3: Wednesday July 10th 2024- Morning
DAY 4: Thursday July 11th 2024- Morning

Courses 3

Characterization of lithium-ion batteries and supercapacitors

Dr. Issam SALHI
UTBM, CNRS, Institute FEMTO-ST, 90010 Belfort, France
issam.salhi@utbm.fr

Abstract

The development of energy storage systems is one of the major challenges in the technological progress of mobile applications. Indeed, an energy storage system needs to be as efficient as possible, whether in terms of reliability, charging and discharging times, and especially in terms of weight and occupied volume. Each technology has its own unique characteristics, making it suitable for different applications and market segments. Lithium-ion batteries and supercapacitors are at the heart of this context, especially lithium-ion batteries as being suitable for many applications. Through this course, we are interested in the characterization of these two energy storage technologies: Lithium-ion batteries and supercapacitors.

Issam SALHI received the master's degree in control system engineering, the PhD degree in electrical engineering, and the Accreditation to Supervise Research (HDR) degree in electrical engineering, in 2006, 2010 and 2016 respectively, all from Cadi Ayyad University (Marrakesh, Morocco). In 2010, he has become an associate professor at the University Cadi Ayyad and since September 2021 he is an associate professor at the University of Technology of Belfort-Montbéliard (Energy Department) and a member of FEMTO-ST institute (Belfort/France). Since September 2023 he is the head of electronics and embedded system division of School of Energy and Computer Science, UTBM, France. His main research topics include fuel cells for transportation, green hydrogen production, modeling and control of nonlinear systems (renewable energy & storage systems) and DC/DC converters design, analysis, and control (real-time simulation and Digital Twin technology).

DAY 3: Wednesday July 10th 2024- Morning
DAY 4: Thursday July 11th 2024- Morning

Courses 4

HIL for energy storage

Prof. David Bouquain, Dr. Youcef Ait-Amirat
UFC, CNRS, Institute FEMTO-ST, FCLAB, 90010 Belfort, France
david.bouquain@univ-fcomte.fr, youcef.ait-amirat@univ-fcomte.fr

Abstract

Modeling and simulation are now present throughout the development cycle of a system : conceptualisation, design, development, operation and retrait. HIL (Hardware in the loop) consists of using a controller, running in real time configuration, working with one or several real components of the final system (actuators, system sensors). The environment can remain simulated. We can thus test abnormal and dysfunctional scenarios without damaging hardware components if the code being developed is not yet perfect.
The objective of this course is to show and explain some typical examples of HIL simulations dedicated to electrical energy storage components as electrochemical battery and ultracapacitor.
The lesson will be completed by a training course by using ultracapacitor and LabVIEW or dSpace tools.

David Bouquain was graduated from the University of Franche-Comté (UFC) in 1999. In 2002 he was recruited as teacher-researcher at University of Technology of Belfort-Montbéliard (UTBM) where he received a PhD in electrical engineering in 2008. He became an associate professor at UTBM in 2009 and was head of the Control and Conversion of Energy research team. From 2012 to 2019 he has been a member of FCLAB. In 2016 he joined the CNRS FEMTO-ST Institute. His research activity focuses on electric and hybrid powertrains as well as fuel cell systems dedicated to transport and stationary applications. In September 2020 he became a Full Professor at UFC. Since January 2020, he is Deputy Director of FCLAB, Center for Service and Research on hydrogen energy systems. Since December 2021 he is also vice-president of UFC in charge of relations with companies.

Y. Ait-Amirat obtained his PhD from the University Claude-Bernard of Lyon (France) by making a major contribution to the control theory of multivariable systems. He joined the University of Franche-Comté in 1995 where he is an active research member and teacher in the area of electrical engineering and hydrogen energy. He is an expert automation engineer in the field of energy conversion. He has a mastery of the entire chain of production, storage, and distribution of electrical energy. He has indeed worked and published his results on fuel cells, static converters, and electric actuators. He is also interested in the hydrogen-energy vector through the study of its low-pressure storage through the thermal management of hydride tanks coupled to a fuel cell. He is now heavily invested in the energy transition and the use of carbon-free energy

DAY 3
Wednesday July 10th 2024- Morning

Conference 9

Solar Thermal Systems and Energy Storage Technologies

Prof. Mounir AKSAS
Higher National School of Renewable Energy,
Environment & Sustainable Development (RE2=SD) - Batna, Algeria.
mounir.aksas@hns-re2sd.dz

Abstract

This presentation provides a comprehensive overview of solar thermal systems and energy storage technologies, covering solar radiation fundamentals, meteorological data analysis, and radiation estimation software. It explores various collector technologies, including flat-plate, evacuated tube, and concentrating collectors, discussing their strengths, limitations, and applications. The presentation examines a range of solar thermal applications, from low-temperature (domestic water heating systems) to high-temperature (Concentrated Solar Power plants). Students gain hands-on experience with industry-standard software tools such as TRNSYS, T*Sol, Retscreen, and SolarPILOT for system modeling and performance analysis. The second part focuses on thermal energy storage, covering sensible, latent, and thermochemical systems, their operating principles, materials, and performance metrics. The presentation incorporates practical examples from existing solar thermal installations and research projects to illustrate key concepts, and students learn to perform simulations using various software tools. By the end, participants acquire the knowledge and skills necessary to design efficient and cost-effective solar thermal systems.

Mounir AKSAS received the B.S. degree in Energy Engineering from the University of Batna, Algeria, in 1995, his M.S and Ph.D. degrees in Fluid Mechanics from the Polytechnic University of Bucharest, Romania in 1998 and 2001 respectively. From 2002 to 2007 he has taught mathematics at the high School “Le Touar/NAFVECO” in Toulon, France. Since 2007, he has been an Assistant Professor and then full Professor in 2015 at the University of Batna 1, Algeria, where he has taught Renewable Energy Resources and Technologies and Applied Fluid Mechanics. Since January 2021, he is a full Professor at Higher National School of Renewable Energy, Environment & Sustainable Development (RE2=SD) at Batna, Algeria. His research interests are in the Thermal Solar Systems and applications (Solar water heating, cooling solar technologies and Heat Pumping technologies) and Modeling of Renewable Energy Systems. Pr. AKSAS is author or co-author of several scientific articles in international journals and conferences, He had supervised in this field several Master and Ph.D. defended thesis.

DAY 4
Thursday July 11th 2024- Morning

Conference 10

Hyd-drive :a world's first hydrogen-powered semitrailer - design and test process

Prof. Abdesslem DJERDIR*, Dr. Nadhir LEBAAL**
*UTBM, CNRS, Institute FEMTO-ST, FCLAB, 90010 Belfort, France
**UTBM, CNRS, ICB, Belfort, France
abdesslem.djerdir@utbm.fr, nadhir.lebaal@utbm.fr

Abstract

The HYD-DRIVE project, funded by the BPI of the Bourgogne-Franche-Comté region - France in February 2021, aimed to create a new market for smart hydrogen propulsion trailers. The trailer becomes propulsive and significantly reduces the energy consumption of the tractor. Electrification is obtained by installing a 40 kW fuel cell generator, its feeding hydrogen tanks, a high-voltage pack battery and the power electronics converters, under the floor of the trailer. Such mounted fuel cell hybrid source ensures the electrical feeding of the rear electrical axle of this world first hydrogen-powered semi-trailer concept: the "Hyd-drive (https://youtu.be/ss8-zsJ8GFk)". The aim of this plenary talk is to present the three main contributions of the UTBM's searchers which were performed at its Hydrogen Energy platform. The first one concerned the fuel cell hybrid propulsion chain where the UTBM searchers were involved to provide their expertise in modelling, numerical simulations, sizing, harness design and experimental tests. The second contribution is about the semi-trailer numerical communication, the safety, and the propulsion chain control according to different hydrogen operating modes (refuelling, drive, and maintenance). This task has involved developing and implementing the vehicle's electrical harness and helping the partners (FRUEHAUF and H2SYS) in implementing a human-machine interface (HMI) allowing an efficient and safety control of the vehicle. The third main UTBM's contribution was about the mechanical design, manufacturing and integration of the mechanical fixations and auxiliaries of the principal drive train components such as the fuel cell air circuits and protections against humidity and various road projections.

Abdesslem Djerdir received the B.S. degree from the National Institute of Electrical Engineering, Bejaia, Algeria, in 1993, and the Ph.D. degree from the University of Franche-Comté, France, in 1999, both in electrical engineering. He is currently a Full Professor at the University of Technology Belfort-Montbéliard (UTBM), Belfort, France. He is the deputy director of the Fuel Cell LABoratory (FCLAB). His research interests include modeling and design of electric and fuel cell vehicle systems (electrical machines, energy storage devices, and power converters). His main research contributions focus on availability and high efficiency of electric drive trains for transport applications by combining the experimental and theoretical approaches. In this framework, he was the Vehicle Referent of the Mobypost Project (http://mobypost-project.eu) where ten fuel cell electrical vehicles were built and tested.

Dr. Nadhir Lebaal received his PhD in Mechanics and Energy from the National Institute of Polytechnique of Lorraine, France. He was an Assistant Professor in computational mechanics at the High School of Engineering Design in Saint-Dié-des-Vosges, France for 2 years. Then, he was an Associate Professor at the Ecole des Mines of Albi-Carmaux for one year. He joined the University of Technology of Belfort-Montbéliard (UTBM) in France in 2009 as a Permanent full-time Associate Professor. He currently conducts research at the ICB CNRS 6303 laboratory. His research interests include optimization and numerical modeling in multi-physics (structural mechanics, thermal and fluid dynamics). Currently, he is the head of the Engineers Training by Apprenticeship (FISA-Mechanics "CoMET") and manages a research axis in the area of robust engineering and optimization of Product-Process-Material interactions.