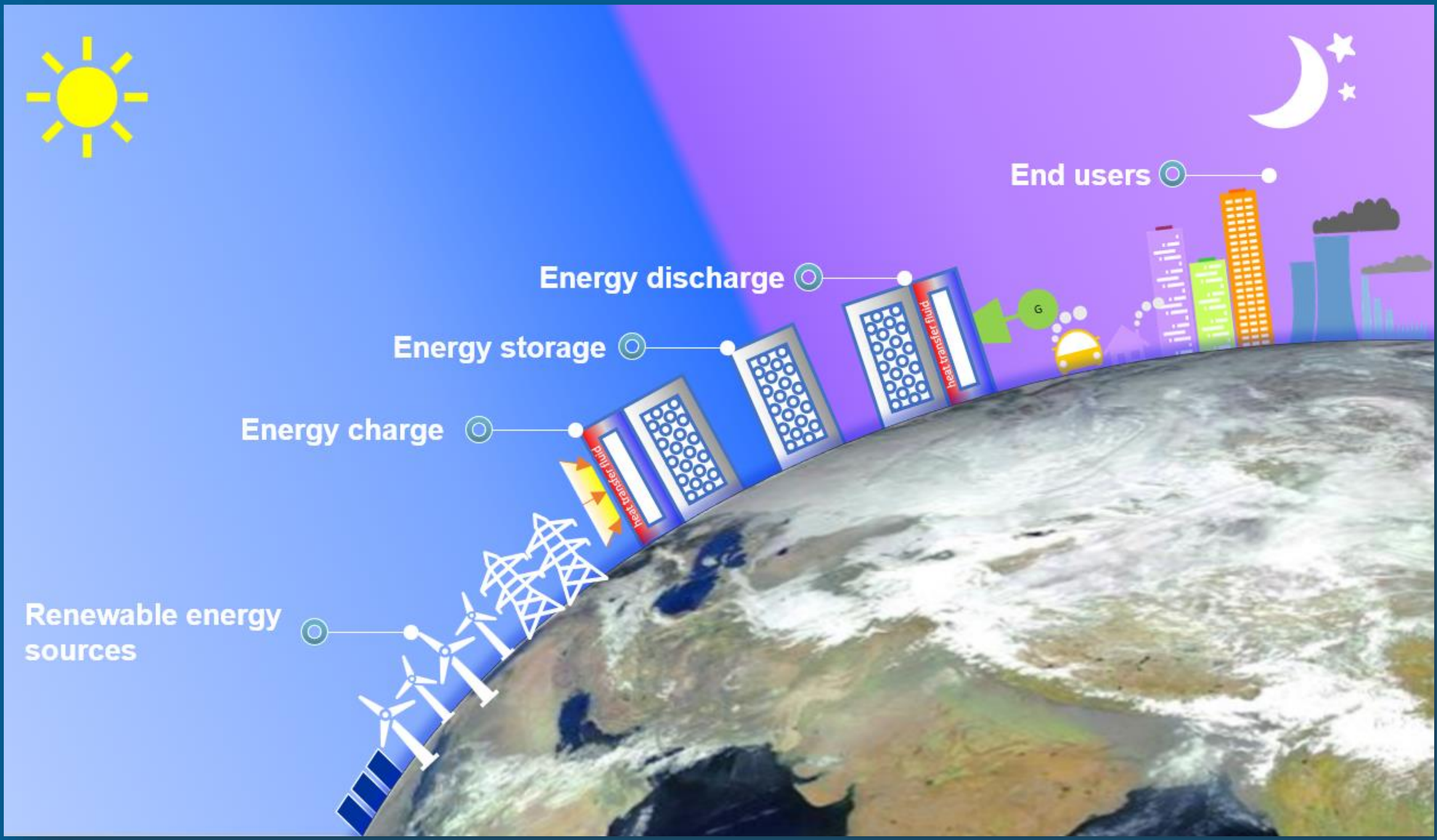
An International Association for Green Energy (IAGE) Magazine April 2023

Green Energy Today



Second Issue 2023

INTERNATIONAL ASSOCIATION FOR GREEN ENERGY

Table of Contents

April 2023

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EDITOR'S LETTER

Jian Zhao, PhD

Editor-in-chief
Green Energy Today
April 2023

Center for Advanced Vehicular Systems,
Mississippi State University

jianzhao@cavs.msstate.edu

Dear readers,

Welcome to the second issue of the International Association for Green Energy (IAGE) newsletter. Starting from this issue, the newsletter will be titled ***Green Energy Today***. As a member of the Communication Committee, I was thrilled to have the opportunity to edit this issue. Our committee aims to have four issues of the *Green Energy Today* magazine annually, with the next issue scheduled for July 2023.

This issue focuses on an emerging topic in the field of green energy – energy storage. Green energy sources, such as solar and wind energy, can be intermittent, difficult to predict, and maybe unreliable when directly integrated in existing power grids. Energy storage technology can capture solar or wind energy when it is available and discharge electricity immediately on demand, which can help reduce reliance on fossil fuel and promote decarbonization. Various energy storage techniques have been developed including thermochemical energy storage, sensible heat storage, latent heat storage, hydrogen, syngas, and batteries, to name a few. Energy storage systems can promote the applications of various green energy technologies, enhance energy security, create job opportunities, and stimulate economic growth, thus building a more sustainable and resilient future.

In this issue, three feature articles are invited from researchers in the field of energy storage. Drs. Oliver Schmidt and Iain Staffell from Imperial College London have contributed a feature article about their new book, 'Monetizing Energy Storage – A toolkit to assess future cost and value', to be released in June 2023. Additionally, Dr. Like Li's group from Mississippi State University has contributed a feature article to introduce high-temperature thermochemical energy storage technology. Finally, Dr. Kui Jiao's group from Tianjin University has contributed an article on green hydrogen production.

I am also happy to share some exciting news on the general topic of green energy with a focus on energy storage in the present issue. I hope you find these news items interesting and useful. Please note that the news list may not be comprehensive, and we welcome any recommended green energy news from readers for upcoming issues.

We also have reports on the latest developments of the IAGE International Chapters and the 15th International Green Energy Conference (IGEC-XV). IGEC-XV will be held on July 10-13, 2023 at the University of Glasgow, UK. Dr. Zhibin Yu, the chair of the IGEC-XV, has been invited to provide the latest updates on the conference preparation. The invited plenary and keynote speeches are also reported, and the readers can refer to the conference websites for more details. I am looking forward to seeing you soon in Glasgow in July 2023.

I hope you enjoy the second issue of the IAGE Newsletter, which will be titled ***Green Energy Today*** from now on.

Sincerely,
Jian Zhao

Welcome to IAGE newsletter, *Green Energy Today*, and IGEC-XV to be held in Glasgow, UK, July 10-13, 2023.

Xianguo Li, Ph.D., P.Eng., FCAE, FEIC, FCSME
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Dear IAGE members,

It's my great pleasure and privilege to write this welcome message to the IAGE members and beyond through this IAGE Newsletters, which will be titled ***Green Energy Today*** going forward, upon solicitation, suggestion, online polling and discussion among the IAGE Communication Committee members and Board of Directors, and final decision by the Board of Directors recently. It is planned that after a couple of issue publications, ***Green Energy Today***, as a magazine published by IAGE, will be receiving International Standard Serial Number (ISSN), and all the articles, especially the featured articles, will be registered with DOI number, so that all the publication in this ***Green Energy Today*** can be easily available for citation and referencing as well as indexing, as appropriate. It's exciting that IAGE is providing this and other planned venues for its members and the relevant professional community to disseminate their knowledge and research outcome for maximum impact. So stay tuned!

The preparation for the 15th International Green Energy Conference (IGEC-XV) is under full gear, with conference technical program being finalized, that consists of contributed presentation led by invited plenary and keynote speeches (see details within this issue). IGEC-XV will be held in hybrid mode at the University of Glasgow, UK, July 10-13, 2023. Deadline for early bird registration is fast approaching by the end of this month. A day of post conference tour is also planned with rich activities.

It is worth emphasizing again that the University of Glasgow, founded in 1451, has a glorious history in energy science and engineering, with well-known energy scientists, researchers and tech innovators, such as Lord Kelvin, William Rankine and James Watt, and is the birth place of many important concepts and ideas of modern energy systems, such as refrigeration, heat pump, Kelvin temperature scale, steam engine, Ranking power cycle, etc. It is a perfect place to meet and discuss green energy, energy transition, and opportunities arising from the solutions to challenges the energy community faces.

I will be looking forward to meeting many of our members and colleagues attending our flagship event in the beautiful historical city of Glasgow in July.

Sincerely,

Xianguo Li, Ph.D., P.Eng., FCAE, FEIC, FCSME
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Monetizing Energy Storage

Oliver Schmidt, Iain Staffell
Imperial College London

The energy sector is transforming rapidly as efforts to reduce carbon emissions intensify and renewables become the cheapest source of electricity. Energy storage can provide the required flexibility to balance variable and inflexible low-carbon power generation with demand. Recent years have seen electric vehicles break through into the mainstream and stationary electricity storage deployment grow at more than 30% each year. In fact, this industry is projected to grow to hundreds of times its current size in the coming decades.

In light of this growth, businesses, policymakers and academics need to assess the future cost and value of energy storage. However, this is complicated by the rapidly falling investment cost, the wide range of technologies with different performance characteristics, the wide range of use cases with different performance requirements and the vastly different market structures around the world. Together, these lead to significant uncertainty regarding the expected commercial viability of energy storage and its potential roles in the future that prevent policy and investment decisions.

In order to overcome this uncertainty and increase transparency on the future commercial viability and potential roles of energy storage, Dr Oliver Schmidt and Dr Iain Staffell wrote the book 'Monetizing Energy Storage – A toolkit to assess future cost and value', which will be released by Oxford University Press in June 2023.

An example from the book is **Fig. 1**, which sheds more light on the future prices that can be expected for different energy storage technologies. It shows product prices per unit of energy capacity for the most common electricity storage technologies as a function of increasing cumulative installed energy capacity. So-called 'experience rates' can be derived from the slope of cost-reduction curves and quantify the percentage change in product price with each doubling of cumulative installed capacity.

All experience rates of the analysed electricity storage technologies are between 10% and 30%, except for pumped hydro systems and lead-acid packs. The highest experience rates can be observed for lithium-ion cells (consumer electronics) and battery packs (EVs). This explains the dominance of the lithium-ion technology in these applications. The strong experience rates in combination with significant deployment levels enabled competitive price levels in the respective applications.

Oliver Schmidt

Oliver Schmidt lives in Berlin and works as management consultant in the clean energy industry. He has previous experience as project manager at the strategy consulting and financial transaction advisory firm Apricum, where he supported top management with strategic advice in the energy storage, solar PV, and hydrogen industries. Oliver also worked as an energy analyst at the International Energy Agency and as a management consultant at E.ON. He has a PhD on the future cost and value of energy storage from Imperial College London. His background is in mechanical engineering and renewable energy, which he studied at Imperial and the Swiss Federal Institute of Technology (ETH).

Iain Staffell

Iain Staffell lives in London with his wife and three children. He is an Associate Professor at Imperial College London, where he teaches energy economics and policy and leads a sustainable energy research group. He holds degrees in Physics, Chemical Engineering and Economics from the University of Birmingham. His research has won the Baker Medal and President's Award for Excellence in Research, and has featured in over 120 national and international media articles. Iain is passionate about making energy research transparent and openly available to all. He is a developer of the www.Renewables.ninja platform for modelling renewable energy supply and demand, and the www.EnergyStorage.ninja platform which accompanies this book.

Experience rates reveal the underlying trend in how historical prices have fallen as a function of increasing cumulative deployed capacity. It is possible to project these experience curves forwards to potential future deployment levels. Of course, there is no guarantee that prices will continue to fall at the same rate as they have done in the past; however, this approach does give an objective, evidence-based view on how costs might develop.

However, technology costs alone are ill-suited to assess the competitiveness of the different technologies. Energy storage can be used in a range of applications (e.g., frequency response, energy arbitrage). These different applications have different operational requirements (e.g., duration of energy supply, number of activations per year) and each storage technology is differently suited to these applications based on their individual cost and performance parameters. Therefore, storage technologies can only be compared using so-called ‘lifetime cost’ for clearly defined application requirements. Lifetime cost accounts for all technical and economic parameters affecting the cost of delivering stored electricity.

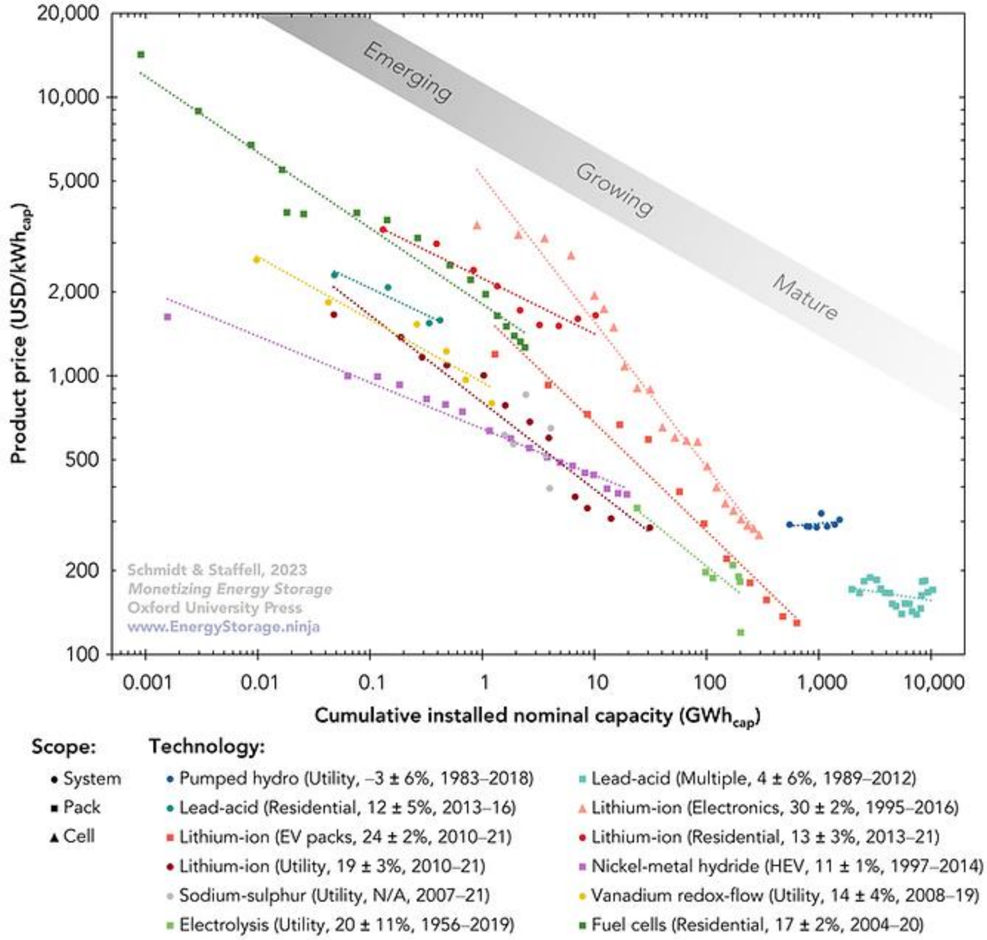

Fig. 1. Cost-reduction curves for storage technologies. Product prices measured in real 2020 USD per nominal energy capacity as a function of cumulative installed nominal energy capacity. The dotted lines represent the resulting cost-reduction curves based on linear regression of the data points. The legend indicates product scope (installed system, pack, cell) and technology (including application category, experience rate with uncertainty, and years covered by the dataset). Grey bars indicate overarching trend in cost reduction for technologies relative to technology maturity as a function of cumulative installed capacity: Emerging (<1 GWh), Growing (<100 GWh) and Mature (>100 GWh). Fuel cells and electrolysis must be considered in combination to form a hydrogen-based storage technology (with an assumed energy-to-power ratio of 10). Data for lead acid (pack) refer to multiple applications, including uninterruptable power supply or heavy-duty transportation.

Fig. 2 shows the technology with lowest lifetime cost for all possible combinations of discharge duration and frequency requirements any application could have. The positions of archetypical applications like frequency regulation (FG), energy arbitrage (EA) or seasonal storage (ST) are indicated by circled letters in the spectrum.

By 2020, pumped hydro and compressed air were most cost-efficient for applications with more than 2 hours discharge duration due to relatively low energy-specific investment cost. Above ~300 hours discharge, hydrogen with even lower energy-specific cost took the lead. Lithium ion was most cost-efficient in applications with below 2 hours discharge and below 300 cycles per year. The longer cycle life of vanadium redox flow made it more cost-efficient between 300 and 1,000 annual cycles. Above that, flywheels took the lead due to even higher cycle life.

With continued investment cost reduction (**Fig. 1**), lithium ion is projected to outcompete pumped hydro and compressed air below 8 hours discharge to become the most cost-efficient technology for most of the 13 archetypical applications by 2030. At the same time, hydrogen storage becomes more cost-efficient than compressed air for long-discharge applications. Vanadium redox-flow batteries dominate in high-throughput applications with 300-3,000 annual cycles and up to 4 hours discharge.

More insights will be available in 'Monetizing Energy Storage – A toolkit to assess future cost and value'. The book is targeted at practitioners from industry like strategists, investors, consultants, at policymakers like policy analysts, regulators, and at academics like graduate students and researchers. It aims to help these stakeholders understand the cost reduction and deployment potential of energy storage as well as assess its economic value by:

- Introducing key cost and performance parameters, and energy storage technologies and applications
- Developing and explaining quantitative methods for assessing the future investment and lifetime cost and economic and system value of energy storage
- Presenting cutting-edge research insights to exemplify the introduced methods with current data
- Introducing the interactive online tool www.EnergyStorage.ninja that enables easy reproduction of the presented analyses with custom data

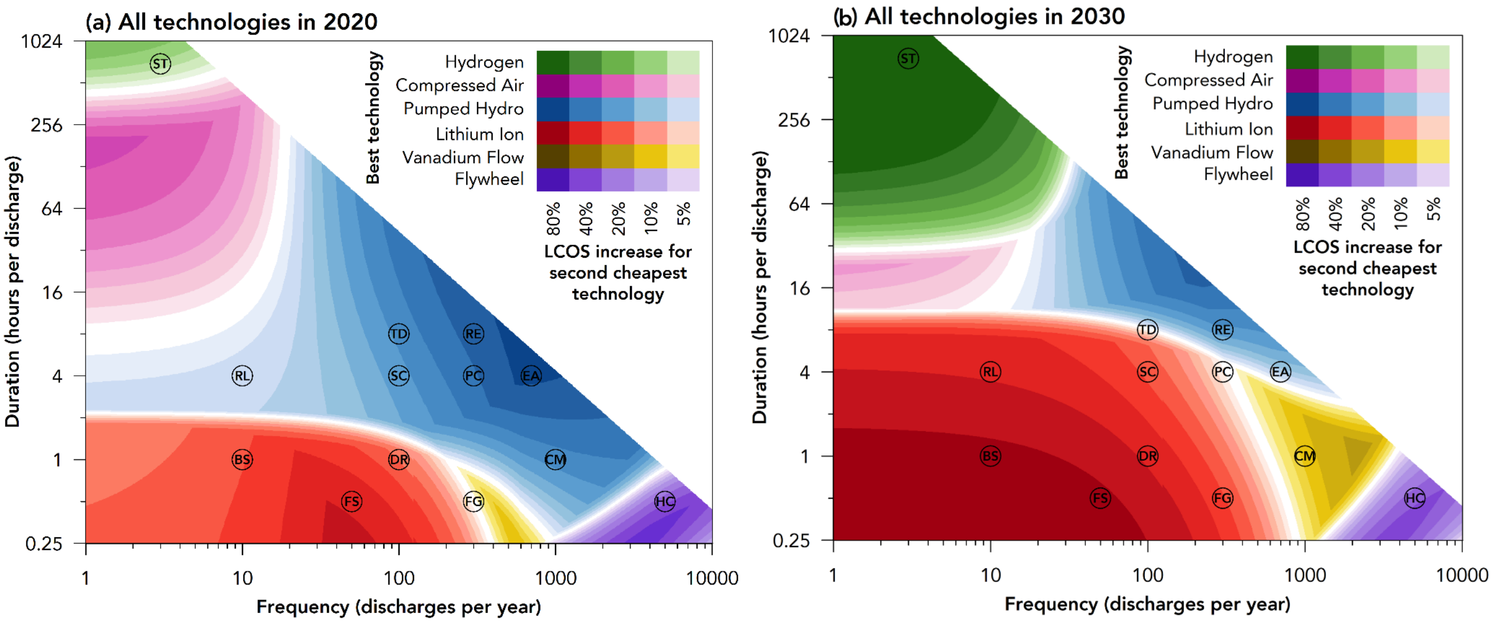

Fig. 2. Competitive landscape showing energy storage technologies with highest probability to have lowest lifetime cost (LCOS) relative to discharge duration and annual cycle requirement in a) 2020 and b) 2030. Circled letters represent the requirements of archetypical applications: BS – black start, FS – frequency response, DR – demand charge reduction, FG – frequency regulation, CM – congestion management, HC – high cycle, RL – power reliability, SC – self-consumption, TD – transmission/distribution network investment deferral, PC – peak capacity, RE – renewables integration, EA – energy arbitrage, ST – seasonal storage. Colour indicates the technology with the lowest lifetime cost. Shading indicates how much higher the lifetime cost of the second most cost-efficient technology is; meaning lighter areas are contested between at least two technologies, while darker areas indicate a strong cost advantage of the dominant technology. Both axes are on logarithmic scale: x-axis with base 10 and y-axis with base 2.

Introduction to Thermochemical Energy Storage

Jian Zhao, David Korba, Like Li
Mississippi State University

Thermal energy storage (TES) is a process to store energy for later use on demand and can be generally divided into three categories – sensible heat, latent heat, and thermochemical energy storage. The first two types of TES technologies have been extensively investigated in the past to store thermal energy through temperature change or phase change of materials. Commonly used materials include molten salts, rocks, sands, concrete, and metals. Their performance can be limited by thermal losses, short storage duration, low energy density, and high storage volume. To overcome these limitations, thermochemical energy storage (TCES) has drawn significant attention by storing energy in chemical bonds through endothermic reactions and releasing heat via exothermic reactions when energy is needed.

A typical TCES system includes a charge unit, a storage unit, a discharge unit, and a power block (see **Fig. 1**). In the charge unit, the reactive materials can be charged by renewable energy sources, such as concentrating solar power (CSP), industrial waste heat, or excess electricity from renewables. The energy will be stored in the form of chemical potential in the rearranged chemical bonds, which are usually stable at standard conditions. This allows the charged materials to be stored for long periods of time, from a few hours to a few months, without noticeable energy losses. When energy is needed, for example at night-time, the stored energy in the charged materials can be released through high-temperature exothermic reactions. The released heat can then be used to drive the power block or as industrial process heat on demand.

TCES materials can be classified as sorption and reaction types. The sorption materials utilize the absorption or adsorption processes to store energy in chemicals, and when energy is needed, desorption reaction is utilized to release heat. Reaction-based materials, especially reduction-oxidation (redox) reaction-based metal oxides, are more commonly investigated in TCES applications, largely due to its long storage duration, high energy density, low thermal dissipation, and high operating temperature. The typical operation temperatures range from 550-1500 ℃. For instance, barium oxides can be operated at 550-900 ℃; cobalt oxides at 700-1000 ℃; copper oxides at 800-1000 ℃; iron at around 1040 ℃; and magnesium-manganese oxides at 1000-1500 ℃. Higher discharge temperature can potentially improve the thermal efficiency of the power block, while extremely high temperature can introduce challenges in material development, component design and manufacturing, durability enhancement, and cost reduction.

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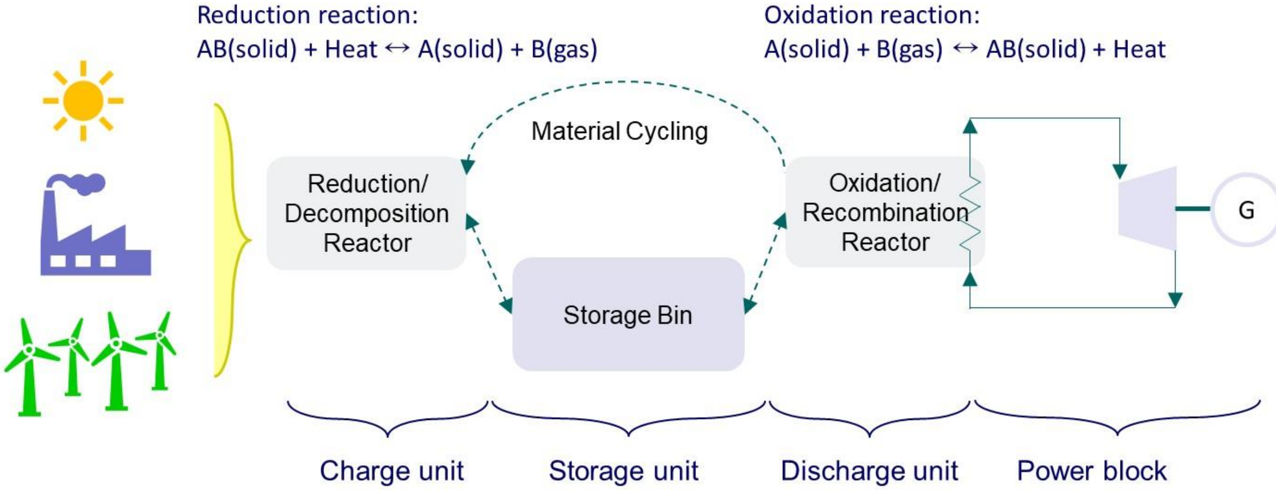

Fig. 1. A typical thermochemical energy storage system

In addition to experimental studies of materials and reactor performance, fundamental understanding of the thermodynamics, chemical kinetics, and transport phenomena in TCES reactors are essential for novel reactor design, scale up and system development at the commercial scale.

In recently published articles from Dr. Like Li's group, Korba et al. (2022) [1] and Huang et al. (2022) [2] developed comprehensive CFD models to scrutinize the heat and mass transfer in a high-temperature moving bed reduction reactor for magnesium-manganese oxide (Mg-Mn-O) particles at about 1450 ℃ (see **Fig. 2** for the experimental setup). In their models, a novel tubular reactor composed of a recuperation zone, a reaction zone, and a quenching zone was simulated by coupling the counter-current two-phase solid-gas flow, transport of heat and gas species, and chemical reactions. The results showed good agreement with corresponding experimental studies in terms of temperature variations within the reaction bed, measured oxygen concentration, and particle bed reaction extent. The predicted thermal-to-chemical energy efficiency and system efficiency can be as high as 95% and 30%, respectively.

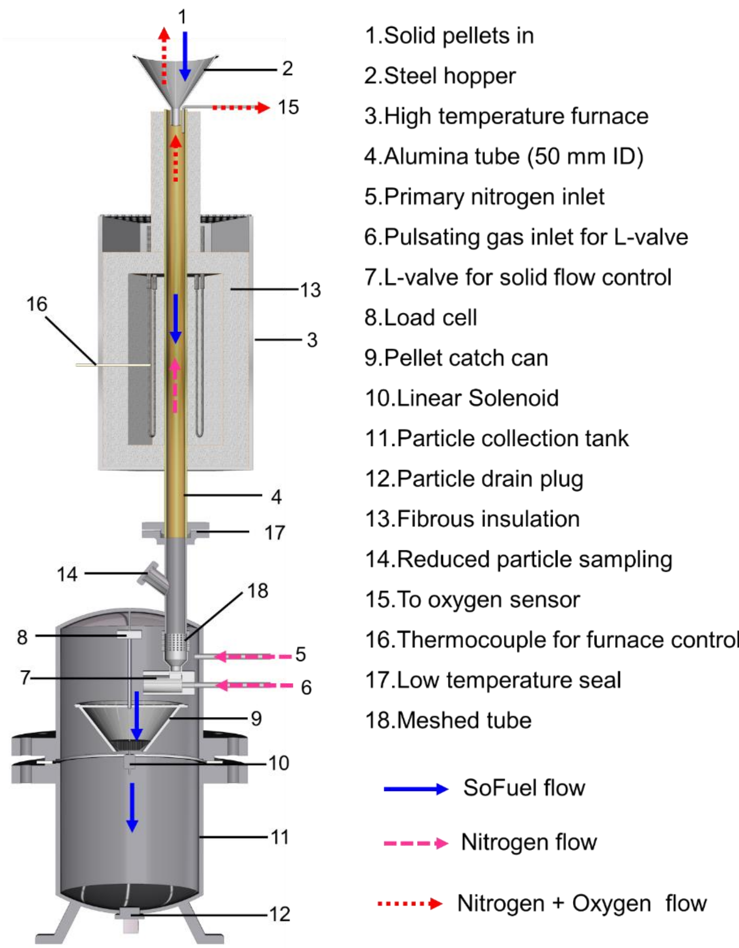

Fig. 2. Diagram of reduction reactor setup

Like Li, Assistant Professor in Mechanical Engineering at Mississippi State University, as well as his academic and industrial partners, have been leading the research and development of next-generation TCES systems through advanced modeling and experimental techniques. The research group has multiple prestigious research projects funded by the US Department of Energy (DOE) and the U.S. National Science Foundation (NSF), aiming to develop high-efficiency, long-lasting, and low-cost thermal energy storage technologies to contribute to the transition to a low-carbon and more resilient energy future by 2050.

References:

1. Korba et al. Applied Energy 313 (2022): 118842.
2. Huang et al. Applied Energy 306 (2022): 118009.

Green hydrogen production - PEM water electrolysis

Xiyuan Zhang, Bowen Wang, Kui Jiao
Tianjin University

In the background of carbon neutrality, renewable energy sources such as tidal, wind and solar are becoming increasingly attractive and widely used, but their applications are affected by intermittency. Thus, it is very promising to store unused intermittent energy in the form of hydrogen by electrolyzing water. Nowadays, Polymer Electrolyte Membrane Electrolysis Cell (PEMEC) has gradually become a research hotspot because of its highest efficiency in coupling intermittent energy.

With the help of simulation and experimental tests, the mechanism of heat and mass transfer and electrochemical reactions inside the electrolyzer has been comprehensively clarified. Prof. Jiao led the establishment of a 3D multi-phase model of the PEMEC and proposed a method for integrating the detailed channel two-phase flow into the 3D model for the first time [1-5]. Based on the above research, Prof. Jiao proceeded to lead the development of a 3D full PEMEC model based on the open-source CFD platform OpenFOAM and proposed a pseudo-coupled method that integrates the effects of the detailed two-phase flow in the anode flow channel into the 3D multi-phase model. The model can be used to propose corresponding optimization strategies for PEMEC flow field and liquid/gas diffusion layers (L/GDL) design and treatment, which is a guide for the future commercializ ation of high-performance PEMECs (see **Fig. 1**).

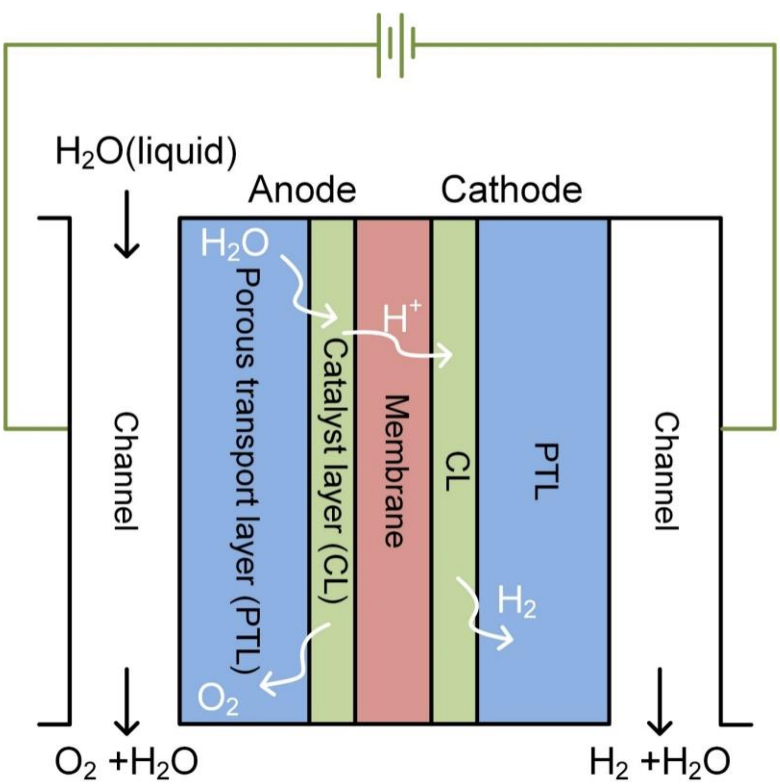

Fig. 1. Schematics of PEMEC

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He proposed a new framework for modeling, established a fast simulation model for the PEMEC cell, stack and system, achieved complete autonomy in simulation technology from each component to the system level, and proposed a new system matching scheme and control strategy. By developing a two-phase analytical PEMEC model considering the liquid saturation jump effect and proposing an intelligent parameter estimation by using the genetic algorithm, high-efficiency model validation can be achieved. This work could provide critical support for the cell and operating conditions designs for future PEMEC studies; the development of the 2D transient PEMEC stack model, which investigates the dynamic response of the performance, species and temperature distribution of a PEMEC stack with cooling channels under variable operating conditions, has significance for further research into optimization strategies for PEMEC stack cooling systems and the subsequent development of coupled integrated renewable energy electrolytic cell energy storage systems; a renewable energy utilization model including photovoltaic module, electrolyzer module, and fuel cell module, is developed to simulate the performance of the system for hydrogen production. The system can generate about 16460MJ of electricity for one year with 28m^2 area of the photovoltaic array, which can almost meet 75% of the annual electricity consumption of one household in Tianjin.

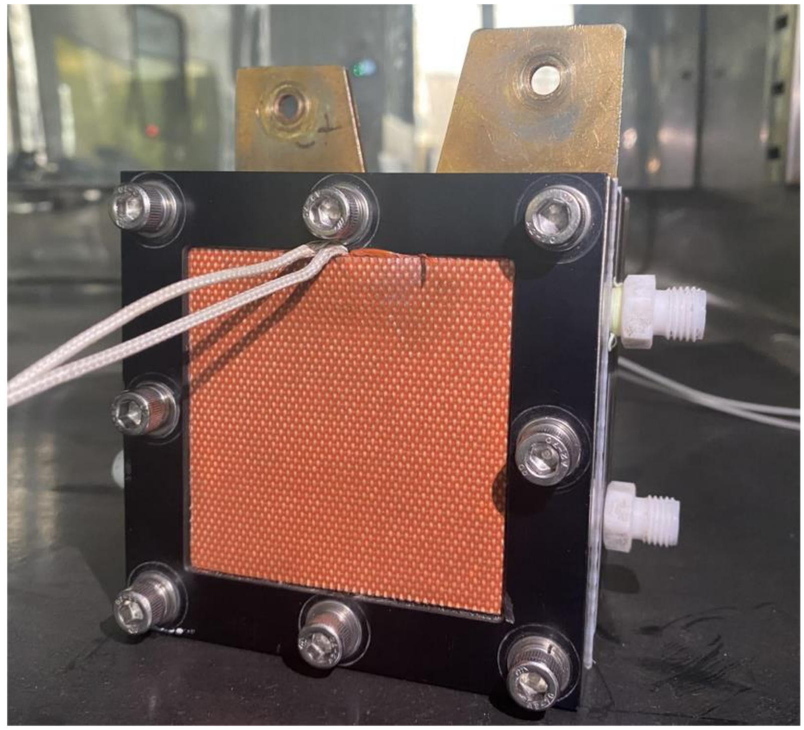


Fig. 2. Schematic diagram of assembled PEMEC

By building a PEMEC test platform (see **Fig. 2**), the influences of anode plate's material, PTL's material and structure, assembly torque, working temperature and flow rate on the overall performance and internal impedance of PEMEC were investigated. The key factors that reduce electrolytic performance of titanium are analyzed. What's more, a variety of surface optimization schemes were designed for the treatment of titanium mesh or titanium felt by Adams fusion. The scanning electron microscopy, polarization curves and EIS were compared to analyze the effect of impedance on performance.

Dr. Kui Jiao (FRSC, FIET) is a professor in the State Key Laboratory of Engines, as well as the associate director of National Industry-Education Platform of Energy Storage at Tianjin University, China. His research interests include fuel cell, battery, thermoelectric generator, turbocharger compressor, etc. He published several books and over 300 papers in international journals such as Nature, with a total citation of > 11000 and an H-index of 62 (Google Scholar). He led over 30 national and industrial projects and provided modeling and design services in the fuel cell engine development for many major automotive fuel cell manufacturers such as Bosch, FAW, and SAIC Motor. He was granted the National Science Fund of China for Distinguished Young Scholars in 2022, and the Advanced Newton Fellowship by the UK Royal Society in 2018. He serves as the founding editor of Energy and AI and associate editor of International Journal of Green Energy.

References:

1. Y Xu, et al. Digital Chemical Engineering, 2021,1:100004.
2. L Wu, et al. Int. J. Green Energy,18(17), 2021.
3. F Zhang, et al. Energy, 263(3), 2022.
4. X Zhang, et al. Fuel, 332(2), 2023
5. B Wang, et al. Renewable Energy, 2023, accepted.

The Editor will curate the news that they have read on the latest development in green energy in every issue of *Green Energy Today*.

Energy Storage News

- Canada Invests to Build the Largest Battery Storage Project. The governments of Canada and Ontario are investing to build the largest battery storage project in the country – the 230 MW Oneida Energy Storage project, which is the milestone make the existing power grid more reliable with low cost.
- Smart Renewables and Electrification Pathways Program. To accelerate Canada's low carbon future, the smart renewables and electrification pathways program (SREPs) provides $1.56 billion over 8 years for renewable energy, energy storage, and power grid modernization projects.
- Electricity and Energy Storage for Growing Demand in Ontario, Canada. Canada is building 4,000 MW new electricity facilities, where energy storage plays a significant role. It is the largest planned clean energy storage project in Canada's history.
- New Solar Thermal Tower under Construction at the National Solar Thermal Test Facility of the Sandia National Laboratories. The concentrated solar power (CSP) tower is part of the $25 million award from the U.S. DOE, which is for the next-generation MW Generation 3 Particle Pilot Plant system for more than 6 hours of particle-based thermal energy storage to be coupled with a supercritical CO_2 power cycle.
- Underground Geothermal Energy Storage for All Seasons. A group of scientists are working together to investigate underground geothermal heat and cooling with long-duration energy storage capabilities.

Green Energy News

- U.S. Power Grid Shifts from Fossil Fuels to Renewable Sources. The U.S. power grid is projected to be doubled in electric capacity from 2022 to 2050, while renewable energy such as solar, wind, battery storage, and nuclear, will contribute to most of the newly built capacity, according to a new a new U.S. Energy Information Administration report.
- Connecting the Largest Onshore Wind Farm in Wyoming and California. A 732-mile transmission line is approved in the U.S. to transport electricity from the country's largest onshore wind farm in Wyoming to end users in California with a transmission capacity of 3,000 MW, reported by E&E News.
- U.S. DOE Announced $750 Million for Clean Hydrogen Technologies. U.S. DOE announced $750 million to stimulate electrolysis technology, lower the cost of hydrogen and fuel cells, and establish Reduce the Cost of Clean Hydrogen and Fuel Cells, and support clean hydrogen hubs.
- Canada's first small modular reactor (SMR). The Canada Infrastructure Bank (CIB) is investing $970 million to Ontario Power Generation (OPG) for Canada's first small modular reactor (SMR) at the scale of 300 MW in Ontario.
- High-Performance Computing Reveals Low-Level Jet Vulnerabilities, Solutions. A recent research project collaborated between NREL and GE Global Research Center found low-level jet (LLJ) streams can significantly impact the performance of a wind farm.

Call for chapters of IAGE Worldwide!

We are establishing chapters worldwide. Ten chapters are being established at the moment in different countries and regions, including Canada, China, Denmark, Hong Kong, Korea, Malaysia, Serbia, Singapore, Turkiye, and United Kingdom.

The IAGE Chapter Board has decided that the new chapters being established will follow the below process.

A Chapter Board consists of one president and six to ten members. Chapter presidents assign six to ten members from different Universities, Research Institutions, or Companies.

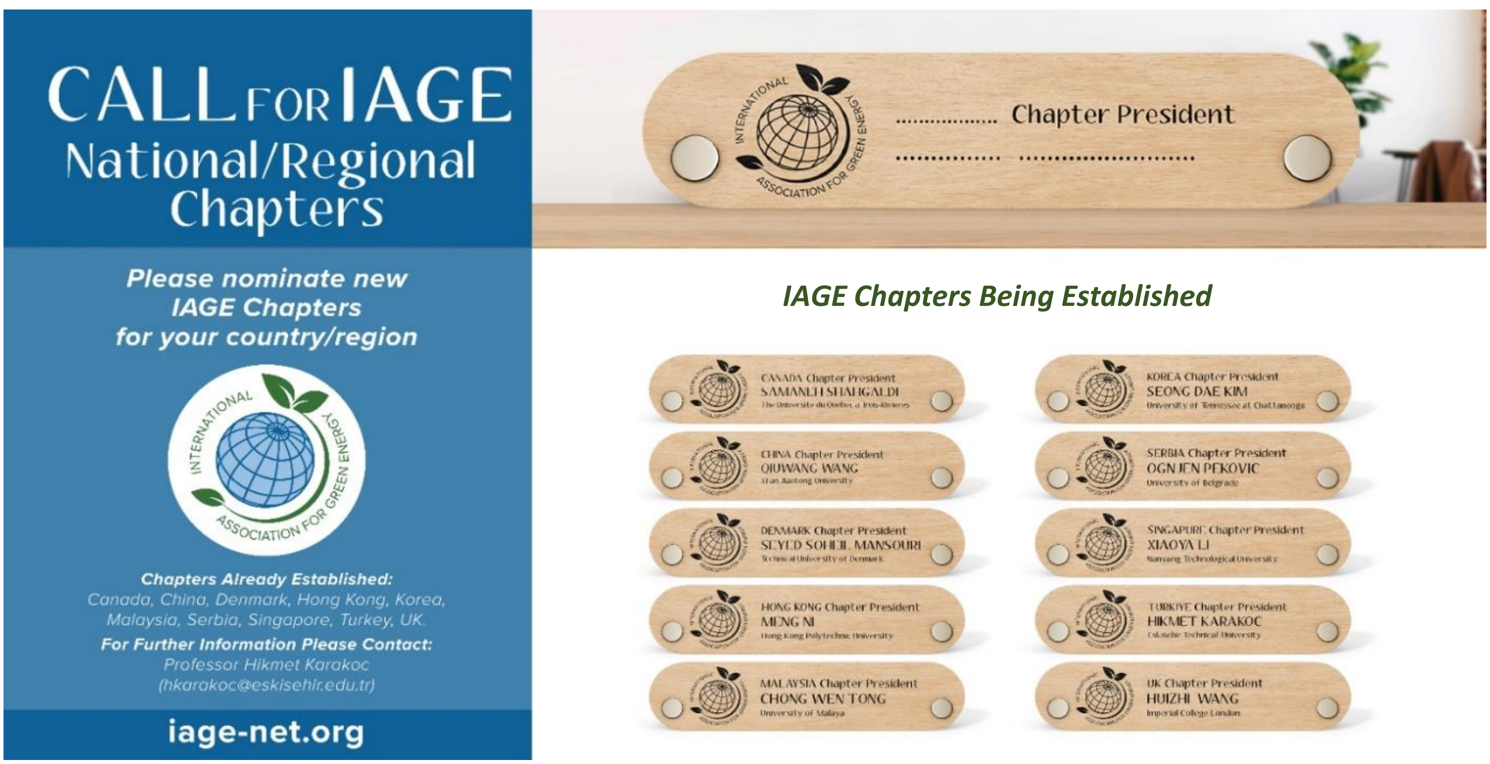
The example below for the roles of the Chapter Board of Directors can be advised:

- **President**: Responsible for all activities of the chapter
- **Vice President**: University representative
- **Vice President**: A company representative
- **Member**: Ph.D. Student representative (Responsible for establishing green energy student clubs at universities)
- **Member**: Responsible for organizing national green energy symposiums and meetings
- **Member**: Responsible for communication, promoting and establishing mailing groups, creating a LinkedIn account, etc., for the chapter
- **Member**: Newsletter connection from the chapter
- **Member**: Representation and announcement for the IAGE conference in chapter
- **Member**: Representative for the International Journal of Green Energy journal in chapter

Professor Hikmet Karakoc
Chair of IAGE International Committee

Faculty of Aeronautics and Astronautics,
Eskisehir Technical University, Turkey

Please contact Professor Hikmet Karakoc (hkarakoc@eskisehir.edu.tr) for more information if you are interested in opening or joining a IAGE chapter.



Updates on the 15th International Green Energy Conference (IGEC-XV) to be held on July 10-13, 2023 at the University of Glasgow, UK

IAGE INTERNATIONAL ASSOCIATION FOR GREEN ENERGY

University of Glasgow

The preparation of the 15th International Green Energy Conference (https://www.iage-net.org/igec2023) is progressing steadily. There are many exciting developments to share with the Green Energy community.

The submission of abstract and paper was closed on February 28, 2023. In total, we received 221 submissions from world widely. Many thanks to our authors for their participation and support to the conference.

We will have seven Plenary Lectures covering a wide range of topics such as fuel cell, battery, thermal energy storage, hydrogen energy, energy trading, and many others. We will have over ten invited Keynote Lectures focusing on the frontier of key disciplines of green energy technologies.

The conference will also host several Special Sessions to create a unique platform to enable our delegates to exchange the most recent research progress in thermoacoustic energy technologies, green refrigeration and cold storage, fuel cell and electrolysers, and energy for buildings.

The conference is sponsored by three leading publishers:

- Frontiers (Frontiers in Thermal Engineering)
- MDPI (Sustainability)
- Taylor & Francis (International Journal of Green Energy)

The generosity of our sponsors enabled us to host three categories of awards with cash prizes at the conference this year.

- Best Paper Award ($1000, sponsored by IJGE, Taylor & Francis)
- Best Student Paper Award (three winners with £500 each, sponsored by Sustainability, MDPI)
- Best Student Presentation Award (three winners with £300 each, sponsored by the Frontiers)

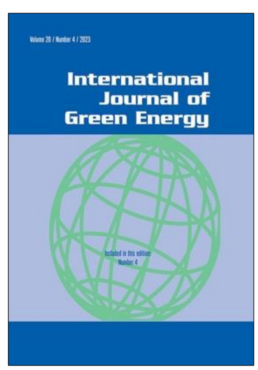
We are also grateful to the seven leading journals for their support. High-quality original papers of archival value presented at this conference will be considered for publication in Special Issues of these prestigious international journals:

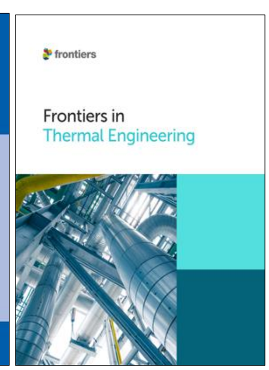
- Applied Energy (Elsevier)
- Energy (Elsevier)
- International Journal of Green Energy (Taylor & Francis)
- Frontiers in Thermal Engineering
- Sustainability (MDPI)
- Energy and AI (Elsevier)
- Energy Storage and Saving (Elsevier)

We are grateful for all your strong support and look forward to meeting you in-person or online in July!

Website: https://www.iage-net.org/igec2023
Abstract/paper submission link: https://www.iage-net.org/igec2023-submission
Sponsorship is available at various levels, please contact conference chair Prof. Zhibin Yu (Zhibin.Yu@glasgow.ac.uk)
All other correspondence regarding the conference to the Conference Secretary, Sambhaji Kadam (Sambhaji.Kadam@glasgow.ac.uk)

Professor Zhibin Yu
James Watt School of Engineering
University of Glasgow
Dr. Yu is the chair of the IGEC2023. His research is focused on thermal energy technologies and their fundamental thermodynamic, heat transfer, fluid-dynamic problems.





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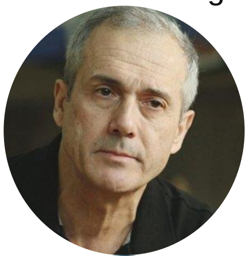
Invited Plenary Speakers at IGEC-XV (2023) Conference

Up to April 2023, seven world-class scientists have been invited by the conference to deliver plenary speeches at Glasgow, UK. More details can be found here: https://www.iage-net.org/igec2023-speakers.



Adrian Bejan
J.A. Jones Distinguished Professor
Duke University, USA

Title: **Predicting Design Evolution**

Nigel Brandon
Imperial College London, UK

Title: **Progress in fuel cell and hydrogen technologies for the low carbon energy transition**

Luisa F. Cabeza
Universitat de Lleida, Spain

Title: **Key challenges of thermal energy storage: a dive into the roadmap**

Ibrahim Dincer
Ontario Tech. University, Canada

Title: **Green Energy Solutions with Hydrogen: Challenges, Opportunities and Future Directions**

Shigeki Hasegawa
Kyoto University & Toyota Motor Corporation, Japan

Title: **Development of physical model based fuel cell system simulator for multi-purpose application**

Jianzhong Wu
Cardiff University, UK

Title: **Peer to peer energy trading to facilitate the net zero transition**

Piotr Zelenay
Los Alamos National Laboratory, USA

Title: **Electrochemical Energy Conversion Using Non-Precious Metal Catalysts**

Invited Keynote Speakers at IGEC-XV (2023) Conference

Up to April 2023, ten world-leading scientists have been invited by the conference to deliver keynote talks at Glasgow, UK. More details can be found here: https://www.iage-net.org/igec2023-speakers

Kodjo Agbossou
University of Quebec Canada
Title: Opportunities of smart grid and hydrogen production

Like Li
Mississippi State University, USA
Title: Decarbonizing Electric Grid and Industrial Heat through Thermochemical Energy Storage

Ming-Jia Li
Beijing Institute Technology, China
Title: Study and application of storage technology in the "generation-grid load-storage" type integrated systems with its energy management method

Shuli Liu
Beijing Institute Technology, China
Title: A study of an indirect expansion solar-assisted air source heat pump with hybrid thermal energy storage for space heating in North China: efficient-economic-environmental analysis

Mohamed Mohamedi
Institut National de la Recherche Scientifique (INRS), Canada
Title: Progress in the design and fabrication of membraneless air-breathing microfluidic fuel cells for electronic applications

Oliver Schmidt
Imperial College London, UK
Title: Monetizing Energy Storage

Samaneh Shahgaldi
University of Quebec Canada
Title: Membrane Electrode Assembly for Proton Exchange Membrane Fuel Cells

Xiaolei Wang
University of Alberta, Canada
Title: Batteries for Sustainability

Jin Xuan
University of Surrey, UK
Title: Building a circular economy for net zero manufacturing of chemicals and materials

Feng-Yuan Zhang
University of Tennessee, Knoxville (UTK), USA
Title: Decarbonization with Efficient Green Hydrogen Production from Water Electrolysis

Call for Nominations

Call for nominations to the 2023 IAGE Awards

The International Association for Green Energy (IAGE) is pleased to announce the Call for Nominations for 2023 IAGE society level awards. For full consideration, nominations must be received by **May 31, 2023**. Award winners will be announced at the 15th International Green Energy Conference venue and will be listed after the conference on the IAGE website.

Nominations should be emailed to the Honours and Awards Committee Chair, Dr. Jing Shi at jing.shi@uc.edu. The entire nomination package (completed nomination form, and the required documents applicable to the award category) should be submitted in one single email.

The IAGE society level awards include the following categories:

- **Lifetime Achievement Award** recognizes an individual who has made extraordinary contribution to the advancement of green energy over his/her lifetime. The Lifetime Achievement Award is the highest honor bestowed upon an individual by IAGE.

- **Distinguished Service Award** is an honor bestowed to an individual who has provided exemplary service to the Association. It recognizes the individual's outstanding contribution to the IAGE, IGEC, IJGE, and the professional communities at large.

- **Outstanding Researcher Award** recognizes outstanding scientific work in green energy research by a world-leading scientist or engineer. The award recipient must have demonstrated exceptional contribution to the green energy research community.

- **Technology Innovation Award** recognizes and celebrates the researchers and/or inventors from the industry, academia, or individuals regarding their innovative ideas, products, or concepts. The Award is intended to encourage individuals or parties to think about "Technology Innovation" benefits.

- **Young Researcher Award** recognizes outstanding scientific work in green energy research by a young scientist or engineer. The award recipient must show exceptional promise as a developing leader and make outstanding and continuing contribution to green energy research.

For more information about the awards, refer to the IAGE award page:
https://www.iage-net.org/igec2023-awards

IAGE
INTERNATIONAL ASSOCIATION FOR GREEN ENERGY

Call for Bids

Call for bids to host the 17th International Green Energy Conference in 2025

The International Green Energy Conference (IGEC) is a multi–disciplinary conference on energy systems and technologies with no/reduced environmental, economic and social impact, and provides a forum for the exchange of technical information, for the dissemination of high-quality research results, and for the debate and shaping of future directions and priorities in energy sustainability and security. IGEC is held annually typically in July and is organized by International Association for Green Energy (IAGE).

IAGE Conference Committee (CC) is calling for bids to host the **17th IGEC in 2025**. For full consideration, bids should be submitted by email with subject line “Bid to host the 17th IGEC” to the CC chair SeongDae Kim (seongdae-kim@utc.edu) by **March 31, 2023**.

To be eligible to host the 17th IGEC,

- The proposed conference city should not have hosted the IGEC within the past 5 years.
- The organizer should have experience in conference organizing.
- The proposed conference city should be able to attract new participants and have good accessibility.

Bids should be brief and include the following information:

1. **Organizers**. List the following organizer(s) with contact info and affiliation:
   a. Organizing committee chair(s)
   b. Organizing committee members
   c. Hosting institution
2. **Institutional support and commitments**.
   a. Relevance of the organization to green energy
   b. Letter(s) of support from upper administration with detailed commitments, such as release time, secretarial support, and financial commitment
   c. Professional conference services that will be available and considered to execute the conference – general description of what is available and whether or not they have been contacted prior to submitting proposal.
3. **Conference site**. Provide the following:
   a. Brief description of the conference city
   b. Brief description of possible conference venues
   c. Site access and travel options: air travel and/or ground transportations with associated cost estimates
   d. Conference facilities
   e. Weather/climate
   f. Local attractions
   g. Accommodation: lodging options and cost estimates
   h. Tentative conference schedule
   i. Technical tours
   j. Conference finance: estimated revenue and expenses, plan for securing sponsorships
   k. Plan for conference promotion

The winning bid is expected to be announced by **May 31, 2023**. Bidders may contact any IAGE Conference Committee members before submitting the bid to discuss any aspect of the bid.

IAGE Conference Committee

- Seong Dae Kim, Ph.D. (seongdae-kim@utc.edu)
- Zhibin Yu, Ph.D. (Zhibin.Yu@glasgow.ac.uk)
- Chong Wen Tong, Ph.D. (chong_wentong@um.edu.my)

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Scientific Committee	Samaneh Shahgaldi	samaneh.shahgaldi@uqtr.ca

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Fuel cell and Electrolyzer	Samaneh Shahgaldi	samaneh.shahgaldi@uqtr.ca

Website: https://www.iage-net.org/
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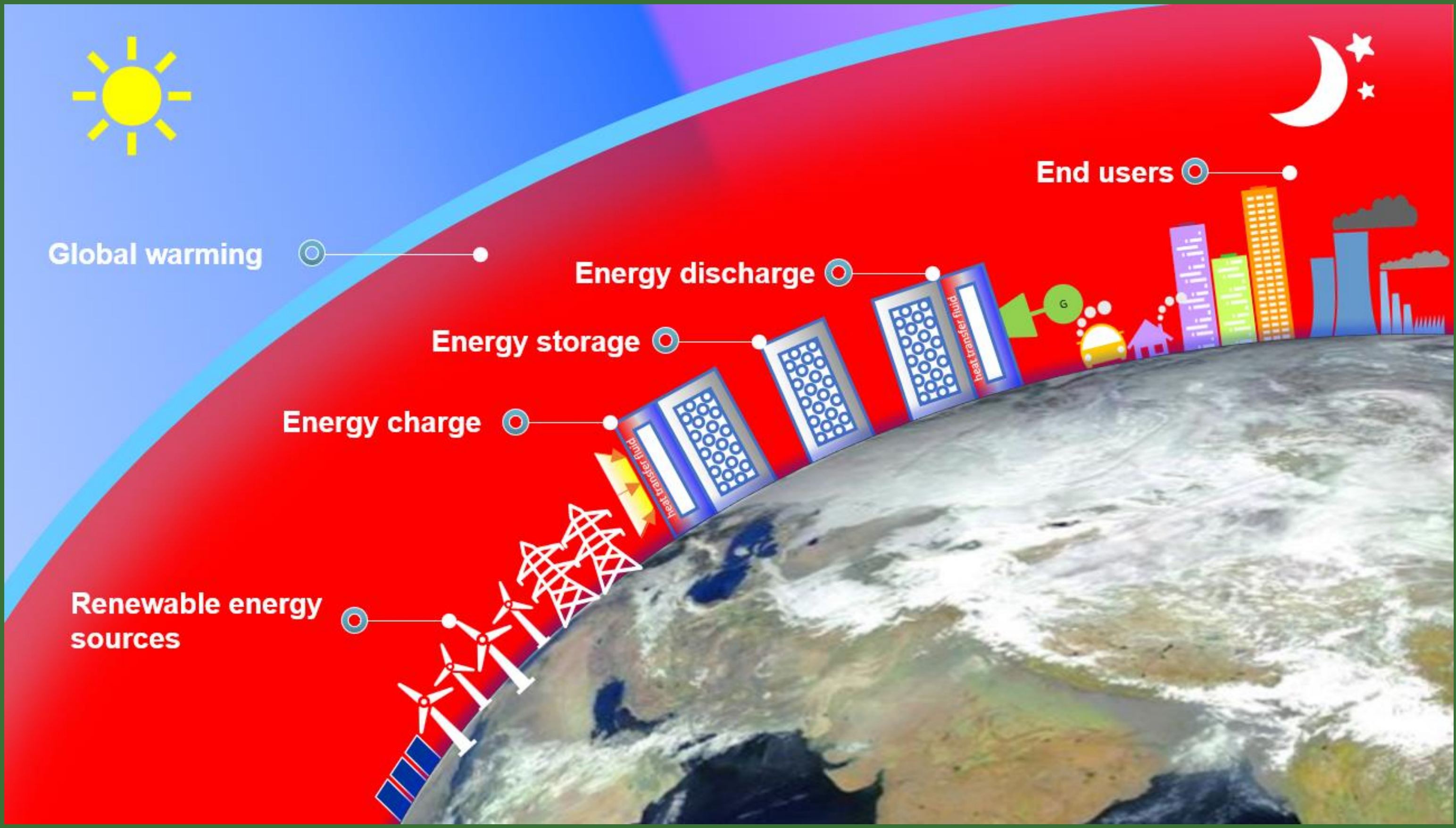
The *Green Energy Today* magazine would like to acknowledge the supports from all the contributors.



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