Annual Report 2024-2025 Academic Year





Sustainable Hydrogen

CENTRE FOR DOCTORAL TRAINING

Email: sushy@nottingham.ac.uk
Website: www.sustainablehydrogen-cdt.ac.uk






University of Nottingham UK | CHINA | MALAYSIA

Loughborough University

UNIVERSITY OF BIRMINGHAM

Ulster University

Funded by

UKRI Engineering and Physical Sciences Research Council

Grant reference EP/S023909/1

Sustainable Hydrogen Centre for Doctoral Training (SusHy CDT) established in 2019.

The Centre is the first UK hydrogen energy CDT, selected through the £446 million CDT call from the Engineering and Physical Sciences Research Council (EPSRC) aimed at tackling pressing global challenges. SusHy CDT has **four** partner universities – **Nottingham, Loughborough, Birmingham and Ulster** – and **four** overarching Centre objectives (see **Vision** below).

We recruited a total of 68 talented individuals to our CDT, which is providing high quality, multi-disciplinary training to achieve mass uptake of hydrogen technologies in the UK and beyond. They work on hydrogen combustion, distribution, production, safety, storage, systems and upgrade. The CDT is supported by the EPSRC and over 50 Stakeholder partners.

UKRI Engineering and Physical Sciences Research Council

wes Partner

WISE campaign for gender balance in science, technology & engineering

Our Vision

In-line with the UK's commitment to reduce emissions by **81% by 2035** and achieve **Net Zero by 2050**, we're developing hydrogen technologies facilitating deep-decarbonisation.

Sustainable Hydrogen CDT's objectives:

- Deliver high quality trans-disciplinary training - covering fundamental science, applied engineering, and systems issues - and build an appreciation of societal barriers to innovation.
- Through innovation opportunities, build initiative and stimulate an entrepreneurial mindset.
- Deliver 'industry ready' doctorates, who have a comprehensive skill set and experiences.
- Co-create research ideas and undertake, in partnership with our stakeholders, cutting edge investigations of hydrogen-based solutions to deep decarbonisation of the energy system.

Contents

Executive Summary

The SusHy CDT continues to deliver training and cohort building activities for our students from The Universities of Nottingham, Loughborough, Birmingham and Ulster. During the 2024–2025 academic year, SusHy CDT students continued to make significant contributions through research, collaboration and engagement activities.

We delivered a diverse programme of training activities throughout the year. These included the annual SusHy CDT research conference, stakeholder engagement events, career sessions with CDT alumni and industry experts, and visits to hydrogen and low-carbon innovation sites such as Tyseley Energy Park. Students also participated in specialised workshops on academic writing and publications, research communications and project management, including an opportunity to gain PRINCE2 certification. These activities ensure students develop not only technical expertise but also the transferable skills required for leadership roles in academia, industry and policy.

SusHy researchers continued their successful public engagement and outreach initiatives at events such as Glastonbury Festival's Science Futures field and the Green Man Festival's Einstein's Garden, where interactive demonstrations and activities engaged thousands of members of the public with the potential of hydrogen as a clean energy vector. In addition, students contributed to science communication events such as Pint of Science Festival and educational outreach programmes in local schools.

We maintain partnerships with our stakeholder organisations across industry, government and academia, ensuring that student research addresses real-world challenges and supports the development of practical hydrogen solutions. A key example was the National Gas Transmission stakeholder challenge, where multidisciplinary teams of students investigated the impact of hydrogen blending in the UK gas transmission network following a visit to the FutureGrid high-pressure test facility at DNV Spadeadam and presented their solutions to industry experts during the challenge workshop.

The CDT continues to foster an inclusive research environment through cohort-based learning and collaborative activities across the partner universities. During the 2024–2025 academic year, students participated in dedicated workshops exploring the transition from doctoral researcher to professional, which provided a forum to discuss challenges that can arise during the doctoral journey. As a proud diverse community we started organising culture celebration sessions where our students and staff share their cultural background.

We are pleased to report that several SusHy researchers successfully completed their PhD journey this year and have progressed to professional roles across a range of sectors, including academia, industry and policy. Further information on the diverse career pathways pursued by our alumni is available on the new Impact page of the SusHy CDT website.

As the CDT progresses, our students continue to produce impactful research and demonstrate the ongoing impact of SusHy CDT in advancing hydrogen technologies and supporting the UK's ambition to achieve net zero emissions.

Sustainable Hydrogen CDT Numbers

(as of October 25)

16% of recruited students identify as part of the LGBTQIA+ community

32% of recruited students identify as female.

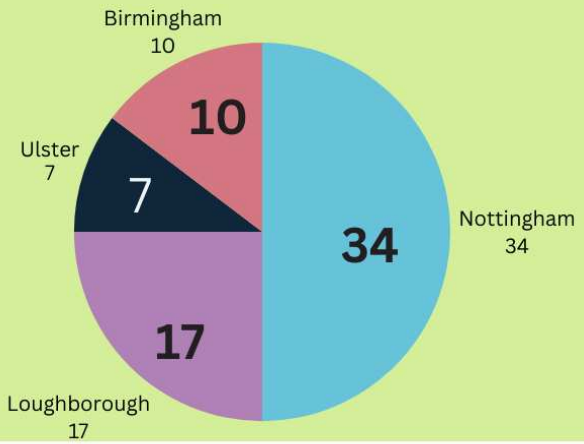
43% of recruited students identify as part of ethnic minority community.

Publications and presentations by CDT students

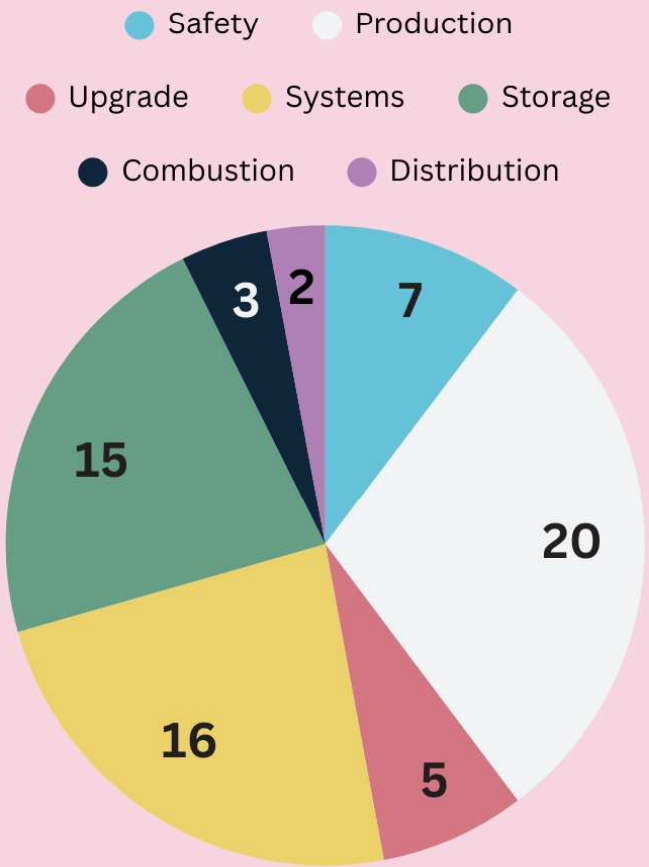
29

34

Where our CDT students are based, as recruited:

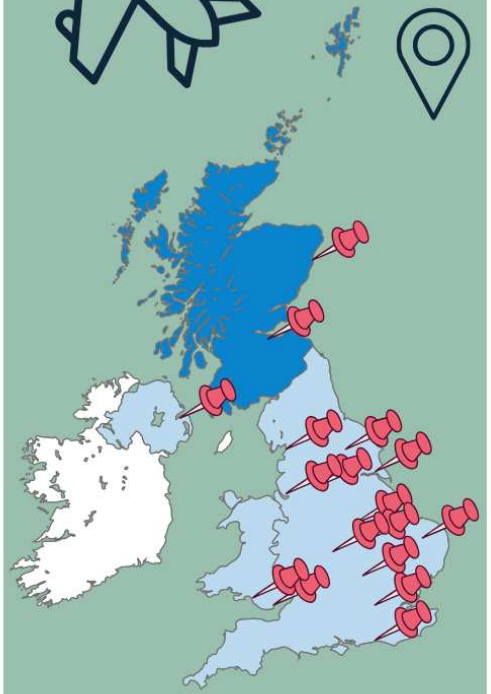


Research themes by number of students, as recruited:



Where they previously studied:

Abroad



Domestic

Equality, Diversity and Inclusivity (EDI)

SusHy CDT aims to train the energy leaders we need to meet the Net Zero global challenge. We have put EDI at the heart of our operations and recruited amazing individuals from a diverse talent pool. We seek to provide and continuously improve our supportive environment, where everyone feels equally valued and able to achieve their full potential.

EDI activities organised or supported by SusHy CDT during the 2024/25 academic year:

- SusHy CDT culture sharing sessions
- Celebrating Women in STEM Conference and Career Event
- Introduction to Neuroinclusive Communication workshop
- EDI workshop in "From Doctoral Researcher to Professional - doing, being, becoming and belonging"
- Various cohort building activities

16% of recruited students identify as part of the LGBTQIA+ community

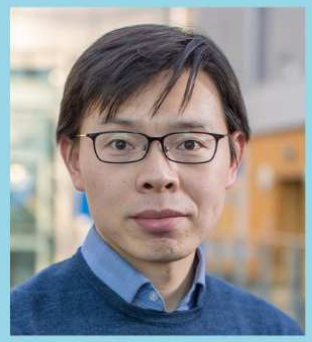
43% of recruited students identify as part of ethnic minority community.

32% of recruited students identify as female.

We create a more inclusive environment with:

- EDI student representatives at Management Board meetings, giving students influence on CDT EDI policy and opportunities to deal with issues.
- The EDI Access Fund financially assists students if they have disability, mobility or domestic (childcare) needs, which might otherwise prevent participation in activities.
- Our newsletters and social media posts reflect CDT gender and cultural diversity, and back relevant advocacy dates, including but not limited to Black History Month in October, International Women Day in March and Pride Month in June.
- SusHy CDT is a proud partner of the Women's Engineering Society (WES) and Women Into Science and Engineering (WISE), and provides free membership for students.

SusHy CDT Team



Sanliang Ling, CDT Director

Gulcan Serdaroglu, Programme Manager

Esther Little, Administrative Officer

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SusHy CDT Management Board

University of Nottingham
UK | CHINA | MALAYSIA

Associate Professor Sanliang Ling
Director

Assistant Professor Annabel Lanterna
Co-Director

Professor Deborah Kays
Co-Director
(previously at Nottingham, now Cardiff)

Loughborough University

Professor Dani Strickland
Co-Director

Professor David Saal
Co-Director

Professor Wen-Feng Lin
Co-Director

Professor Upul Wijayantha
Co-Director
(previously at Loughborough, now Cranfield)

UNIVERSITY OF BIRMINGHAM

Professor David Book
Co-Director

Dr Daniel Reed
Co-Director

Professor Lynne Macaskie
Co-Director

Dr Rafael Orozco
Co-Director

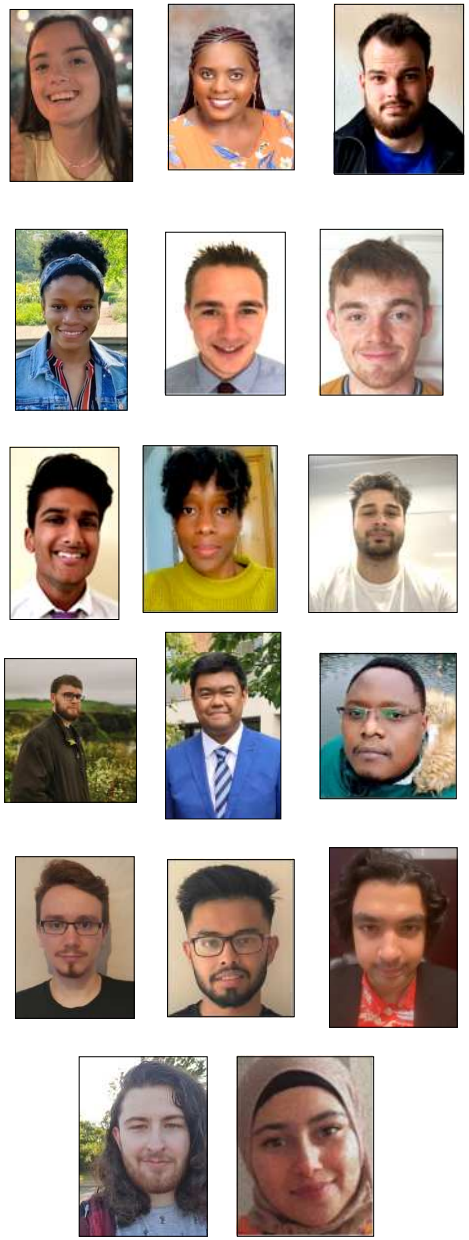
Ulster University

Professor Vladimir Molkov
Co-Director

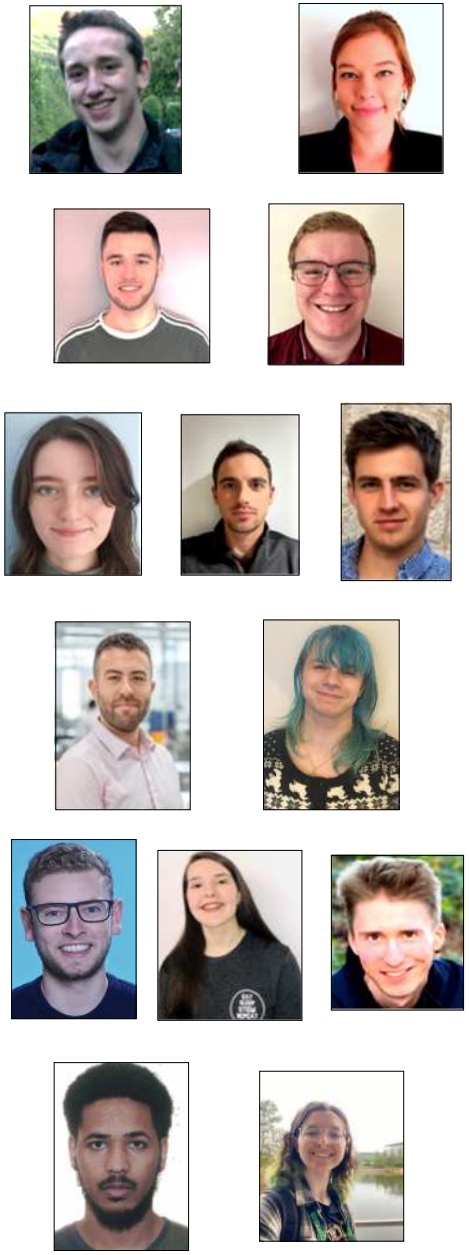
Professor Dmitriy Makarov
Co-Director

Our Students

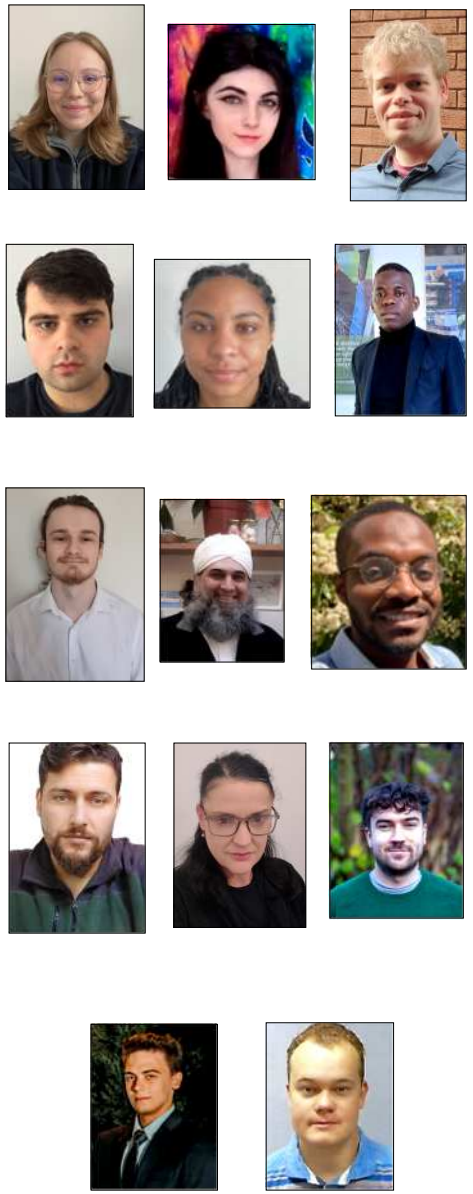
Production



Storage



System



Safety

Distribution

Combustion

Upgrade

Stakeholders

We work with 50-plus partners and stakeholders including energy providers, researchers, UK government and engineering consultancies. Such links are vital as the CDT pursues its four overarching objectives; particularly, delivering 'industry ready' doctorates and co-creating research ideas in collaboration with stakeholders. A Stakeholder list is at: www.sustainablehydrogen-cdt.ac.uk/stakeholders/stakeholders.aspx

Stakeholders Supporting PhD Projects:

Sustainable Hydrogen CDT gratefully acknowledges those stakeholders collaborating on students' PhD projects, ensuring our research is answering those questions the hydrogen sector needs to further develop.

SusHy stakeholder challenge workshop, 17 October 2024

National Gas Transmission set a stakeholder challenge for our Cohort 4 and 5 students in understanding the impact of variable hydrogen blends within the National Transmission System (NTS). As part of this activity, the SusHy students visited the FutureGrid high-pressure test facility at DNV Spadeadam, where a wide range of essential hydrogen tests are carried out to demonstrate that the pipelines and assets of the gas NTS could be used safely and reliably to transport hydrogen gas.

SusHy students in team of 5 – 6 worked on this multidisciplinary research project and presented their findings to the National Gas Transmission team during the workshop at The University of Nottingham on 17 October 2024. There were very interesting and thought-provoking discussions around how to address the challenges during the transition from natural gas to hydrogen.

Begum Tokay, Don Giddings, Haiqin Zhou, Andrea Laybourn and Zak Waite from The University of Nottingham also participated in the workshop to talk about their research activities around hydrogen blending and give feedback on the projects presented by the student teams.

National Gas Transmission team commented that the results and solutions proposed by our students were very impressive, especially in such a short period of time. All challenges were thoroughly addressed, and each team managed to take a unique approach, presenting individual and innovative ideas. They also enjoyed hearing their thoughts around societal acceptance and opinions on how they should address this concern.

Stakeholder activities 2024-2025 academic year

Regular SusHy stakeholder events enable students to network and exchange knowledge with our stakeholders. Through the stakeholder challenge activity students work on a multidisciplinary real sector challenge set by the stakeholder.

Joint stakeholder event at Loughborough University, 21 November 2024

In collaboration with the EnerHy CDT, we ran a joint stakeholder engagement event in Loughborough, where we had industrial speakers from a range of expertise, sharing their knowledge and insights with the PhD students:

- Paul Holland from Paul Holland Consulting, ‘Gas metrology’
- Alan Beesley from ALPS Ecoscience, ‘Bio-Hydrogen an industry perspective’
- Iain Silverwood from ISIS, ‘Neutron and Muon techniques’
- Julian Hasinski from Constain, ‘Systems thinking’

Stakeholder engagement session with ARUP, 11 February 2025

Lois Milner-Elkharouf and Trystan Cowen from ARUP gave an online talk about a wide range of hydrogen projects that ARUP have been undertaking including UK Government Hydrogen Technical Advisor, H2NorthEast – Pre FEED, Cadent hydrogen vision, RoughH2: Needs Case and Storage Development Plan and Assessing the Regional Demand for Geological Hydrogen Storage

Career session with CDT alumni, 21 November 2024

We had a career session with the alumni from SusHy and Fuel Cells and Their Fuels CDTs and our stakeholder Sophie Cozien-Cazuc sharing their PhD experience and career journey with our students:

- Will Bowling, Hydrogen Production Systems Engineer at Energy System Catapult
- Sophie Cozien-Cazuc, Senior Strategist at Advance Propulsion Centre UK
- Dr Daniel Smith, Research Associate at Lancaster University
- Dr Chris Harrison, Energy Sector Analyst at National Energy System Operator
- Dr Alan Stephen, Business Development Manager at National Gas Transmission

Stakeholder engagement session with Oort Energy, 6 May 2025

Dr Nicholas Van Dijk, CEO/Founder of Oort Energy, gave a guest lecture at The University of Nottingham, sharing interesting developments in the field of next generation hydrogen electrolysers. Nick is an internationally recognised technical leader in the field of water electrolysis and has spent his career focussing getting electrochemical processes and products to market.

Training activities 2024-2025 academic year

Career talks with CDT alumni, 21 November 2024

We invited CDT alumni from different professionals and expertise to share their career journey and learnings with our students.

Tyseley Energy Park Visit, 22 November 2024

SusHy students visited the Tyseley Energy Park (TEP) to find out about various demonstration projects committed to delivering low and zero carbon power, transport, heat, waste and recycling solutions in Birmingham.

A series of panel sessions with CDT alumni, 25 February, 1 April, 20 May, 18-19 September 2025

These online Q&A sessions were organised in thesis writing, viva preparation, writing publications and job applications in collaboration with three other CDTs, bringing together alumni from different CDTs with the current students to share about their PhD experience including techniques that helped them, lessons learned (e.g., what worked well, what they would have done differently) and any recommendations.

Career session: Identifying your strengths, 6 March 2025

This session explored how the students can gain valuable insights into their strengths to support career-decisions and make informed decisions.

From doctoral researcher to professional - doing, being, becoming and belonging, 6 March 2025

This training workshop gave the opportunity to the students from 4 CDT programmes to come together to discuss some of the challenges that potentially impede their doctoral journey, including imposter phenomenon and how EDI matters to them throughout their doctoral journey.

CDT annual research conference, 11-13 June 2025

This year's CDT conference took place at The University of Nottingham, where Cohort 3 and 4 students gave an oral presentation about their research work and Cohort 5 students presented their research posters. This event also included team building activities.

Writing retreat, 22-24 July 2025

We organised a 3-day writing retreat for Cohort 3 students to provide a lightly time structured and focused event in a quiet environment, to focus specifically on doctoral writing projects, whether this be for the PhD thesis, research paper submission, analysis work or journals.

Training sessions in academic writing, 18-19 August 2025

Our students attended the workshops in The Effective Research Writer and Writing for Publication at Ulster University. These sessions explored the key features and habits of an effective and productive writer and covered planning and editing techniques, targeting a journal and overcoming the difficulties in writing research.

PRINCE2 Foundation and Practitioner course

This course was offered to Cohort 3 students who wish to obtain a certification in project management.

SusHy CDT outreach activities 2024-2025 academic year

SusHy students educating school pupils

Antonia Dase of University of Nottingham worked with Foxwood Academy, a special educational needs school in Nottingham, designing and delivering 6 weeks of chemistry lessons to students aged 11-13. Antonia designed practical experiments for the topic of "Separation Techniques " and a booklet for students to record their findings as well as some quiz questions. The students made many colourful resources to demonstrate what they had learned over the weeks. Antonia and her peers also showcased some of the practical experiments that they had done at the Real Science in Schools Symposium as part of Nottingham Festival of Science and Curiosity.

Public engagement award

Kieran Heeley was awarded the Professor Alice Roberts Award for Public Engagement by University of Birmingham. Kieran and other SusHy CDT researchers Will Bowling, Una O'Hara, Cheryl Duke, Yassin Ziar, Paddy Powell, Antonia Dase, Aryamman Sanyal, Samir Soares, Zak Waite, Niko Muhammad Hilmi and Emily Blackett established and participated in the ‘Get with the H2type” outreach team to bring hydrogen education to the general public. They have interacted with several thousands of members of public for the last couple of years through their interactive and educating hydrogen activities and demonstrations as part of Science Futures Field at Glastonbury Festival and Einstein’s Garden at Green Man Festival.

SusHy Glastonbury outreach

For the third year running, the SusHy researchers’ team were back to Glastonbury Festival 2025 to share their passion for hydrogen and engage the public with the future of clean energy at Science Futures. Here are remarks from the team:
“We are happy to have had another successful year at Glastonbury, outreaching to a wide variety of people in the Science Futures area. Overall, 1,316 people came to the stall and interacted with our demonstrators. This doesn’t include those who came to a talk by Cheryl and Paddy where we promoted the stall with a demonstrator and an overview of what we were doing. In addition to this, Dayo did an amazing job with our Instagram account where we had ~6,500 interactions!

At the stall, we had demonstrators of hydrogen electrolysis, storage and a fuel cell, as well as hydrogen powered RC cars. We also had a return appearance of the bean bag game, with new games of a maze climbing game and a hydrogen board game. Next time, we would like to totally revamp the stall, to keep the interactions fresh and fun for festival attendees.”

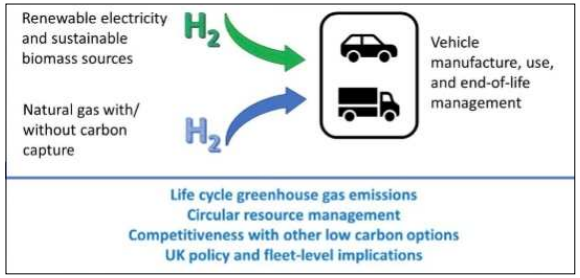
Pint of Science 2025

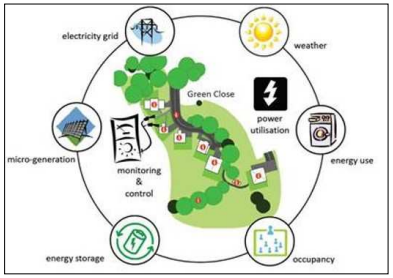
The Pint of Science Festival Loughborough 2025 held on 19–21 May, delivered an exciting and engaging celebration of cutting-edge research, drawing together university researchers, industry partners, and the local community to explore the latest advances in arts, science, engineering, and social sciences all presented in a relaxed, welcoming setting in the heart of Loughborough. The events included live experiments, demonstrations, panel discussions, and hands-on exhibitions. Key highlights:
- Attendance: Over 270 attendees across the three-day festival.
- Speakers: 82 expert presenters
- Volunteers: A dedicated team of 32 doctoral researchers volunteered their time for event delivery and ensured a smooth, enjoyable experience.
- Collaborations: Featuring key contributions from Intelligent Energy, Johnson Matthey, NCCAT, DNV, Sustainable Hydrogen CDT, Engineering Hydrogen CDT, Energy Research Accelerator, and Henry Royce Institute.
- Special Collaboration: Involvement of the SusHy CDT researchers (Cheryl Duke and Amy Liscoe from University of Nottingham) from the GetWithTheH2ype outreach team, delivering a fantastic exhibition.

Student Research Projects

Our **Sustainable Hydrogen CDT** PhD students, across all five Cohorts, are undertaking hydrogen research in a wide variety of areas.

In this section you will find research profiles for each CDT student researcher; working in areas such as Combustion, Distribution, Production, Safety, Storage, Systems, and Upgrade.





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Antonia Dase (Cohort 2)
School of Chemistry

Development of dehydrogenation catalysts for hydrogen storage materials

Antonia is working on the development of catalysts based upon earth abundant metals for application towards hydrogen storage materials including ammonia borane and metal borohydride ammoniates. Critical to the project is developing a fundamental understanding of the mechanisms involved the dehydrogenation of these materials in order to optimise catalytic performance.

Supervisors: Associate Professor Jesum Alves Fernandes, Professor Deborah Kays, Dr Saad Salman, Professor David Grant

Hazhir Ebne-Abbasi (Cohort 2)
Belfast School of Architecture and the Built Environment (BSABE)

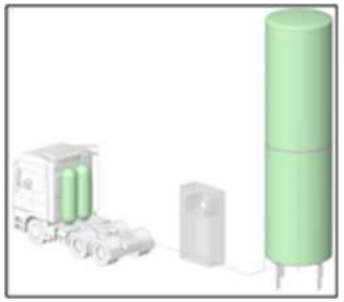


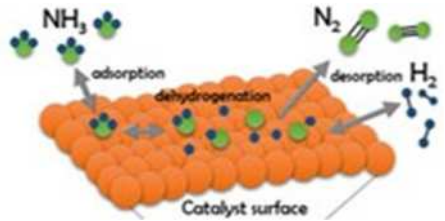
Figure 1. CFD modelling of a sub-cooled liquid hydrogen station

CFD model of fuelling through the entire equipment of a hydrogen refuelling station

Since joining HySAFER (Hydrogen Safety Engineering and Research) at Ulster University Hazhir has contributed to anumber of projects, including HyTunnel-CS, and SH2APED. He is now focusing on the development and validation of the firstof its type CFD model for simulation of complex heat and mass transfer processes during refuelling; through the entire chainof equipment at HRS from a high-pressure tank through piping, pressure control valve, precooler, breakaway, hose, nozzle,etc. to onboard storage tanks. The research would be followed by focus on modelling sub-cooled liquid hydrogen stations.

Supervisors: Dr Dmitriy Makarov, Professor Vladimir Molkov.

Bakhtawar Ahmed (Cohort 4)
School of Chemistry



Developing imide/amide catalysts for the ammonia decomposition process to produce hydrogen

Ammonia has the potential to provide itself as an effective medium for energy storage in the form of hydrogen. Implementing this idea of transforming existing hydrocarbon-based energy sources to renewable and essentially zero carbon energy in the form of hydrogen, requires overcoming limitations and working on research gaps.

The production of hydrogen from ammonia (NH□) through catalytic decomposition has gained significant attention as a potential avenue for clean and efficient hydrogen production. Developing efficient catalysts for this process is crucial to enhance the kinetics and selectivity of ammonia decomposition, thereby enabling the large-scale utilization of ammonia as a hydrogen carrier. Bakhtawar's project will explore group 2 and transition metal imide/amide catalysts for ammonia decomposition, with an aim to operate the process at lower temperature and pressure. Bakhtawar will investigate sustainable catalysts, avoiding resource limited rare earth metals.

Supervisor: Dr Joshua Makepeace and Prof Paul Anderson

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Ben Drake (Cohort 5)
Faculty of Engineering

Stakeholder collaboration

ROLLS ROYCE

Investigating the use of alternative fuel pump designs for cleaner aviation

Civil aviation needs to transition from kerosene to more sustainable fuels, liquid hydrogen (LH2) has emerged as a promising candidate. One key technological barrier to LH2 fuelled flight is reliably pumping the cryogen to the jet engines at sufficient rates for the duration of the pump's life cycle. LH2 turbopumps have existed for decades in the rocketry sector but with an active service life measured only in minutes and not the 10,000+ hours required for civil aviation. The lifespan of a LH2 turbopump is dictated by the failure of its bearing components, a consequence of traditional lubrication being unviable in cryogenic temperatures.

Ben will explore the operation of bearings in the harsh conditions by modelling various candidates, including foil, electromagnetic, and more conventional fluid bearing designs. The research will also explore the potential use of solid lubricants to further reduce wear.

Supervisors: Dr Benjamin Rothwell, Dr Mohammadreza Amoozgar, Professor Seamus Garvey, Dr Rajab Omar

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University of Nottingham
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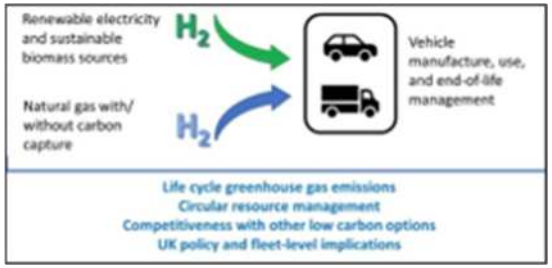
Cheryl Duke (Cohort 3)
Faculty of Engineering



Stakeholder collaboration

aramco

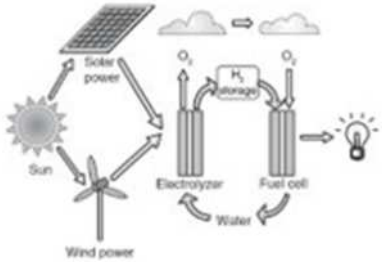
Quantifying environmental and resource impacts of the future UK hydrogen-fuelled vehicle fleet

Cheryl's project is developing novel Life Cycle Assessment (LCA) models to assess the resource and environmental implications of deploying hydrogen-fuelled vehicles in the UK's light duty and heavy duty road fleets. Cheryl's comprehensive approach will consider the current and future mix of hydrogen production routes, vehicle manufacture and use, and end-of-life vehicle management (e.g. recycling).

Beyond more common LCA studies comparing technologies on a vehicular level, this project will consider the turnover of UK vehicle fleet and the uptake of hydrogen technologies, to quantify cumulative resource and environmental implications.

Supervisor: Professor Jon McKechnie

Loughborough University



Esther Mgbemeje (Cohort 5)
School of Mechanical, Electrical and Manufacturing Engineering

Green Hydrogen Production from Waste: A Techno-Economic and Social Analysis of Waste-to-Hydrogen Conversion Technologies

Esther's research aims to assess the techno-economic and social viability of waste-to-energy technologies, particularly waste-to-hydrogen, in developing countries. Through process simulations, sensitivity analysis, and laboratory experiments, the study will optimise energy integration, account for mass and energy flows and validate model accuracy. Laboratory experiments will clarify operational challenges, while a social impact assessment will address barriers to adoption, such as workforce skills and community readiness. The work seeks to advance sustainable waste management strategies that reduce landfill use and support economically viable, large-scale waste-to-energy solutions in resource-constrained settings, contributing to cleaner energy generation and resource recovery. Environmental performance will also be evaluated using life cycle assessment (LCA) to ensure the sustainability of optimized WtH processes.

Supervisors: Dr Richard Blanchard, Dr Simon Kondrat

University of Nottingham
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Amy Liscoe (Cohort 5)
School of Psychology

Public values for a hydrogen energy system

Amy's project will investigate the public's view of novel sustainable technologies and their willingness to engage with a hydrogen fuelled future. Amy's project looks to broaden the current participant pool by speaking to experts in the field of hydrogen to gain an updated perspective on the UK's energy future and perceptions held by these experts about hydrogen and the public's views. With the aim of appreciating the trajectory of public values, Amy's project hopes to explore longitudinal perspectives held by the public and methods in which these can be measured. By appreciating the perspectives and views of individuals from all backgrounds, industries, and ways of life Amy aims to initiate an area of research which can progress the acceptance and application of hydrogen technologies in our society.

Supervisors: Professor Alexa Spence, Professor Begum Tokay and Dr Nikki Dean Marshall

Loughborough University

Faris Elasha (Cohort 5)
School of Mechanical, Electrical

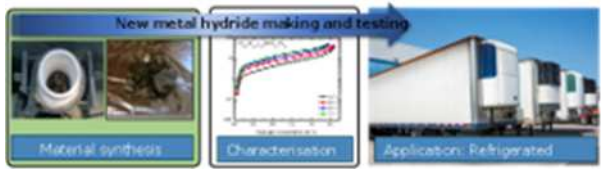
Low pressure, low cost hydrogen storage technology

Currently green hydrogen production and storage is focused primarily around electrolyser technology with high pressure storage. However, there are many uses for hydrogen aside from the transportation industry that do not require compressing hydrogen to high pressures. For example, in the context of adding Hydrogen to the gas supply system of up to 20 %, pressures to domestic premises can be between 75 mbar and 2 bar, a big step down from the 350-700 bar of a high pressure system. It makes more sense from an energy perspective to store the hydrogen at low pressures and avoid the round trip energy cost and the financial cost of the compressors and tanks. There is no low-pressure low-cost, hydrogen storage products on the market. Faris' research aims to understand the fundamental science behind low pressure hydrogen storage and design low pressure hydrogen storage systems using sustainability principles. Faris will also validate the technology and analyse the suitability and durability of the system using a small-scale test rig.

Supervisors: Dr Jonathan Wilson

University of Nottingham
UK | CHINA | MALAYSIA

Elizabeth Agathanggelou (Cohort 5)
Faculty of Engineering



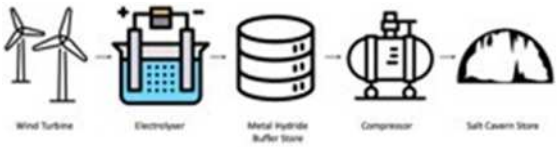
H2COOL - dual energy store for refrigerated transportation

Elizabeth's project will be part of H2COOL, a project which aims to develop metal hydrides to take advantage of their endothermic dehydrogenation, to provide cooling for refrigeration, in addition to hydrogen storage. This dual-use store has the potential application for transporting perishable goods in heavy goods vehicles, as the hydrogen release can be used for powering a hydrogen fuel cell whilst the cooling effect refrigerates the cargo space inside.

Supervisors: Professor David Grant, Assistant Professor Alastair Stuart, Professor Martin Dornheim, Dr Jorge Montero Banuelos

University of Nottingham
UK | CHINA | MALAYSIA

Amelia-Rose Edgley (Cohort 4)
Faculty of Engineering



Nanostructured hydrogen storage materials for offshore green hydrogen

Metal hydrides are a more compact storage medium than compressed gas or liquid hydrogen. If a successful candidate can be found, metal hydrides can be used to simplify the equipment needed for an offshore hydrogen generation platform. Amelia is researching into higher capacity metal hydrides that are also resistant to the impurities found by generating hydrogen from seawater electrolysis.

Supervisors: Professor David Grant, Dr Marcus Adams, Dr Timothy Cooper

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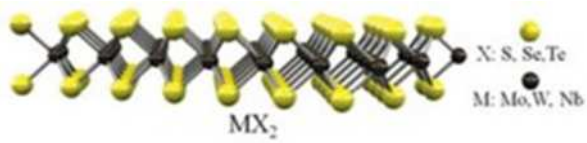
Joseph Parkinson (Cohort 5)
School of Chemical Engineering



Novel materials and methods in electrocatalysis

Transition metal dichalcogenides (TMDs, e.g. MoS2, WS2) have been the subject of intense research in recent years as low-cost catalysts for the Hydrogen and Oxygen evolution reactions. The chemistry of the catalytically active sites is currently becoming more understood, and Joe's project seeks to build on these recent advances through:
(i) Maximising edge sites through controlled TMD electrodeposition forming porous structures,
(ii) Modifying the catalytic sites through metal doping,
(iii) Optimising the stability of active sites,
(iv) Elucidation of mechanistic detail

Supervisors: Dr Neil Rees, Dr Shangfeng Du

UNIVERSITY OF BIRMINGHAM

Una O'Hara (Cohort 2)
School of Chemistry

Figure: Raman equipment, University of Birmingham

Development of high-performance complex hydrides

Una is investigating thermodynamic tuning of boron and nitrogen-based complex metal hydrides (CMHs), synthesized by chemical and mechano-chemical routes.

Nano-structuring by encapsulation in mesoporous-frameworks seeks to enhance cyclic stability, discharge and recharge rates whilst maintaining storage capacity. The materials will be characterised using a wide range of techniques to assess electrical, thermal and hydrogen storage properties.

Supervisors: Associate Professor Josh Makepeace, Professor David Book

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University of Nottingham
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Salim Ubale (Cohort 3)
Faculty of Engineering

Stakeholder collaboration

ITM POWER
Energy Storage | Clean Fuel

Optimisation of PEM electrolyser balance of plant operation and maintenance to maximise performance and resilience of key infrastructure

Salim's project seeks to develop an asset management strategy for a hydrogen plant. Given the reliability issues faced by PEM electrolysers, the project aims to increase the reliability of the plant, thereby increasing its performance and to optimise the plant operation through the application of reliability and resilience engineering principles.

Supervisors: Dr Rasa Remenyte-Prescott, Professor David Grant, Assistant Professor Alastair Stuart

Ulster University

Shiqi Cui (Cohort 5)
Belfast School of Architecture and the Built Environment (BSABE)

Safety of hydrogen and natural gas blends

Shiqi's research will focus on injecting hydrogen into natural gas pipelines and quickly mixing hydrogen and methane evenly. The homogeneous mixing of hydrogen and methane helps to prevent hydrogen embrittlement in the pipeline to prevent leakage from spreading. Safe handling of hydrogen and hydrogen-natural gas mixtures and understanding of the hazards and associated risks from leakage will also be included in future studies. These include (but are not limited to) hazard distances defined by the extent of the flammable cloud, and thermal effects from jet fire. Shiqi will focus on theoretical modelling and computational fluid dynamics (CFD) simulations. The research objective is to develop safety engineering tools related to hydrogen-methane mixtures. This will include consideration of theoretical modelling of unignited and ignited jets of hydrogen-methane mixtures and the effect of buoyancy on release.

Supervisors: Dr Sile Brennan, Dr Dmitriy Makarov, Professor Vladimir Molkov

University of Nottingham
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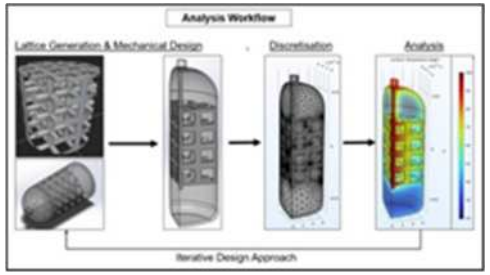
Yassin Ziar (Cohort 3)
Faculty of Engineering



Lattice Structures as Effective Thermal Augmentation in Solid-State HydrogenStorage Systems

Compact hydrogen storage is a major challenge for hydrogen powered vehicles, with current state-of-the-art storage vessels being too large and operating at dangerously high pressures. Solid state Metal Hydrides (MH) can store large (relative to gaseous storage) quantities of hydrogen in much smaller volumes and at lower pressures, however current suitable candidate metals that reversibly store hydrogen are characterised by poor thermal conductivities which is detrimental to refuelling rates.

To improve heat transfer into the powdered metal, Yassin's PhD research aims to exploit the benefits and design freedom that Additive Manufacturing (AM) offers, by incorporating lattice structures into the vessel's internal architecture. This project will involve cell selection, lattice generation, mechanical design, numerical analysis, and experimental validation.

Supervisors: Dr Ian Maskery, Assistant Professor Alastair Stuart.

University of Nottingham
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William Baker (Cohort 5)
Faculty of Engineering

Sustainable hydrogen for agriculture and rural environments

William's project identifies and analyses the key factors that determine how distributed sustainable hydrogen generation can help decarbonize agriculture and bring the rural environment into the hydrogen economy. The rapidly changing global environment means that the work seeks to understand the impact of different factors via: techno-economic assessments, energy system modelling and renewable resource identification, so that specific scenarios can be analysed, making the understanding gained widely applicable. An important part of the work is direct engagement with stakeholders to understand their priorities for agricultural decarbonisation and undertaking fieldwork within the UK to gain a psychological understanding of the differences between industrial and small-scale farming, to present real-world case studies.
Supervisors: Associate Professor Katy Voisey, Professor Jon Mckechnie, Associate Professor Alexa Spence

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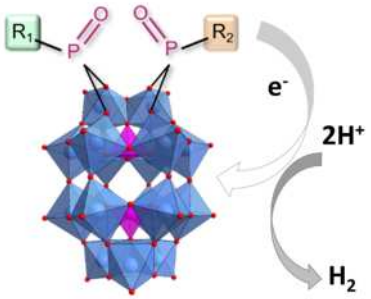
Adedayo Dada (Cohort 4)
School of Chemistry



Highly efficient molecular hydrogen-evolution catalysts

Molecular hydrogen evolution electrocatalysts allow efficient hydrogen production from water under mild conditions.

Adedayo will research development of fully tailorable molecular clusters based on molybdenum/tungsten and sulfur/oxygen. Systems will be combined with conductive nanocarbon materials to develop highly efficient composite electrocatalysts for the water splitting reaction. The stability and efficiency of these systems will be explored during prolonged electrolysis.

We are looking to design a new generation of inexpensive electrocatalysts which could outperform state-of-the-art materials, while allowing atomic control of catalyst structure. The cheap and easy-to-prepare systems are particularly interesting from a commercialisation perspective, given the ease with which their preparation could be scaled-up.

Supervisors: Dr Graham Newton, Professor Lee Johnson, Dr Kieran Jones

Loughborough University

Chisom Okeke (Cohort 5)
School of Mechanical, Electrical and Manufacturing Engineering

Low cost hydrogen technology for developing countries

Chisom's project aims to enable clean cooking and off-grid energy solutions in underserved rural areas in Africa by leveraging affordable green hydrogen. The project will explore the feasibility of using a flow battolyser—a device that stores electricity and produces green hydrogen—as a sustainable source of fuel for cooking. This work integrates green hydrogen production with a solar-panel-based microgrid, ensuring access to both clean cooking fuel and electricity.
To achieve this, the project will:

- Build knowledge of hydrogen-based cooking appliances and their applications in developing countries.
- Analyse the economics of using hydrogen for clean cooking and off-grid energy systems.
- Design and prototype low-cost hydrogen cooking appliances, such as cookstoves.
- Conduct testing and validation of hydrogen cooking appliances to ensure affordability, efficiency, and usability

Supervisors: Dr Richard Blanchard, Dr Jonathan Wilson, Professor Dani Strickland

University of Nottingham
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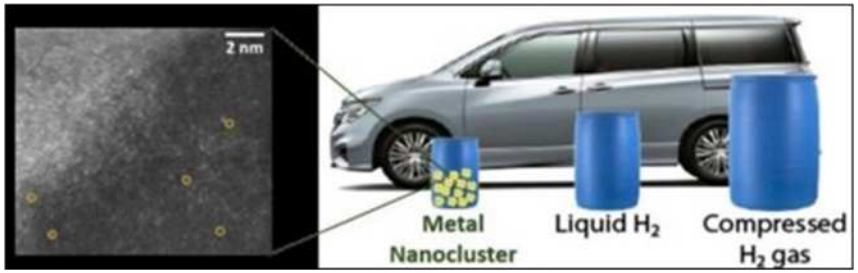
Stakeholder collaboration

diamond

Thomas Liddy (Cohort 4)
School of Chemistry



Insights on metal nanoclusters (MNCs) (de)hydrogenation for on-board hydrogen storage application using electron microscopy and spectroscopy techniques

Ammonia is a rich source of hydrogen (17.8 wt%) and is suitable for room temperature and low-pressure storage. The use of catalysts addresses some of the challenges of ammonia decomposition, however the benchmark, ruthenium, poses scale up issues due to its cost. Thomas' project will explore bimetallic nanoclusters (diameters >2 nm), which are fundamentally different to metal nanoparticles where most metal atoms remain 'hidden' within the lattice, to present a potential solution, offering tuneable characteristics from more than one metal without the reliance on costly ruthenium. Advancing the viability of ammonia as a storage medium.

Supervisors: Associate Professor Jesum Alves Fernandes, Professor David Grant.

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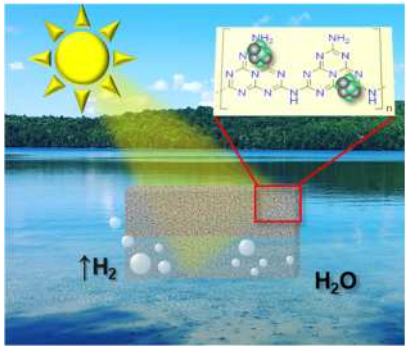
Samuel Balmer (Cohort 5)
School of Chemistry



Supported nanoalloys for sustainable hydrogen production

Sam is researching supported nanoalloys for sustainable hydrogen production through photocatalysis. Sam's project aims to investigate the mechanisms that affect photocatalyst performance through pre- and post-reaction analysis using novel approaches to in-situ analysis.

Supervisors: Assistant Professor Anabel Lanterna, Associate Professor Jesum Alves Fernandes

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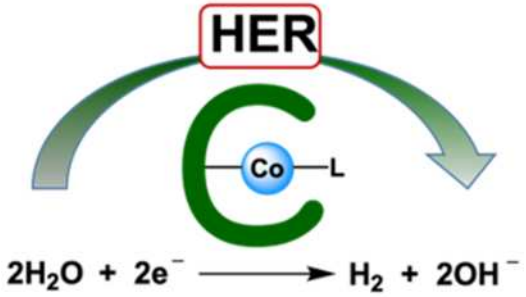
Rafael Sanchez (Cohort 5)
School of Chemistry



Low-Coordinate 3d Metal Complexes as Alternatives to Platinum

Group Metals for Hydrogen Evolution Reaction

Rafael's project will develop a range of cobalt(I) organometallic complexes as single metal HER catalysts, where the metal centre is stabilised using highly sterically encumbering ligands. These unique complexes have never been investigated for HER chemistry, despite their favourable redox chemistry and substrate binding environment. The cobalt(I) compounds will be investigated for their redox chemistry and sensitivity to acid, along with their electrochemical response in the HER conditions.

Supervisors: Professor Graham Newton, Professor Jonathan McMaster, and Professor Deborah Kays

Loughborough University

Redwan Atwiri (Cohort 5)
Department of Aeronautical and Automotive Engineering

Reliability modelling of equipment engaged in the production (electrolysers) and usage of hydrogen

Redwan's project aims to improve the reliability and reduce the wear and tear of hydrogen production and consumption equipment, notably electrolysers. It addresses the current research gap in system and cell-level reliability of green hydrogen technology equipment. By using advanced reliability analysis techniques, the project will develop comprehensive models for equipment reliability and degradation. The methodology combines deterministic physics-based models, stochastic coloured petri nets, and machine learning to predict equipment lifespan. Validation will occur through experimental testing and system-level analysis, using shared data and literature. Redwan also plans to develop new methods to accelerate equipment degradation for more accurate reliability assessments.

Supervisors: Professor Lisa Jackson, Dr Ashley Fly

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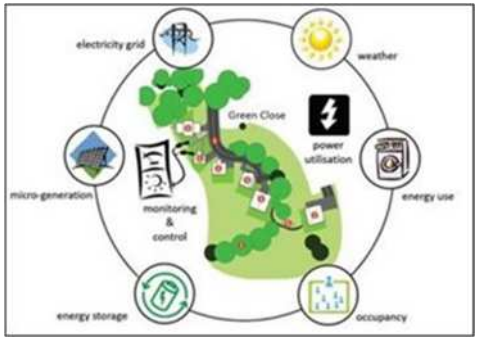

Samir Soares (Cohort 2)
Faculty of Engineering

Hydrogen for a sustainable rural built environment

Samir is working to evaluate and model rural domestic energy systems and looking towards the opportunities and technologies to transition to low carbon energy consumption including technologies such as hydrogen fuel cells and boilers, with key considerations to energy accessibility challenges rural energy users face. Samir is also working on development of a green solid state hydrogen store with a digital twin.

Supervisors: Professor Mark Gillott, Assistant Professor Alastair Stuart

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Luke Thompson (Cohort 4)
Faculty of Engineering

Development of electronically coductive ceramic supports for sustainable industrial processes

Luke is investigating the role of key catalyst support materials and how through novel techniques these materialscan increase their electronic conductivity by orders of magnitude, for further use in large scale industrialprocesses with a focus on hydrogen technologies. Luke's project will look directly at the crystal structures ofthese enhanced materials and how the role of oxygen vacancies and other structural defects within allows for aconductive pathway to form.

Materials of interest: Yttria Stabilised Zirconia (YSZ), Ceria, Lanthanum Oxides, Niobium Oxides and Strontium Oxides

Supervisors: Dr Ming Li, Professor Begum Tokay, Professor David Grant.

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Isabelle Marriot (Cohort 4)
School of Chemistry

Base metal catalysis of acceptorless alcohol dehydrogenation for hydrogen storage

Catalytic acceptorless alcohol dehydrogenation is an atom-economical approach for alcohol oxidation, without need for an oxidant. Reversible dehydrogenation/hydrogenation catalysis from this reaction provides a route to the use of organic molecules derived from biomass as liquid organic hydrogen carriers (LOHCs). Alcohols such as ethylene glycol, glycerol and the C4−C6 analogues erythritol, xylitol and sorbitol are considered to be potentially useful biomass-derived feedstocks; derived from agricultural or lumber resources, including waste streams and gravimetric hydrogen storage capacities, meeting targets set by the EU and the US Department of Energy. This chemistry has long been dominated by the platinum group metals (PGMs); however, low PGMs abundance means high economic and environmental cost, and their high toxicity means their removal from products can produce significant waste streams. Researchers are looking to other catalysts for industrial processes; with obvious candidates being base metals exhibiting low cost, high natural abundance, uniform global distribution and low toxicity. Isabelle's project will investigate a range of low coordinate and pincer complexes of the first-row transition metals in order to achieve the acceptorless dehydrogenation reactions and, with appropriate candidates, investigate the possibility of undertaking the reverse reaction with addition of H2.

Supervisors: Professor Deborah Kays, Professor Peter Licence.

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Andreas Ioannides (Cohort 5)
Faculty of Engineering

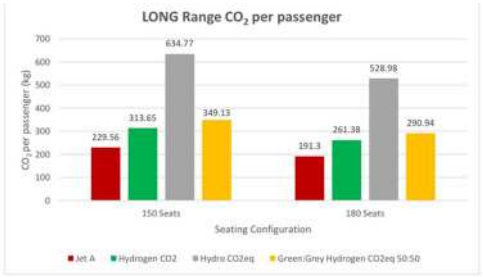

Figure 16 CO2 emissions per passenger for hydrogen against jet A fuel using seating arrangemer from 150-180 seats.

Assessing the environmental and economic sustainability of hydrogen and sustainable fuels for aviation

To achieve significant climate change mitigation in aviation, transitioning to low life cycle greenhouse gas (GHG) emission fuels is crucial. Sustainable aviation fuels (SAF), specifically drop-in fuels, offer near-term solutions by displacing conventional fuels without requiring modifications to existing infrastructure or aircraft engines. Hydrogen, a vital input for SAF production, plays a key role in various pathways. In the long term, direct use of hydrogen as an aviation fuel shows promise due to its higher energy density than conventional fuels, potentially improving aircraft fuel efficiency. However, adopting hydrogen fuels necessitates substantial changes in both aircraft technologies and ground systems. Andreas' project aims to comprehensively assess the potential of SAF and hydrogen fuels for low carbon aviation, considering technology readiness, fuel availability, techno-economic performance, and life cycle GHG and environmental implications.

Supervisors: Dr Ioanna Demetriou, Dr Vilius Portapas, Professor Jon McKenchnie

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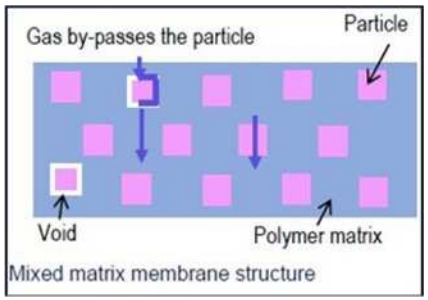
Niko Hilmi (Cohort 4)
Faculty of Engineering

Stakeholder collaboration

national gas transmission



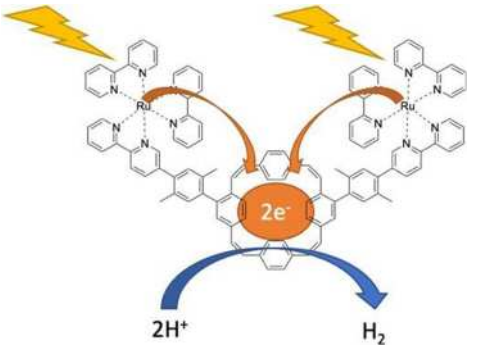
Composite membranes for H2 purification

H2 is a high quality and clean energy carrier. Most hydrogen is produced by steam methane reforming, followed by water-gas shift reaction, with bio-hydrogen production increasing. Before hydrogen is used in fuel cell and other applications CO2 and CH4 resulting from production processes has to be removed. Membrane-based separation technologies are promising alternatives to conventional separation technologies, i.e. pressure swing adsorption, due to low energy consumption. Many inorganic membranes of zeolites, metal alloys and carbon molecular sieves have been developed but scaling-up difficulties limit applications. Polymer membranes are useful, whilst controlling permeability/selectivity in harsh conditions is challenging. Recently, mixed matrix membranes (MMMs) – where inorganic material is embedded into polymer matrix – have attracted attention; as they combine porous materials' functionality with polymer processability. In this context, metal–organic frameworks (MOFs), comprised of metal ions connected by organic linkers, are most promising; due to their diverse and flexible structure. In addition, MOFs' organic linker typically have greater affinity towards polymer chains; allowing control of the MOF/polymer interface. Void-free MMMs can be prepared without requirement for modification of filler or membrane surfaces. Niko's project will explore development of MOF/polymer MMMs with enhanced H2 selectivity, to enable membrane based H2 purification.

Supervisors: Professor Begum Tokay, Professor Edward Lester, Assistant Professor Andrea Laybourn

Loughborough University

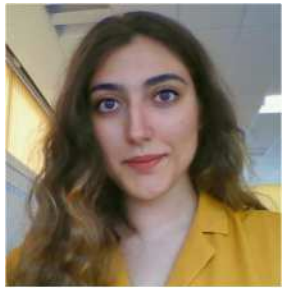
James Turner (Cohort 5)
School of Chemistry



Modelling of photochemical water splitting based on charge accumulation in macrocycles

Photochemical water splitting using homogeneous catalysts provides a conceptually simple and promising route towards sustainable hydrogen production. At the heart of this processes lies a molecular photosensitizer along with a catalyst. Whereas such photoredox catalytic systems are well-established in other areas of synthetic chemistry, it is a particular challenge that photocatalytic water splitting requires a multielectron process where several electrons are accumulated in one molecular unit. These molecular systems that can accumulate several charges is provided by a class of recently developed macrocycles based on paracyclophanetetraene (PCT), where multiple charges can be stabilized with the occurrence of global aromaticity in the macrocycle. James will investigate prototype macrocyclic catalysts, contrast their properties with existing photoredox catalysts and suggest new candidates, through detailed computational studies.

Supervisors: Dr Felix Plasser, Dr Pooja Goddard



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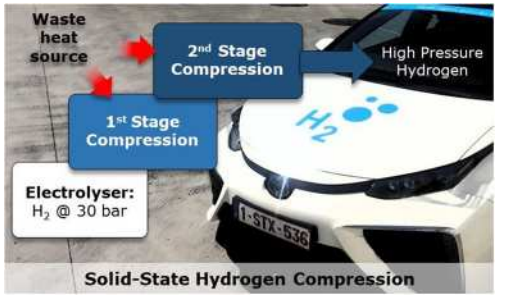
Ramas Al Qudah (Cohort 5)
Faculty of Engineering



Innovative materials for thermal compression – Solving the challenge of hydrogen compression

Ramas' project focuses on overcoming challenges currently present in the field of hydrogen compression. Through utilizing the thermodynamics of metal hydrides, solid–state compression circumvents some of the economic and safety concerns present in mechanical compression. MHHC utilize high-pressure alloys to absorb hydrogen and compress it by heating the metal hydride. Ramas' project is centred around researching and developing suitable AB2 group alloys that will provide the desired isotherms with low hysteresis, flat pressure plateaus, and fast kinetics. Ramas aims to improve the efficiency of hydrogen compression through analysing hydrogen uptake, as well as thermodynamic and kinetic measurements for various alloy compositions. High-pressure alloy properties will be characterized by using analytical techniques such as XRD, SEM, and XPS. Moreover, Ramas' project also aims to evaluate and modify the design of existing solid-state compressor prototypes to enable its successful deployment for hydrogen compression applications.

Supervisors: Professor David Grant, Assistant Professor Alastair Stuart, Dr Marcus Adams

UNIVERSITY OF BIRMINGHAM

Mossen Randeree (Cohort 5)
Department of Marketing

Developing a roadmap for adoption of sustainable hydrogen: A Delphi study of business and industry

Mossen's research aims to identify the challenges, barriers and opportunities for businesses involved in the transition to a low-carbon and sustainable hydrogen economy. Utilising a mixed method forecasting approach, including Delphi, Mossen will survey practitioners in a sector or industry and through interviews with experts and practitioners, the Delphi method will produce a clear road map for the adoption of hydrogen technologies that can inform policy, design and use.

Supervisors: Dr Robert Cluley, Professor William Green

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Gagan Krishna Gopakumar Suja (Cohort 5)
Faculty of Engineering

Dual Fuel Ammonia Engines for Future Heavy Transport and Power Generation

The aim of Gagan's research involves the investigation of ammonia combustion on Compression Ignition (CI) Engines [Dual Fuel Operation]. Due to its potential advantages over traditional fossil fuel-powered systems in terms of performance, emissions reduction, and environmental sustainability, ammonia-fuelled dual fuel combustion engines have gained traction. Gagan's research will be conducted using a Volvo-Penta engine. This engine has the capability to operate on both ammonia and a conventional hydrocarbon fuel or hydrogen in dual-fuel mode.
Gagan is also a member of the MariNH3 research group. "MariNH3" is a five-year research program to develop new and disruptive engine technology that will significantly cut greenhouse gases and pollution emitted by diesel-powered marine vessels. Gagan's research is part of Theme 2 of the MariNH3 research programme – Combustion Mode Fundamental Studies.

Supervisors: Professor Alastair Cairns, Dr Antonino La Rocca

Loughborough University

Harvey Monroe (Cohort 2)
Department of Chemistry

Development of odour additives for use in hydrogen technology

The remit of Harvey's project involves the design, synthesis and testing of novel compounds for use in hydrogen storage.
A number of potential odorants will be selected and compared with the novel compounds, as well as some odorants present in literature.

The tests will consist of hedonic tone and odour character tests, to ensure the suitability of an odorant's scent before fuel cell tests are performed to test which odorants don't poison the catalyst. So far, work on the novel compounds has been fully focused on the bicyclopentane framework, due to its volatility and broad substrate scope.

Supervisors: Dr Marc Kimber, Dr Gareth Pritchard.

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Will Bowling (Cohort 1)
Faculty of Engineering

Experimental study of advanced ammonia-fuelled, heavy duty, internal combustion (IC) engines under low load operation

Will is carrying out an experimental research project looking to utilise advanced combustion techniques such as turbulent jet ignition and dual fuel operation to enable the use of ammonia as a fuel in heavy duty, internal combustion engines; with a specific focus on low load operation, during which the combustion is the most challenged.

The project will be formed of two main studies, a fundamental combustion study carried out using a bespoke optical constant volume combustion chamber to understand flame development in a laminar environment, as well as an applied engine study, converting a diesel heavy duty compression ignition engine to operate using ammonia and hydrogen.

Supervisors: Professor Alasdair Cairns, Professor Antonino La Rocca, Dr Richard Jefferson-Loveday.

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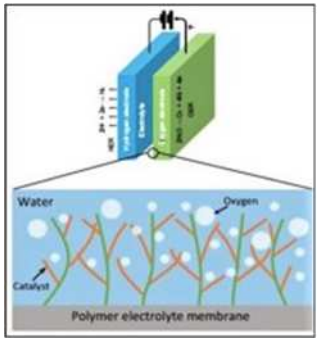
Alexandra Brochoire (Cohort 4)
School of Chemical Engineering



Proton exchange membrane water electrolysers with thin film nanostructured electrodes

The biggest challenge with current proton exchange membrane water electrolysers (PEMWE) is their poor power performance and durability; which is mainly caused by large mass transfer losses and degradation of the electrode structure, from the random electrode structure from catalyst nanoparticles. Alexandra's PhD project will seek to develop a new generation of catalyst electrodes from aligned IrO2- and metal oxide-based nanowires for PEMWE applications; taking advantage of the high stability of nanowires and the boosted mass transfer characteristics of the unique thin catalyst layers from nanowire arrays.

Project aims are substrate surface modification approach to increase surface activity, in-situ nanowire array growing process based on IrO2 and metal oxide materials, surface deposition technique of SrIrO3 on nanowire arrays, and electrode evaluation using half-cell and single cell test.

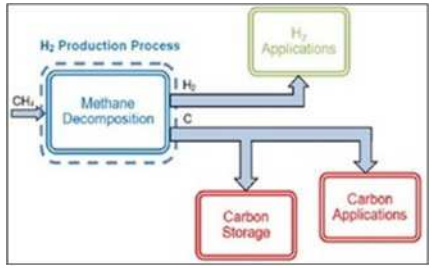
Supervisors: Dr Shanfeng Du, Dr Neil Rees.

Loughborough University

Mickella Dawkins (Cohort 1)
Department of Chemistry

Stakeholder collaboration

CATAPULT Offshore Renewable Energy



Hydrogen enrichment of natural gas by thermo-catalytic decomposition of methane

The gas network currently supplies natural gas to consumers but could supply gases, such as hydrogen, in the future. Thermo-catalytic decomposition of methane allows enrichment of natural gas with hydrogen, a carbon-free fuel.

Mickella's research is focused on the development of this technology and the incorporation of wind energy. Her research looks at the use of iron oxide from a natural source as the catalyst for the thermo-catalytic methane decomposition process.

Supervisors: Dr James Reynolds, Professor Sandie Dann and Professor David Saal.

Atish Gawale (Cohort 4)
Belfast School of Architecture and the Built Environment

Safety strategies and engineering solutions for hydrogen heavy-duty vehicles

Pursuit of a low carbon economy means practical implementation of zero-emission applications, including hydrogen-fuelled heavy-duty vehicles (HDV) such as buses and trucks. Hydrogen's use in public transport implies stringent bus design requirements. Industry and regulators' concerns over HDV design, considered critical for successful roll-out, include:
1. Development of HDV refuelling protocol comparable with modern fossil-fuel vehicles, without jeopardising onboard compressed hydrogen storage system (CHSS) safety.
2.Fire-resistance rating of current CHSS, which may lead to rupture in a fire with catastrophic consequences, i.e. blast wave, fireball and projectiles.

Atish's project will review 'old' and new HDV hazards of different designs and sectors (buses and trucks); identifying and analysing existing prevention and mitigation safety strategies, engineering solutions, knowledge gaps and technological bottlenecks in provision of HDV safety.

Supervisors: Dr Sergii Kashkarov, Professor Dmitriy Makarov, Professor Vladimir Molkov.

Emily Blackett (Cohort 4)
Faculty of Engineering

Advanced hydrogen sensing platform based on functionalised metal-organic frameworks

Developing efficient sensor materials with superior performance for selective, fast and sensitive hydrogen detection is essential for environmental protection and human health. Metal–organic frameworks (MOFs) – crystalline and porous solid materials constructed from metal nodes (metal ions or clusters) and functional organic ligands – are of interest for gas sensing for their large surface area, adjustable pore size, tuneable functional sites and intriguing properties; such as electrical conductivity, magnetism, ferroelectricity, luminescence and chromism. However, selectivity, sensitivity and stability are still major challenges for MOFs–based sensors used in hydrogen detection.

Emily's project aims to fabricate novel multifunctional MOF composite materials with improved sensitivity and stability for hydrogen detection. The rational design of these robust, multifunctional MOFs composites will combine multiple post synthetic modification and deposition techniques to achieve selective sensing of hydrogen over multiple cycles.

Supervisors: Professor Begum Tokay, Professor David Grant, Dr Zakhar Kudrynskyi

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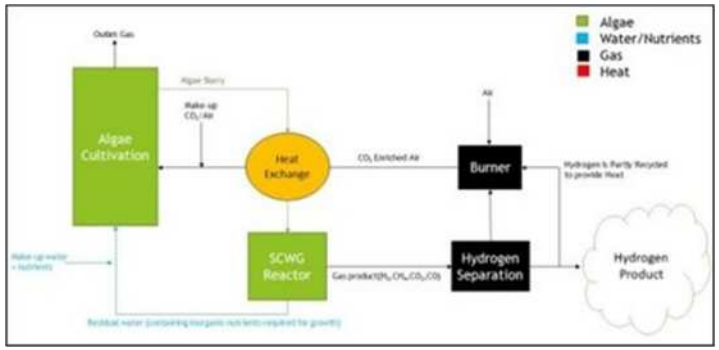
Kieran Heeley (Cohort 2)
Chemical Engineering



Algal biomass to hydrogen: A circular approach for green sustainable processing with enhanced efficiency and minimal waste

Kieran's project investigates hydrothermal conversion of algal biomass to hydrogen-rich gas, in a sustainable circular approach. It looks at optimising the catalyst, feedstock and operating conditions to increase the hydrogen yield; whilst maximising the nutrient recovery.

Supervisors: Professor Bushra Al-Duri, Dr Rafael Orozco, Professor Lynne Macaskie.

University of Nottingham
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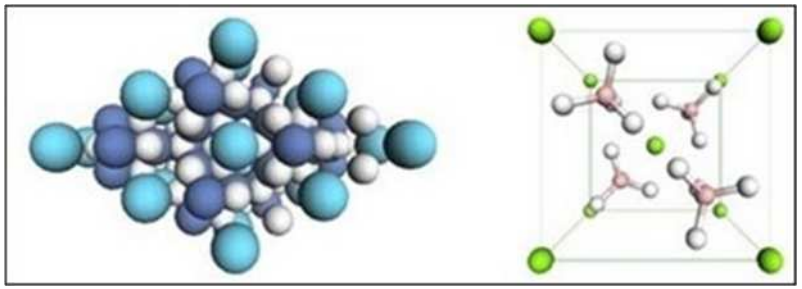
Samuel Lines (Cohort 3)
Faculty of Engineering



Computational modelling of Solid-State Hydrogen Storage Materials

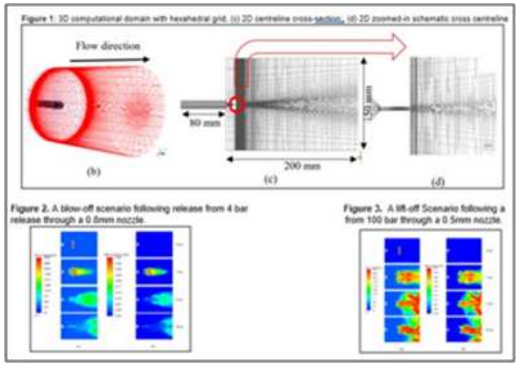
Sam's project aims to understand the composition-structure-property correlations of solid-state hydrogen storage materials, through accurate density functional theory simulations of both existing and hypothetical materials.

The most promising candidate materials discovered from the computational simulations will be synthesised and characterised, and their hydrogen storage properties will be validated by experiments.

Supervisors: Dr Sanliang Ling, Professor Martin Dornheim, Professor David Grant.

Ulster University

Mina Kazemi (Cohort 2)
Belfast School of Architecture and the Built Environment (BSABE)



Prevention and mitigation of accidents with hydrogen-powered vehicles in confined spaces

The scope of Mina's doctoral study includes the identification and prioritisation of relevant knowledge gaps, to develop innovative safety strategies to mitigate and prevent hydrogen-fuelled vehicles accidents in confined spaces. The first step is performing analytical and numerical studies to increase hydrogen-powered vehicles' safety, through improving TRRDs design; to prevent pressure peaking phenomenon and blow-off phenomenon, which would both lead to hydrogen deflagration or detonation and catastrophe in confined spaces.

Supervisors: Dr Sile Brennan, Professor Dmitriy Makarov, Professor Vladimir Molkov.

Loughborough University

John Taverner (Cohort 5)
Department of Chemical Engineering

Understanding the lifecycle carbon footprint and costs of sustainable hydrogen energy systems

John's project delves into comprehensive research on current hydrogen production methods. Focussing on sustainability, this project involves developing analytical models to assess the carbon footprint associated with various hydrogen production techniques. By analysing the entire lifecycle of hydrogen energy systems, from production to utilisation, John's project aims to provide invaluable insights into environmental impact and cost-effectiveness.

Supervisors: Professor Wen-Feng Lin, Professor Jin Xuan.

UNIVERSITY OF BIRMINGHAM

Vinay Patel (Cohort 5)
School of Chemical Engineering

Production of Hydrogen from Termites

Vinay is studying and quantifying the chemical activity of Termites, in order to fully incorporate them into process engineering and Hydrogen production. This will primarily include quantifying the chemical reaction stoichiometry, and the chemical kinetics as a function of gas partial pressures and the temperature. The secondary objective will be to quantify the Termite reproduction rate as a function of temperature, gas partial pressures, and space.

Supervisors: Dr Taghi Miri, Dr Scott Hayward and Helen Onyeaka

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University of Nottingham
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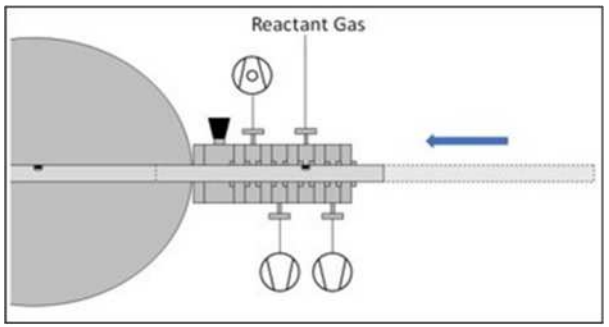
Chris Ryder (Cohort 1)
School of Physics and Astronomy



High-throughput cycling coupled X-ray photoelectron spectroscopy (XPS) of hydrogen storage materials

Chris's research looks into the application of X-ray photoelectron spectroscopy (XPS) to samples after reactions at elevated pressures.

Chris is designing a sample transfer device that enables rapid X-ray photoelectron spectroscopy (XPS) analysis of samples after reactions at elevated pressures. The device will soon be used to investigate various solid-state hydrogen storage materials, with a particular focus on their change in performance with increasing hydrogen cycles.

Supervisors: Associate Professor James O'Shea, Professor David Grant.

Loughborough University

Stephen Marr (Cohort 2)
Department of Chemistry

Stakeholder collaboration

E4tech
Strategy | Energy | Sustainability

Development of techniques and methods for sampling, calibration and testing of hydrogen purity for fuel cell vehicles

Measurement challenges for hydrogen fuel cells are preventing the overall sector from growing. Stephen's project is looking at ways of developing a cylinder passivation technology, which would provide temporal stability data for the 14 trace contaminants outlined in ISO (International Organization for Standardization) 14687-2.

Supervisors: Dr Ben Buckley, Professor Upul Wijayantha, Dr Paul Holland.

University of Nottingham
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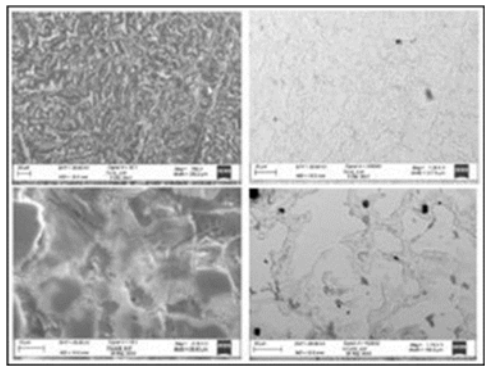
Alex McGrath (Cohort 2)
Faculty of Engineering

Stakeholder collaboration

LCM
less common metals



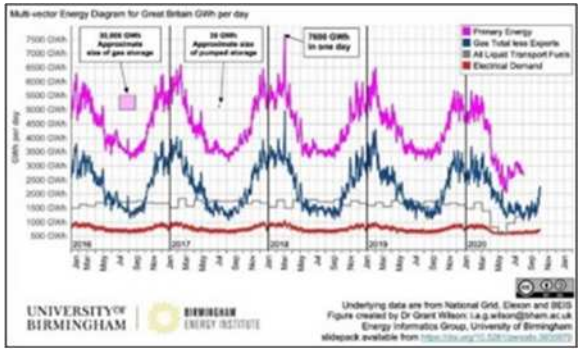
Synthesis and characterisation of metal alloys for hydrogen storage and related applications

Alex's project aims to experimentally synthesise new metal alloys shortlisted by computational screening; and characterise their physical, chemical and structural nature along with their thermodynamic and kinetic properties, during hydrogenation and de-hydrogenation. Alex is investigating synthesising new metal alloy compositions which will have improved hydrogen storage properties, forming their hydrides and characterising their microstructures.

Supervisors: Professor David Grant, Dr Sanliang Ling

UNIVERSITY OF BIRMINGHAM

Katarina Pegg (Cohort 3)
School of Chemical Engineering



The role of green hydrogen in the West Midlands Combined Authority local energy system

Green hydrogen production from weather dependent low carbon generation is an area of growth signposted in the UK Committee on Climate Change's 6th Carbon Budget (published December 2020); which provides UK Government Ministers with advice on the volume of greenhouse gases the UK can emit during the period 2033-2037.

Katarina's research will focus on the advantages and disadvantages of green hydrogen generation at a local level, specifically within the West Midlands Combined Authority area.

Supervisors: Dr Grant Wilson, Professor Bushra Al-Duri.

University of Nottingham
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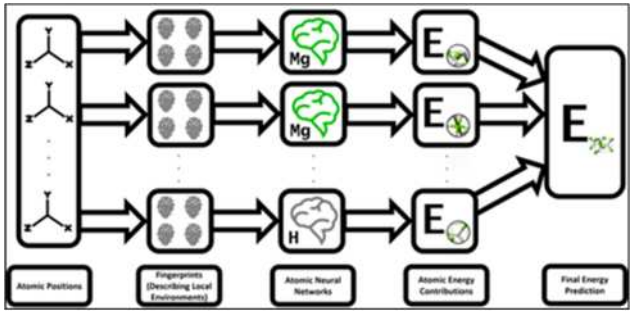
Oliver Morrison (Cohort 1)
Faculty of Engineering



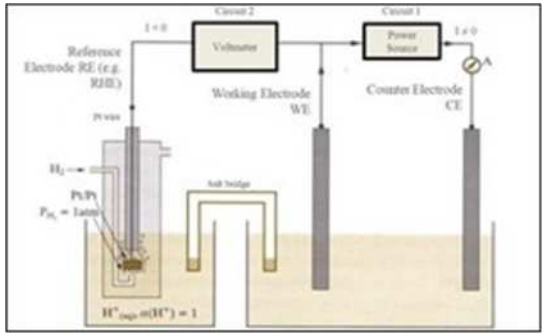
Hydrogenation of storage materials

Oliver is undertaking research into the use of Machine Learning Potentials (MLPs), models that use machine learning to approximate the potential energy surface; with particular focus on High-Definition Neural Networks (HDNNs). With sufficient training data, MLPs enable large-size and long time-scale, accurate molecular dynamics simulations, which are unattainable via conventional methods.
Oliver has used MLPs to simulate a variety of Magnesium-Hydrogen systems, including hydrogenation of magnesium clusters. Future simulations, with larger atom counts and time scales, will be used to gain insight into the process of hydrogenation and may inform the selection of improved hydrogen storage materials.

Supervisors: Dr Sanliang Ling, Professor David Grant.

Loughborough University

Adam McKinley (Cohort 1)
Department of Chemical Engineering



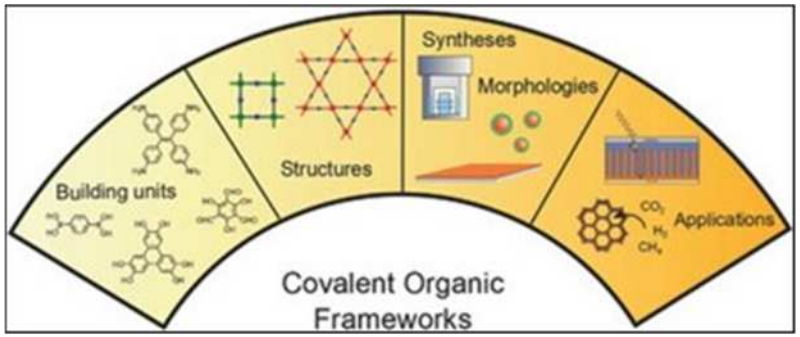
Catalyst development for low-cost, large-scale sustainable hydrogen production from water and seawater using renewable energy sources

Adam is looking at the oxygen evolution and hydrogen production, via water and seawater splitting, driven by renewable energy. He is interested in the production and utilisation of low-cost, highly efficient and highly selective catalysts for the process. Adam is currently investigating the performance of Ruthenium and Palladium (Ru and Pd) nanoparticle-based electrodes for the hydrogen evolution reaction at varying temperatures. He aims to explore the prospect of a bifunctional catalyst capable of efficient and consistent performance in both the hydrogen evolution reaction and oxygen evolution reaction (HER and OER).

Supervisors: Professor Wen-Feng Lin, Professor Jin Xuan, Dr Darren Walsh.

Loughborough University

Jai-Ram Mistry (Cohort 1)
Department of Chemistry



Photocatalytic covalent organic frameworks for hydrogen production and storage

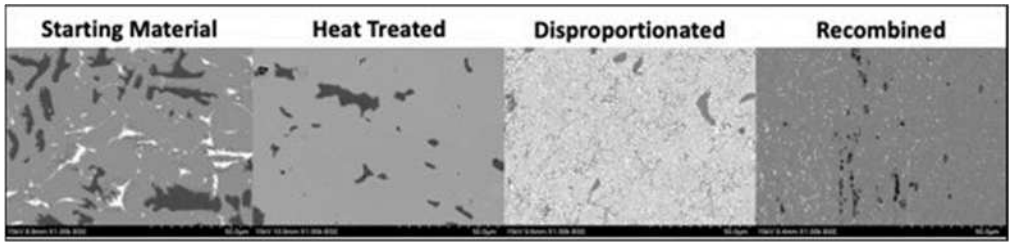
Jai undertakes research into the use of covalent organic frameworks (COFs) for hydrogen production and storage, as opposed to the popular metal organic frameworks (MOF) alternative.

His project involves the synthesis of new molecules which can be functionalised onto the surface of COFs; creating photocatalytic and size-specific channels which will permit hydrogen production from water and selective ingress, storage and egress.

Supervisors: Dr Iain Wright, Dr Simon Kondrat.

UNIVERSITY OF BIRMINGHAM

Patrick Powell (Cohort 3)
School of Metallurgy and Materials



The use of hydrogen as a processing gas to produce rare earth magnets

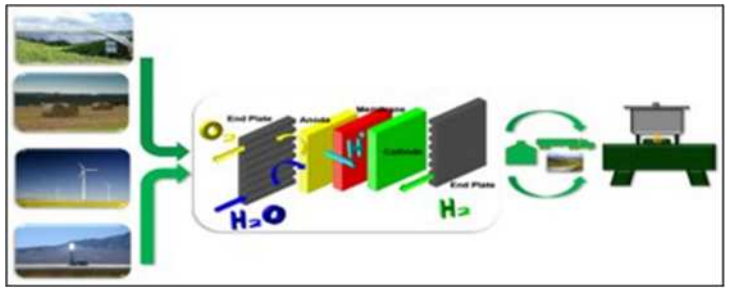
Hydrogen is used in the conventional production of sintered (rare earth) neodymium-iron-boron magnets and in the recycling of these materials. In recent years new methods to manufacture rare earth magnets based on a process called the Hydrogen Ductilisation Process have been found.

This process reduces the number of processing steps, reduces waste and could give a significant economic advantage to magnet manufacture. However, the process is far from optimised and the aim of Patrick's project will be to develop this process.

Supervisors: Professor Allan Walton, Dr Richard Sheridan, Professor David Book.

Loughborough University

Mulako Mukelabai (Cohort 3)
Centre for Renewable Energy Systems Technology
Wolfson School of Mechanical, Electrical, and Manufacturing Engineering



Renewable hydrogen production to transition to clean cooking

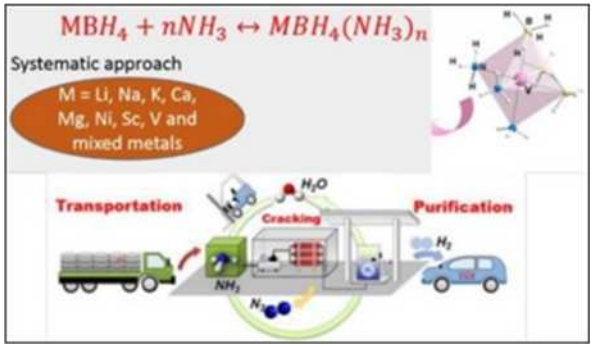
Mulako's project aims to develop technical and business models, and processes which will enable hydrogen produced from renewable energy to be utilised for cooking.

Though this process is understood, the system needs not just the right technology but also development of the right business model, human capacity and social acceptance to bring about the transformation of traditional cooking practices.

Supervisors: Dr Richard Blanchard, Professor Upul Wijayantha, Dr Alastair Livesey

University of Nottingham
UK | CHINA | MALAYSIA

Jacob Prosser (Cohort 1)
Faculty of Engineering



High capacity single and mixed metal borohydrides ammoniates for hydrogen energy storage applications

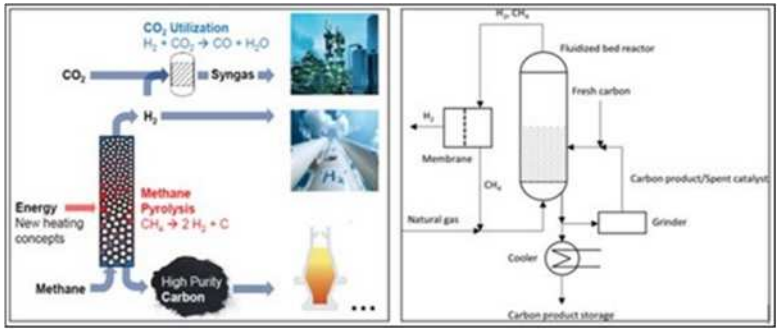
Jacob is researching the synthesis and characterisation of single and mixed metal borohydrides ammoniates (MBA/MMBAs), to increase the hydrogen storage performance of these materials and elucidate the reaction mechanisms of the decomposition process.

He is assessing the influence of metal charge density, electronegativity, additional metal cations and the number of ammonia ligands on the hydrogen storage performance.

Supervisors: Professor David Grant.

Loughborough University

Aryamman Sanyal (Cohort 3)
Department of Engineering



Reactor design and performance optimisation for catalytic hydrogen production from methane

Aryamman's project aims to design, develop and test a hydrogen generation reactor suitable for advanced catalyst; demonstrating high H2 yield and efficient carbon separation.

Natural gas into hydrogen and graphite has the potential to be highly disruptive and could be of substantial value if the process can be scaled up to commercial quantities.

Supervisors: Professor Weeratunge Malalasekera, Dr Hemaka Bandulasena

Ulster University

Srinivas Sivaraman (Cohort 3)
Belfast School of Architecture and the Built Environment (BSABE)

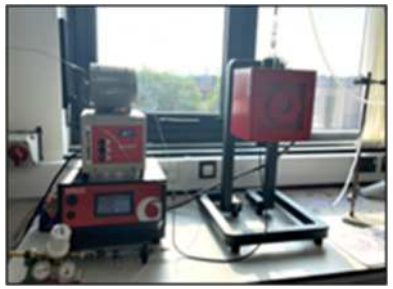
Safety of Using Ammonia in the Hydrogen Economy

Owing to characteristics such as high energy density and the experience of the use of ammonia in industries; its transportation around the globe offers practical, cost-effective means of storing and transporting large quantities of hydrogen. Using ammonia as a hydrogen carrier and in fuel applications calls for a reassessment of hazards and risks. Srinivas's project aims to develop safety strategies and engineering solutions for the handling of large quantities of ammonia, used as a hydrogen carrier during transport and storage onboard, and the use of relevant infrastructure. His project will analyse the hazards – including toxicity effects, existing prevention and mitigation safety strategies – and perform comprehensive quantitative risk assessment for safe utilisation of ammonia as hydrogen carrier.

Supervisors: Dr Dmitriy Makarov, Prof Vladimir Molkov, Dr Volodymyr Shentsov.

Loughborough University

Jack Shacklock (Cohort 2)
Department of Chemistry



Lowering the H2 cost in methane cracking technology by using solid carbon as an energy storage material

Jack's research is designed to investigate the systematic alteration of process conditions to obtain value-added solid carbon, specifically for energy storage whilst still maintaining a high yield of hydrogen. Initial studies have been conducted to improve the methane cracking process to increase yield and longevity. By-product carbon has separated in batch processes and been studied in electrochemical supercapacitors, demonstrating a high rate of performance compared to commercial carbon used for supercapacitor manufacturing. These results suggest lowering the cost of turquoise hydrogen, by finding applications for by-product carbon, is promising. Further studies are currently underway to separate by-product carbon in real-time operation (as opposed to batch process) and evaluate their performance in applications.

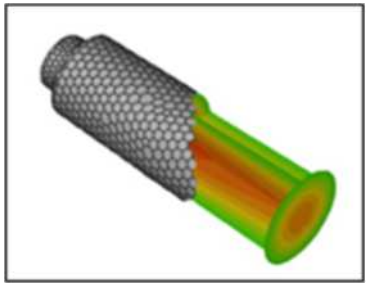
Supervisors: Dr Simon Kondrat, Prof Upul Wijayantha, Dr Niladri Banerjee

University of Nottingham
UK | CHINA | MALAYSIA

Zak Waite (Cohort 2)
Faculty of Engineering

Stakeholder collaboration

Beckett THERMAL SOLUTIONS



To a 100% hydrogen domestic boiler

Zak's project seeks to redesign the domestic boiler so that hydrogen can be used as a network fuel. At the moment because methane, which is currently used, burns quite differently from hydrogen our existing domestic boilers cannot utilise hydrogen gas.

Supervisors: Dr Donald Giddings, Professor David Grant, Professor Robin Irons

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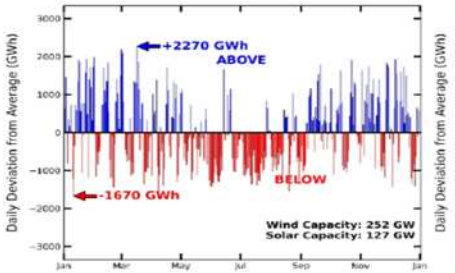
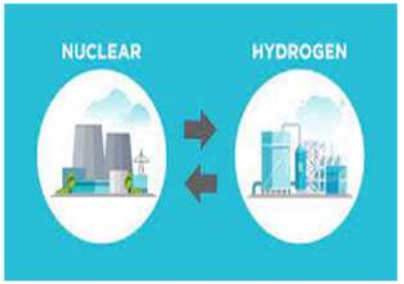
Loughborough University

Kate O'Neill (Cohort 5)
Business School

Stakeholder collaboration

NATIONAL NUCLEAR LABORATORY





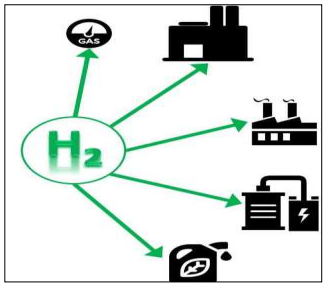
Investigating the economic impact of water availability on nuclear-hydrogen

Kate's research explores nuclear–hydrogen cogeneration as a source of flexibility in the Great Britain energy system, focusing on how water availability affects its technoeconomic performance and system value. Using scenario analysis, she investigates the water–energy nexus and the potential for water conservation in nuclear–hydrogen hybrid systems. Her work aims to develop an integrated modelling framework linking water demand from thermal power plants with the open-source PyPSA-FES model to assess the economic and system benefits of nuclear–hydrogen cogeneration.

Supervisors: Professor David Saal, Associate Professor Grant Wilson, Professor Monica Giulietti

UNIVERSITY OF BIRMINGHAM

Joseph Walton (Cohort 4)
School of Chemical Engineering



Business cases for green hydrogen

It is generally agreed that hydrogen employed in sustainable and emission-reducing projects needs to be sourced from ‘green’ feedstock and energy. Nevertheless, the vast majority of hydrogen sold today is ‘grey’ and produced by steam reforming of natural gas. Obviously, there are cost issues. Joseph’s work will look into how green hydrogen can be costed, so that it is more compatible with today’s energy system. This will include several areas of analysis: hydrogen production costs; externalities and effects on energy poverty; and business cases, high-value applications, and options to sell ‘greened’ products based on green hydrogen application. Joseph’s research aims to deliver a fully established cost model including environmental pricing, conclude business model development, dialogue with organisations/industry and validation of models and approaches.

Supervisor: Professor Robert Steinberger-Wilckens, Dr Rosie Day, Dr Grant Wilson.

University of Nottingham
UK | CHINA | MALAYSIA

Lukas Paulsson-Habegger (Cohort 5)
Business School

Manufacturing conductive oxides as catalyst support for energy efficient production of hydrogen and ammonia

Lukas will investigate and characterise a variety of metal oxides, such as yttria-stabilised zirconia and copper aluminate, withthe goal of improving their electronic conductivity whilst remaining stable in harsh chemical and thermal environments. Thiswill involve synthesising and characterising new compositions of materials through doping and defect chemistry. The goal is toutilise these materials as catalyst supports or electrodes in applications such as in electrolysers or fuel cells, with a focus onimproving the efficiency of sustainable hydrogen and ammonia production and use.

Supervisors: Dr Ming Li, Professor David Grant, Dr Sanliang Ling

Ulster University

Alemtsehay N Negash (Cohort 5)
Belfast School of Architecture and the Built Environment (BSABE)

Safety of compressed hydrogen storage systems for maritime applications

As the maritime industry moves towards greener fuels, hydrogen is emerging as a promising alternative due to its potential for zero-emission propulsion. However, ensuring the safety of compressed hydrogen storage systems in transport and other hydrogen-powered applications within the decarbonised maritime sector is critical for widespread adoption. Alemtsehay's project addresses the safety challenges, including those identified in IGF/IGC Codes, through rigorous research and focuses on identifying potential hazards and associated risks, including hydrogen leakage, overpressure scenarios, and fire hazards. These efforts aim to set new standards for safe hydrogen adoption and to close knowledge gaps by means of beyond state-of-the-art numerical models, and developing safety engineering solutions and strategies to ensures hydrogen-powered applications can operate inherently safer.

Supervisor: Dr Segii Kasharov, Professor Dmitriy Makarov, Professor Vladimir Molkov

Ulster University

Mayank Kamboj (Cohort 5)
Belfast School of Architecture and the Built Environment (BSABE)

Modelling heat and mass transfer during liquid hydrogen refuelling

Liquified hydrogen (LH2) is considered as the most practical storage method onboard heavy-duty vehicles (HDV), trains, ships and planes in case of long distances. Currently there are no fuelling protocols for hydrogen inventory in excess of 10 kg when refuelling gaseous hydrogen. Modelling of fuelling of cryogenic hydrogen and LH2 transfer will pose even more challenges due to significantly lower temperatures and presence of two-phase flows with evaporation and condensation.

LH2 refuelling will require development of innovative safety strategies and engineering solutions for storage and transfer infrastructure, understanding of underlying physical phenomena, development and validation of contemporary Computational Fluid Dynamics (CFD) and reduced engineering models and tools for safety design. The developed and validated LH2 model will allow to run "numerical experiments" to get insight into underlying physical phenomena avoiding high costs, hazards and associated risks typical for large-scale experimental studies, and, on practical side, develop LH2 refuelling protocols.

Supervisors: Professor Dmitriy Makarov, Professor Vladimir Molkov, Dr Donatella Cirrone

Student publications as of October 2025

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Student publications as of October 2025

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Student publications as of October 2025

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Student publications as of October 2025 continued

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Student publications as of October 2025 continued

Publication
Montanaro, S., Pander, **P., Mistry, J.R.**, Elsegood, M.R., Teat, S.J., Bond, A.D., Wright, I.A., Congrave, D.G. and Etherington, M.K., 2022. Simultaneous enhancement of thermally activated delayed fluorescence and photoluminescence quantum yield via homoconjugation. *Journal of Materials Chem-*
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Selected student presentations (2024-2025 Academic Year)

SusHy student	Presented at	Presentation title/topic
Mayank Kamboj Atish Gawale	11th International Conference on Hydrogen Safety, 22 – 26 September 2025 (Seoul, South Korea)	Modelling radiative heat transfer to closed LH_2 storage Simulations of Blast Wave After Hydrogen Tank Rupture in Fire Using LS-DYNA
Tom Liddy	16th European Congress on Catalysis, 31 August to 5 September 2025 (Trondheim, Norway)	Catalysts for ammonia decomposition (oral presentation)
Joe Parkinson	Joint UK Resonant Acoustic Mixing Workshop and Birmingham Symposium on Mechanochemistry and Sustainability, 30 July – 1 August 2025 (Birmingham, UK)	Developing a sustainable mechanochemical synthesis of Transition Metal Dichalcogenides and their hybrids for the Hydrogen Evolution Reaction (poster presentation)
Paddy Powell	28th International Workshop on Rare Earth and Future Permanent Magnets and Their Applications, 27 – 31 July 2025 (Tsukuba, Japan)	Influence of the Nd-rich phase when processing Nd-Fe-B through the Hydrogen Ductilisation Process (HyDP) (poster presentation)
Adedayo Dada	Frontiers in Metal Oxide Cluster Science VIII Conference, 21 – 26 July 2025 (Mainz, Germany)	Design and Synthesis of pyridyl phosphonate-functionalised polyoxometalates (oral and poster presentations)
Adedayo Dada Isabelle Marriott Thomas Liddy	Postgraduate Research Symposium, 16 – 18 July 2025 (Nottingham,UK)	Design and synthesis of symmetrical pyridyl phosphonate-functionalised polyoxometalates Activated from Within: In-Situ Nitridation of Ru/GNF enhances hydrogen production from ammonia cracking Acceptorless alcohol dehydrogenation using a sulfur-based manganese catalyst (poster presentations)
Mossen Randeree	Academy of Marketing Doctoral Colloquium, 7 – 10 July 2025 (Cork, Ireland)	Market Shaping in a Global Green Hydrogen Economy Context (oral presentation)
Niko Hilmi	8th Annual UK Porous Materials Conferences, 3 – 4 June 2025 (Birmingham, UK)	Metal-organic Framework (MOF)/Polymer Mixed Matrix Membranes (MMMs) for Hydrogen Purification (oral presentation)
Yassin Ziar	ASME Summer Heat Transfer Conference, 8 – 10 July 2025 (Colorado, USA)	Optimised Heat Transfer Architecture (HTA) for Enhanced Solid-State Hydrogen Storage (poster presentation)
Sam Lines	The Gordon Research Conference (GRC) on Hydrogen-Metal Systems, 22 – 27 June 2025 (Les Diablerets, Swit-	Ab Initio Modelling of the Kinetics of Hydrogen Absorption in $TiCr_2$ and $TiMn_2$ Surfaces and the Effect of Surface Substitutions (poster presentation)
Emily Blackett	International Meeting on Chemical Sensor, 22 – 26 June 2025 (Freiburg, Germany)	Advanced hydrogen sensing platform based on optimised semiconductor composites (poster presentation)

Selected student presentations (2024-2025 Academic Year) continued

SusHy student	Presented at	Presentation title/topic
Gagan Gopakumar Suja	MariNH$_3$ Conference, 17 June 2025 (Nottingham, UK)	Crack, Burn, Compare: Evaluating Electric and Thermal Recuperated Ammonia Crackers in Spark Ignition Engines (oral presentation)
Salim Ubale William Baker	35th European Safety and Reliability and 33rd Society for Risk Analysis Europe Conference, 15 – 19 June 2025 (Stavanger, Norway)	Modelling of polymer electrolyte membrane electrolyzer degradation and reliability (oral presentation) Sustainable Hydrogen for Agricultural and Rural Environments: Risks of Energy System Change (poster presentation
Niko Hilmi	8th Annual UK Porous Materials Conferences, 3 – 4 June 2025 (Birmingham, UK)	Metal-organic Framework (MOF)/Polymer Mixed Matrix Membranes (MMMs) for Hydrogen Purification (oral presentation)
William Baker Joe Walton	The European Hydrogen Conference, 9 – 11 April 2025 (Trieste, Italy)	Discovering the key social values for hydrogen acceptance in rural farming communities Competitive green hydrogen production and the potential impact on energy poverty (oral presentations)
Rafael Sanchez, Isabelle Marriott Adedayo Dada	RSC Dalton Conference, 1-3 April 2025 (Warwick, UK)	Synthesis and characterisation of polypyridyl pincer complexes of first-row transition metals Acceptorless alcohol dehydrogenation using a sulfur-based manganese catalyst Design and synthesis of pyridyl phosphonate-functionalised polyoxometalates (poster presentations)
Joe Walton	Hydrogen Days, 19 – 21 March 2025 (Prague, Czechia)	How can green hydrogen be made economically competitive? (poster presentation)
Luke Thomson and Lukas Paulsson-Habegger	Electronic Materials and Applications (EMA) conference, 26 – 28 February 2025 (Colorado, USA)	High electrical conductivity of 0.1 - 0.01 S/cm at room temperature in yttria stabilised zirconia (oral presentation)
Salim Ubale	71st Annual Reliability and Maintainability Symposium, 27-30 January 2025 (Florida, USA)	Reliability Analysis of PEM Electrolyser Balance of Plant (oral presentation)
Alexandra Brochoire	5th Annual International Conference in Advances in Materials Science, 27 – 28 November 2024 (Lahore, Pakistan)	Towards a straight-forward synthesis for high-performing iridium OER catalysts (oral presentation)
Alexandra Brochoire	Pacific Rim International Meeting of The Electrochemical Society, The Electrochemical Society of Japan, and The Korean Electrochemical Society, 6 – 11 October 2024. (Hawaii, USA)	Towards a straight-forward synthesis for high-performing iridium OER catalysts (poster presentation)





Sustainable Hydrogen

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