THE UNIVERSITY OF SYDNEY

Net Zero Initiative
Powerfuls

Powerfuls to drive industry and transport

Our vision and mission

Powerfuels are synthetic liquid or gaseous fuels produced using renewable energy. These powerfuels – which include hydrogen, ammonia, methane and others – are carbon neutral and transportable. As such, they have the potential to play a major role in the Net Zero economy. In fact, production of green hydrogen is already evolving as a multi-trillion-dollar industry and Australia is geared to become a super-power in this field.

We are developing new strategies and technologies to increase the efficiency of powerfuel production and utilization. This endeavor has the potential to save billions of dollars while accelerating the global transition to a net-zero carbon energy system.

Our approach

Because of their unique properties, hydrogen and ammonia are not drop-in replacements for fossil fuels. They require new technologies to harness their potential as energy sources. We are using state-of-the-art diagnostics to understand their combustion characteristics and are designing technologies that will enable the use of powerfuels in future engines and industrial processes.

Our research

A key Enabling Research Theme of the Net Zero Initiative (NZI) is 'Emissions Avoidance through Zero Emissions Energy'. Under the pillar 'Powerfuels', our researchers are developing novel, efficient and cost-effective technologies for the synthesis of hydrogen (H_2) and ammonia (NH_3) while enhancing carbon sequestration from point sources and direct air capture. Our research will speed-up the implementation of green fuels in combustion systems with applications in power generation, transport and industry.

We are also developing efficient, durable and stable fuel-cell technologies to span a wide a range of applications from household power to transport. Projects underway include:

- Plasmonic photo-induced water splitting
- A CO_2-free process for H_2 production from biomass and wastes
- Nanostructured catalysts for low-P NH_3 synthesis in industry
- Plasma synthesis of ammonia over nano-metallic catalysts
- Solar NH_3 synthesis by $N_2 + H_2O$
- Direct capture of atmospheric CO_2

Meet our research experts:

Our interdisciplinary research team leverages outstanding capabilities and infrastructure. Experts working under this pillar include:

School of Aerospace, Mechanical & Mechatronic Engineering

Assaad Masri (Lead): Specialises in burner design, gas and spray combustion systems, laser diagnostics.
Matthew Cleary: Specialises in modelling turbulent combustion systems.
Matthew Dunn: Specialises in turbulent combustion and laser diagnostics.
Agisilaos Kourmatzis: Specialises in sprays, atomization and article-laden flows.
Dries Verstraete, Yuan Chen, Jianguo Zhu: Specialise in improving fuel cell efficiency and applications.
Eason (Yi-Sheng) Chen: Specialises in hydrogen compatibility of materials.

Nanophotonics and Plasmonics Advancement Lab:

Stefano Palomba: Specialises in nanophotonics and plasmonics.

School of Chemical and Biomolecular Engineering:

Jun Huang: Specialises in biomass/wastes-to-H2, nanocatalysts for renewable NH3 synthesis.
PJ Cullen: Specialises in ammonia production using cold plasma.
Alejandro Montoya: Specialises in organic waste resources to Biofuels and Chemicals.
Ali Abbas: Specialises in circular economy and waste heat recovery.
Fengwang Li: Specialises in electrochemical conversion of CO2 to valuable fuels.

School of Chemistry:

Francois Aguey-Zinsou: Specialises in energy storage and advanced catalysts for water electrolysis and fuel cells.

School of Biomedical Engineering

Antonio Tricoli: Specialises in nanomaterials & devices for renewable fuels & energy storage.

How your business will benefit

By partnering with us, your business will be able to:

- collaborate with leading academic and industry experts from the University of Sydney to address the challenges faced by your business;
- help shape the next generation of postgraduate students with skills relevant for your business needs;
- host one of our talented PhD students, who will be placed in your business for up to one year; and
- benefit (pending eligibility) for the Australian Government's R&D Tax Incentive Scheme.

Past projects

Our progress in this space is evident in a number of past and ongoing projects such as the successful development of Nickel-based nano-catalysts for sustainable H_2 production.

Contact us

For further information or to discuss in greater detail, please contact:

Net Zero Initiative

assaad.masri@sydney.edu.au

THE UNIVERSITY OF SYDNEY