Project Title: Renewable Hydrogen Carriers from High-Sugar-Content Waste Streams (based at the University of New South Wales)

Project background and description:

The growing reality of nations adopting a sustainable H_2 economy has fuelled considerable interest in producing H_2 using renewable energy approaches. Solar-powered electrocatalytic water-splitting is a favoured route, although using water as the sole feed-stock has its own constraints (e.g., reasonably energy intensive, sluggish water oxidation reaction, need for freshwater source). An alternative is to replace the water being feed to the anodic compartment of the electrocatalytic cell with a waste organic/biomass. Doing so can lower the energy requirement, accelerate the oxidative reaction and reduce the sole reliance on water. Further, there is the potential to convert the organic/biomass into useful chemicals, adding value to what was previously considered to be a waste product.

Whether the state of the original waste organic/biomass is suitable for direct use in an electrocatalytic cell is not a trivial consideration. It may need to be initially converted into a form that is more amenable for use in the system. This will require some measure of organic/biomass preconditioning with one such option being a thermal catalytic reactor system. To maintain overall process sustainability though, heat has to be supplied to the reactor by the sun in the form of a solar-thermal reactor array.

Waste streams and waste products from certain food manufacturing processes (e.g., beverages, sauces) can have a high sugar content. Waste sugar-containing solutions represent a potential organic/biomass feedstock to produce chemical-based hydrogen carriers and/or for renewable hydrogen production. The process requires two steps: (1) converting the sugar into a chemical hydrogen carrier using a solar-thermal catalytic reactor; (2) generating renewable hydrogen by using the hydrogen carrier in a solar-powered electrocatalytic system. This Ph.D. project will focus on the first stage of the process. It will involve developing a continuous-flow solar-thermal catalytic reactor and suitable catalyst material which is able to accelerate the conversion of high-sugar-content waste into chemical hydrogen carriers and have long operational lifetimes while doing so. The product stream from the solar-thermal catalytic reactor has to be suitable for hydrogen generation in a downstream electrocatalytic system.

Aim/objectives:

1. Develop a continuous-flow solar-thermal catalytic reactor for converting high-sugar-content waste streams into chemical hydrogen carriers.
2. Establish active, selective and stable catalysts suitable for converting high-sugar-content waste streams into chemical hydrogen carriers.
3. Demonstrate capacity of system in handling high-sugar-content waste streams from different food manufacturing processes.

Environment

The GlobHE Training Centre is offering 12 Higher Degree by Research (HDR) Scholarships (PhD) that will provide a unique training opportunity through:

- World-class and state-of-the-art facilities and experts across the participating universities, research institutions, industry partners and other organisations
- An integrated Training Centre research agenda with inter-disciplinary projects across 5 themes area
- Opportunity to work or placement with partner organisations and industry partners
- Research skills, career development workshops and relevant industrial training
- Competitive support for national and international conference travel and networking opportunity
- Generous project support and excellent mentorship
- Delivering the next generation of highly skilled workforce to give Australia the ability to build home-grown hydrogen solutions and economic models.

Eligibility

PhD applicants must be acceptable as candidates for a PhD degree at the University of New South Wales, University of Queensland, University of Sydney, University of Newcastle, Curtin University and Monash University.

The minimum requirement for admission to a PhD programme is:

- an appropriate Bachelor degree with upper second class Honours from one of the above universities; or
- a completed Masters by Research from one of the above universities with a substantial research component and demonstrated capacity for timely completion of a high quality research thesis; or
- an equivalent qualification from a tertiary institution as determined by the Faculty Higher Degree Committee (HDC)

The minimum requirement for Scholarship with admission to a PhD is:

- a four-year Bachelor's degree with Honours Class I from an Australian institution or equivalent research qualification experience. This qualification must be in a field relevant to the proposed area of research.

Please note that ALL applicants, whether domestic or international must provide evidence that their language ability meets the **minimum English language*** requirements. The following table provides guidelines on common English language test acceptable for meeting English requirement:

IELTS (Academic)	TOEFL (Internet based test)	Pearson Test (Academic)
Overall: 6.5 (min 6.0 in each subset)	Overall: 90 (min 23 in writing, 22 in reading, listening and speaking)	Overall 64 (min. 54 in each subset)

*please check individual institutions' requirement for English language. For UNSW, check out: https://www.international.unsw.edu.au/english-language-requirements?field_english_language_tid=4018

Selection Criteria

- Bachelor (honours) or Masters degree from relevant disciplines include chemical engineering, mechanical, electrical engineering, computer science and social policy; at 1st class or upper second class level, or equivalent
- Proficiency in computer programming/modelling is required for some of the projects.
- In assessing applications, preference will be given to applicants who can demonstrate an ability to work across disciplines, have excellent interpersonal, communication and management skills
- When applying for a particular project, please state briefly and clearly the relevance of your degree and/or your experience to the project description

PhD Stipend

PhD scholarships will be available for a period of three and a half (3.5) years. The PhD stipend rate is $33,413 per annum tax-free. International applicants are encouraged to apply and maybe eligible for Tuition Fee Scholarship. See International Research Scholarship (for UNSW applicants).

Application Process

Interested applicant must email the following to be considered for Scholarship:

- CV
- Academic transcripts for all completed/pending completion degree
- Testamurs of previous study
- Statement addressing interest relevant to selection criteria
- Name of referees (can be academic or former employer)

For UNSW application, applicants are encouraged to use the HDR Self-assessment Tool: https://selfassessment.research.unsw.edu.au/ to give indication of eligibility and competitiveness for a scholarship (please also send the outcome of this self assessment).

Closing date:

Scholarship application outcomes are released progressively from the 'Offers Released' date. To find out more on 'Offers Released' date for your application round, visit Key Dates for specific Universities. Please note that there are different deadlines for Domestic and International applicants.

For those wanting to start studies in 2021/2022 – UNSW scholarship application:

- Domestic applicants closed on 9th July 2021 (T3 2021 start)
- International applicants closed on 27 August 2021 (T1/T2 2022 start)

Enquiries

For general enquiries regarding the Training Centre, please contact Professor Rose Amal: r.amal@unsw.edu.au, Professor Francois Aguey Zinsou Kondo: f.aguey@unsw.edu.au

For enquiries on PhD project, please contact Associate Professor Jason Scott at jason.scott@unsw.edu.au