Project Title: Technoeconomic Analysis of Power-to-X (P2X) Value Chains

Project Summary:

Commercial maturity of Power-to-X (P2X) technologies to utilise renewable energy resources for electrochemical conversion of abundant molecules like water, CO_2, and N_2, into green renewable energy-carriers, fuels and chemical feedstocks have opened new avenues for deep-routed decarbonisation.[1] A transition that is well underway, with 25 of the world's largest and leading economies introducing policies and incentives to kick start the P2X economies, leading to large scale up of electrolyser manufacturing, renewable energy deployment for P2X and a commitment of investment of ~240 billion USD.[2,3]

Yet only 4 - 10% of these investment commitments have reached a final investment decision (FID). [2,3] The critical bottlenecks are the current high cost of electrolysis technology, renewable electricity, and low capital efficiency of the projects due to intermittent and variable operation of solar/wind energy sources which results in high production costs making them unviable against their fossil fuel counterparts.[4] However, there is expectation that the cost of P2X will decrease with ongoing cost reduction in electrolyser and renewable energy production, achievement of economies of scale and optimisation of project designs.[5] Therefore, in the meantime while the cost remain high and relatively incompetent for large scale offtake, there is a need to find niche utilisation opportunities to enable scale up of technology.

This PhD project will focus on the technoeconomic analysis (TEA) of various Power-to-X conversion pathways, with an emphasis on modelling end-use scenarios (such as chemical manufacturing, green steel production, etc.). In order to inform and determine the commercial feasibility of these pathways, the student will use and build on existing TEA models and frameworks developed at GlobH2E. Hence a background in technoeconomic analysis, project design, simulation tools like Aspen/DWSIM, Excel VBA Programming, HOMER, excel and python coding would be beneficial, but not essential.

Key Techniques:

Technoeconomic Analysis, Process Simulation, Open-Source Assessment Tool Coding and Development.

PhD Stipend:

PhD Scholarship will be available for a period of 3.5 years. The PhD stipend rate is $35,000 per annum tax-free (2023 rate). International applications are encouraged to apply and maybe eligible for Tuition Fee Scholarships.
***Note** that Domestic Student maybe eligible for Engineering Top Up (to maximum of $10,000 per annum.)*

Research Environment:

The GlobHE Training Centre is offering PhD Scholarship 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.

Supervisors:

Dr. Rahman Daiyan (School of Chemical Engineering) and Prof Iain MacGill (School of Electrical Engineering)
Further information regarding the project, can be obtained by contacting Prof. MacGill (i.macgill@unsw.edu.au) or Dr. Daiyan (r.daiyan@unsw.edu.au) and for application process please contact: GlobH2E Centre Manager: mandalena@unsw.edu.au

Eligibility and Process:

If you are interested to apply for PhD admission and scholarship at UNSW, please go to UNSW Graduate Research Website outlining eligibility requirement and application step by step process: https://research.unsw.edu.au/submit-application

Key Dates:

Applications must be submitted by the application deadline for the intended study period (Term) to ensure acceptance and enrolment processes are completed by the Term Start Dates. Please check the key dates for application deadlines: https://www.unsw.edu.au/research/hdr/application

References:

(1) Daiyan, R.; Macgill, I.; Amal, R. Opportunities and Challenges for Renewable Power-to-X. *ACS Energy Lett* **2020**, 3843–3847. https://doi.org/10.1021/acsenergylett.0c02249.

(2) Hydrogen Council; McKinsey & Company. *Hydrogen Insights 2022: An Updated Perspective on Hydrogen Market Development and Actions Required to Unlock Hydrogen at Scale*; 2022. https://hydrogencouncil.com/en/hydrogen-insights-2022/.

(3) IEA. *Global Hydrogen Review 2022*; International Energy Agency, 2022. https://doi.org/10.1787/39351842-en.

(4) Ali Khan, M. H.; Daiyan, R.; Han, Z.; Hablutzel, M.; Haque, N.; Amal, R.; MacGill, I. Designing Optimal Integrated Electricity Supply Configurations for Renewable Hydrogen Generation in Australia. *iScience* **2021**, *24* (6), 102539. https://doi.org/https://doi.org/10.1016/j.isci.2021.102539.

(5) Khan, M. H. A.; Heywood, P.; Kuswara, A.; Daiyan, R.; MacGill, I.; Amal, R. An Integrated Framework of Open-Source Tools for Designing and Evaluating Green Hydrogen Production Opportunities. *Commun Earth Environ* **2022**, *3* (1), 309. https://doi.org/10.1038/s43247-022-00640-1.