Industry PhD Project: Techno-economic Analysis and Social License Framework Development for Synthetic Fuel Production

Project Summary:

Commercial maturity of Power-to-X (P2X) technologies to utilise renewable energy resources to generate synthetic fuels have opened up considerable opportunity to decarbonise a wide range of hard-to-abate sectors such as aviation, maritime and heavy-duty transportation.[1,2] Specifically, the sustainable production of renewable methanol, sustainable aviation fuel (SAF), renewable diesel and other synthetic fuels that can leverage renewable hydrogen and CO_2 (captured from industrial point sources and biomass) offers opportunity to utilise current infrastructure and use these fuels and chemicals as drop-in fuels.[3,4,5,6] While considerable focus has been placed on the certification and green labelling of hydrogen[6], a key question for subsequent synthetic fuel production and end-use is, of course, the source of carbon, which must be sourced from sustainable and acceptable sources. Therefore, considerable debate remains on what constitutes 'acceptable' sources of carbon.[6]

To address this gap in understanding, consolidatory frameworks are required for sustainable hydrogen production and CO_2 sourcing to support project developers as they progress their projects from the feasibility stage to final investment decisions. This project will aim to fill this knowledge gap by creating overarching techno-economic and social license frameworks for synthetic fuel supply chains. Key research themes will include:

- Developing comprehensive mass and energy balance models to account for carbon, hydrogen and renewable energy integration across the green fuel value chains. The models will then be packaged into open-source techno-economic and life cycle assessment tools that academia, policymakers and industry can then use.
- Develop an understanding of policy, public, and industrial perceptions of sustainable sources of CO_2, as well as subsequent mapping of availability of such sustainable sources, particularly biomass-based sources across Australia and potentially globally.
- Development of a social acceptance framework that encompasses not only sustainable sources of CO_2 and H_2 but also considers other factors like competition for water and water, safety risks and other social/environmental impacts.
- Engagement with stakeholders for knowledge sharing, capacity building and iterative improvements of the tools/frameworks.

Industrial Partner

The project is supported by industry partner "Iberdrola Australia". Iberdrola is a global renewable energy developer with a key interest in power to x technologies and green fuels. In Australia, Iberdrola is looking to develop e-fuel facilities, and findings and tools developed through this result will support the company's projects.

Key Techniques:

Power to X, Technoeconomic Analysis, Social Acceptance Framework, Open-Source Assessment Tool Coding and Development.

Supervisors:

Dr Rahman Daiyan (School of Minerals and Energy Resource Engineering) and Professor Iain MacGill (School of Electrical Engineering) and supported Dr Muhammad Haider Ali Khan (School of Chemical Engineering).

Further information regarding the project can be obtained by contacting Dr Daiyan (r.daiyan@unsw.edu.au) and for the application process, please contact: GlobH2E Centre Manager: mandalena@unsw.edu.au

HDR Stipend:

This position is based at UNSW Sydney and will be supported with stipend rate of $ $37,684 per annum tax-free (for 2024 rate and indexed annually). International applications are encouraged, and they may be eligible for Tuition Fee Scholarships.

***Note** that Domestic Students may be eligible for Engineering Top Up (to a maximum of $10,000 per annum.)*

Research Environment:

The GlobHE Training Centre is offering HDR 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 five 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 opportunities
- 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 and Process:

If you are interested in applying for PhD/Master admission and scholarship at UNSW, please go to the UNSW Graduate Research Website outlining eligibility requirements 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) Rego de Vasconcelos, B. *et al*. *Recent Advances in Power-to-X Technology for the Production of Fuels and Chemicals*. Frontiers in Chemistry. 2019, Vol 7. https://www.frontiersin.org/articles/10.3389/fchem.2019.00392
3) Valera, H *et al*. *Methanol as an Alternative Fuel for Diesel Engines*. Methanol and the Alternate Fuel Economy. Energy, Environment, and Sustainability. Springer, Singapore 2019. https://doi.org/10.1007/978-981-13-3287-6_2
4) Vardon, D.R. *Realizing "Net Zero Carbon" Sustainable Aviation Fuel.* Joule 2022, Volume 6 (1). https://doi.org/10.1016/j.joule.2021.12.013
5) *The role of hydrogen in synthetic fuel production strategies*. International Journal of Hydrogen Energy 2024, Volume 54, 1169 – 1178. https://doi.org/10.1016/j.ijhydene.2023.11.359
6) Rozzo, E. et al. *Green Synthetic Fuels: Renewable Routes for the Conversion of Non-Fossil Feedstocks into Gaseous Fuels and Their End Uses.* Energies 2020, 13(2), 420. https://doi.org/10.3390/en13020420
7) Jones, *et al*. *The Social Acceptance of Carbon Dioxide Utilisation: A Review and Research Agenda*. Front. Energy Res. 2017, Vol 5. https://doi.org/10.3389/fenrg.2017.00011