Department	School of Engineering and the Built Environment
Supervisors	Dr Viviani Onishi, Dr Zuansi Cai
Project Title	**Optimising Work and Heat Exchange Networks Towards Improved Energy Efficiency Processes**

PROJECT DESCRIPTION

Work and heat exchange networks (WHENs) have become increasingly important for industrial processes in the past few years. Growing research has distinctly shown that work and heat integration plays a critical role in reaching significant energy and cost savings while enhancing system energy efficiency and reducing environmental impacts. This is especially relevant for energy-intensive processes in oil refineries and cryogenic technology, such as the air separation, hydrogen liquefaction and production of liquefied natural gas (LNG). In LNG and hydrogen liquefaction plants, excessive energy consumption is associated with compressing and cooling streams at sub-ambient conditions. Besides, the continuous rise in global energy demand, highly volatile energy prices, and stricter environmental policies towards the reduction of carbon emissions, have also boosted the development of more efficient process integration techniques and work and heat recovery strategies for industrial processes.

Within this framework, we are seeking an outstanding candidate to develop new mathematical modelling approaches for the cost-effective design and optimisation of WHENs. This PhD studentship project is aimed at (i) investigating fundamental work and heat recovery mechanisms at sub-ambient and ambient conditions; and, (ii) expanding previous knowledge to develop mathematical models for the systematic integration of work and heat in hydrogen industry. The models will be mainly based on mathematical programming techniques, including deterministic (e.g., global optimisation, multi-objective optimisation, games theory, etc.) and/or stochastic optimisation. The application of machine learning techniques will also be considered. The main objectives include developing improved energy efficiency solutions, reducing process costs, decreasing environmental impacts, evaluating riskier decision-making attitudes (uncertainty analysis), among others.

This project is aligned with different UN Sustainable Development Goals. More specifically, the SDG 7 "Affordable and Clean Energy"; SDG 9 "Industry, Innovation and Infrastructure"; and, SDG 13 "Climate Action".

The PhD student will be supported through periodic meetings with the supervisory team, and trained on technical relevant skills such as writing research articles for publication and presenting at international conferences.

Perspective applicants are encouraged to contact the Supervisor before submitting their applications. Applications should make it clear the project you are applying for and the name of the supervisors.

Academic qualifications

A first degree (at least a 2.1) ideally in Mechanical Engineering or Chemical Engineering with a good fundamental knowledge of thermodynamics and applied mathematics.

English language requirement

IELTS score must be at least 6.5 (with not less than 6.0 in each of the four components). Other, equivalent qualifications will be accepted. Full details of the University's policy are available online.

Essential attributes:

- Experience of fundamental research analysis skills.

- Competent in mathematical modelling in MATLAB.
- Knowledge of fundamental energy transfer processes.
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

Desirable attributes:

- Knowledge of mathematical programming in GAMS software.
- Knowledge of life-cycle analysis.
- Experience in using engineering software tools (SimaPro, EES, TRNSYS Professional, or HOMER pro).
- Experience in undertaking independent research.
- A completed or near-completition MSc in a relevant subject area.

Indicative Bibliography	**Onishi, V.C.**, Quirante, N., Ravagnani, M.A.S.S., Caballero, J.A., 2018. Optimal Synthesis of Work and Heat Exchangers Networks considering Unclassified Process Streams at Sub and Above-Ambient Conditions. Applied Energy 224(C), 567-581. DOI: 10.1016/j.apenergy.2018.05.006 **Onishi, V.C.**, Ravagnani, M.A.S.S., Jimenéz, L., Caballero, J.A., 2017. Multi-Objective Synthesis of Work and Heat Exchange Networks: Optimal Balance between Economic and Environmental Performance. Energy Conversion and Management 140, 192-202. DOI: 10.1016/j.enconman.2017.02.074. **Onishi, V.C.**, Ravagnani, M.A.S.S., Caballero, J.A., 2015. Retrofit of Heat Exchanger Networks with Pressure Recovery of Process Streams at Sub-Ambient Conditions. Energy Conversion and Management 94, 377–393. DOI: 10.1016/j.enconman.2015.02.002. **Onishi, V.C.**, Ravagnani, M.A.S.S., Caballero, J.A., 2014. Simultaneous Synthesis of Work Exchange Networks with Heat Integration. Chemical Engineering Science 112, 87–107. DOI: 10.1016/j.ces.2014.03.018. **Onishi, V.C.**, Ravagnani, M.A.S.S., Caballero, J.A., 2014. Simultaneous Synthesis of Heat Exchanger Networks with Pressure Recovery: Optimal Integration between Heat and Work. AIChE Journal 60 (3), 893–908. DOI: 10.1002/aic.14314.
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