# 2022 Global Change Youth Research Project Description

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| **Project title:** | State of Knowledge of Scope 1 emissions from Wastewater Treatment Plants |
| **Project duration, hours of engagement & delivery mode** | 4 weeks during Winter Vacation and 1 day a week during semester 2, 2022.<br><br>Hours of engagement: 30 hrs per week during Winter Vacation and 6 hrs per week during semester 2, 2022.<br><br>The project must be completed on campus. |
| **Description:** | With the urgent demand to tackle with climate change, the water utilities are required to report on greenhouse gas (GHG) emissions, where both Scope 1 and Scope 2 emissions are included. The scope 1 emissions, which mainly include methane ($CH_4$) and nitrous oxide ($N_2O$) during the biological wastewater treatment processes, are the key contributors and are also more difficult to be reduced. This is because both $CH_4$ and $N_2O$ are potent GHG, with the global warming potential 25-fold and 265-fold, respectively, stronger than that of carbon dioxide ($CO_2$). $N_2O$ emissions are especially important, contributing up to 70% of the overall carbon footprint of a sewage treatment plant (STP). The pathways and factors leading to biological nitrous oxide and methane formation and emissions from wastewater are also highly complex and site-specific.<br><br>The water industry has a very strong interest in improving environmental performance, sustainability and reducing greenhouse gas emissions. The objective of this research project is to review and improve the scientific basis used by the water industries to quantify emissions resulting from water and wastewater treatment processes. |
| **Expected outcomes and deliverables:** | The outcome of this project will provide state-of-the-art knowledge and operational practices on Scope 1 emissions from wastewater treatment processes. It would potentially enable process optimisation and facilitate further development of the predictive modelling to estimate the greenhouse gas emissions and inform decision making around process selection for upgrades.<br><br>The successful applicant is required to do a thorough literature review on the greenhouse gas emissions from the wastewater treatment facilities with a focus on reporting guidelines and decentralized treatment facilities. Lab experience will also be provided with testing of key wastewater characteristics.<br><br>The research student can gain variety of skills in this project including but not limited to data collection, data processing and analysing, reporting writing, literature review and lab skills. There is also an opportunity to generate publications as co-authors from the project.<br><br>The student is required to produce a report and is encouraged to do an oral presentation at the end of the project. |
| **Suitable for:** | This project is open to applications for students with a background in basic chemistry and biology. 3rd – 4th year students will be prioritized. |
| **Primary Supervisor:** | A/Prof. Liu Ye<br>Dr. Haoran Duan |
| **Further info:** | A/Prof. Liu Ye: l.ye@uq.edu.au<br>Dr. Haoran Duan: h.duan@uq.edu.au |

# 2022 Global Change Youth Research Project Description

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| **Project title:** | *Designing low-toxicity and stable perovskites for solar energy conversion* |
| **Project duration, hours of engagement & delivery mode** | *Duration of the project*<br><br>*4 weeks during Winter Vacation and 1 day a week during semester 2, 2022.*<br><br>*Hours of engagement must be between 20-36hrs per week*<br><br>*Applicant will be required on-site for the project.* |
| **Description:** | *Project title: Designing low-toxicity and stable perovskites for solar energy conversion*<br><br>*Efficient solar energy conversion systems can significantly promote a sustainable and low carbon-emission economy. This project aims to rationally design low-toxic and stable metal halide perovskites for efficient solar hydrogen conversion. The key concept is to design stable lead-free metal halide perovskite semiconductors with superior photophysical properties for solar-driven valuable chemical production. Lead-free perovskite and its analogues will be designed based on computational predictions and synthesized experimentally. Their stability and photocatalytic performance will be evaluated for solar hydrogen production in this project.* |
| **Expected outcomes and deliverables:** | *Scholars will have the opportunities to gain skills in semiconductor synthesis, characterizations, and applications. In addition, scholars will learn basic research skills in data collection, analysis and research communications. Scholars will also have an opportunity to generate publications from their research. Students may also be asked to produce a report or oral presentation at the end of their project.* |
| **Suitable for:** | *This project is open to applications from students with a background in material engineering and chemical engineering.* |
| **Primary Supervisor:** | Dr Miaoqiang Lyu |
| **Further info:** | Please email m.lyu@uq.edu.au prior to submitting an application. |

# 2022 Global Change Youth Research Project Description

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| **Project title:** | Microbial encapsulation and the intensified removal of nutrients from water |
| **Project duration, hours of engagement & delivery mode** | 4 weeks during Winter Vacation and 1 day a week during semester 2, 2022.<br><br>Hours of engagement must be between 20-36hrs per week<br><br>Applicant will be required on-site for the project. |
| **Description:** | The aim is to investigate the production and application of immobilized microbes for use in wastewater treatment processes. For the first time, an enriched culture of microbes known to be able to remove nitrogen and phosphorus will be encapsulated in a polymeric biobead. These biobeads will then be applied in a lab-scale treatment process, with the aim of understanding the benefits encapsulation can bring to a wastewater treatment process. It is expected that these biobeads will provide a sustainable environmental technological solution.<br>The project will involve experimental work in a laboratory where bioreactors are being operated for nitrogen and phosphorus removal. The student will work side-by-side with other team members to operate and monitor bioreactors, which are used to enrich microorganisms to be immobilised in the biobeads. The biobeads will then be tested in order to evaluate their capacity for nitrogen and phosphorus removal from wastewater. The student will gain a wide range of relevant practical experiences. The techniques involved centre on environmental bioprocess engineering, but also incorporate chemical analytical procedures to analyse solid, liquid, and gaseous-phase components, and microbial analyses to characterize the organisms present in the cultures. |
| **Expected outcomes and deliverables:** | The student will learn how to conduct an applied research project and appreciate the challenges and perspectives associated with industry-focussed research. The student will be expected to produce a report and oral presentation at the end of their project about their work. |
| **Suitable for:** | Chemical engineering, chemical+bio(or bioprocess) engineering and chemical+environmental engineering UQ students in $4^{th}$ or $5^{th}$ year. |
| **Primary Supervisor:** | Adrian Oehmen |
| **Further info:** | a.oehmen@uq.edu.au |

# 2022 Global Change Youth Research Project Description

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| **Project title:** | Artificial Intelligence-based Software to Improve Safety of Workers in Hazardous Industries<br><br>Research Priority: Human and Computer Interaction |
| **Project duration, hours of engagement & delivery mode** | Duration of the project<br><br>4 weeks during Winter Vacation and 1 day a week during semester 2, 2022.<br><br>Hours of engagement must be between 20-36hrs per week.<br><br>COVID-19 considerations: The project can be completed under a remote working arrangement. On-site attendance **is not** required. |
| **Description:** | This project pioneers the development of a world-first Natural Language Processing and Deep Learning-based software tools to identify and computationally analyse literature on improvement practices relevant to workers in hazardous industries.<br><br>Specific objectives associated with the project are to: 1. Identify and specify potential sources of relevant data repositories. 2. Design, develop and use data scraping methods to search for relevant data. 3. Validate research hypotheses using collected data and advance statistical methods. |
| **Expected outcomes and deliverables:** | Scholars will be involved in data collection and analysis and will gain experience in Data Science for Natural Language Processing tasks. Scholars will be asked to produce a report at the end of their project and will have an opportunity to generate a publication from their research. |
| **Suitable for:** | This project is open to all students looking for gaining experience in research on Artificial Intelligence/Natural Language Processing. Computer science and programming background will be helpful but is not required. |
| **Primary Supervisor:** | Dr Maureen Hassall, Dr Nikodem Rybak |
| **Further info:** | Supervisors can be contacted by students prior to applying. |

# 2022 Global Change Youth Research Project Description

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| **Project title:** | **Discovering the known and unknown risks and risk management practices associated with small modular reactors** |
| **Project duration, hours of engagement & delivery mode** | Project is expected to be 4 weeks during Winter Vacation and 1 day a week during semester 2, 2022.<br><br>COVID-19 considerations: The project involves a comparative analysis of literature using risk management tools power generation using small modular reactors. No lab work or specialist equipment is required, which means the project can be completed using remote working arrangements. |
| **Description:** | The provision of this funding provides a unique opportunity to undertake cutting edge research in an area that is often not explored. Sustainability and environment was highlighted as a key research priority by the Global Change Youth Research program. Reducing greenhouse gas emissions, to reduce the impacts of climate change a key amongst environmental and sustainability concerns. In 2020 the electricity sector produced 36% of energy related emissions (International Energy Agency, 2021). Using nuclear energy to generate electricity could contribute to the massive increase in the amount of low emissions electricity generation needed to decarbonise the electricity sector (International Energy Agency, 2021). Bans on the use of nuclear energy in Australian mean there are gaps in literature about how nuclear energy could contribute to Australia's energy transition. Interest in nuclear power in Australia, is however growing as shown by the federal parliamentary inquiries conducted in 2019 and 2020 (Wilson, 2021). Nuclear power generation can contribute to energy security as well as decarbonisation. Understanding the complete range of options available is valuable when the path forward is not clear (Wilson, 2021). Small modular reactors may present a nuclear option that could meaningfully contribute Australia's electricity grids. Social acceptance is however key to the nuclear energy's ability to contribute to Australia's decarbonisation efforts (Wilson, 2021). Health, safety and operational risk are key societal concerns. Improved understanding of these risks could contribute to an informed discourse which may could improve public trust and perception of risk. Risk perception and trust are contributors to accepting acknowledging a role for nuclear energy (Harris et al., 2018)<br><br>This project aims to systematically review grey and academic literature to uncover the risks associated with small modular nuclear reactors used to generate electricity. Systematic review supports a transparent and unbiased method for discovering, assessing and processing literature to relevant to a particular research question (Boland, Cherry, & Dickson, 2017). Risk management tools, such as bow tie and Accimap, will be used analyse the information. Bowtie is a risk management tool used to identify, communicate and understand the causes and controls associated with high impact risks (Hassall & Lant, 2022). AcciMap was originally used to investigate the contributions of different internal and external organisational layers of a company to accidents or incidents (Svedung & Rasmussen, 2002). However, Accimap-like swim lane diagrams can be used to analyse the relationship between controls and organisational layers which manage risk (See Hassall & Lant, 2022). Applying Accimap-like |

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| | techniques to the nuclear industry is an extension of Jens Rasmussen's work (Waterson, Jenkins, Salmon, & Underwood, 2017).<br><br>The project aims to answer the following questions:<br>• Do the risks presented by small modular reactors differ from those presented by more traditional nuclear power generation?<br>• Are any of the risks specific to the Australian context?<br>• What controls are in place to manage these risks?<br>• What are gaps extant knowledge?<br><br>Insights into further work and capability gaps in the Australian workforce may also be found. |
| **Expected outcomes and deliverables:** | The scholar is expected to complete a systematic literature review, bow tie analysis and an Accimap. Completing these tasks, the scholar will improve the student's data collection, data analysis and risk management skills. The attention to detail and analytical skills acquired during the systematic literature review will be useful to the student for academic and industrial pursuits. Bow tie is widely used in industry and so may be of benefit to a student after they graduate. Although less commonly used in industry, exposure to Accimap illustrates to the student the value in using different analysis tools and encourages novel thinking.<br><br>This work could result in a journal publication because it aims to contribute to an existing gap in the current literature on the risks associated with electricity production using SMR. |
| **Suitable for:** | This project is open to 4th year or masters students who have completed some study in risk management or systems safety. |
| **Primary Supervisor:** | Dr Maureen Hassall<br>Kelly Smith |
| **Further info:** | Please contact m.hassall1@uq.edu.au or k.smith3@uq.edu.au |


Boland, A., Cherry, M. G., & Dickson, R. (2017). *Doing a systematic review : a student's guide* (2nd edition.. ed.): Thousand Oakes, California : SAGE Publications.

Harris, J., Hassall, M. E., Muriuki, G., Warnaar-Notschaele, C., McFarland, E., & Ashworth, P. (2018). The demographics of nuclear power: Comparing nuclear experts', scientists' and non-science professionals' views of risks, benefits and values. *Energy Research & Social Science, 46*, 29-39. doi:10.1016/j.erss.2018.05.035

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Svedung, I., & Rasmussen, J. (2002). Graphic representation of accident scenarios: mapping system structure and the causation of accidents. *Safety Science, 40*, 21.

Waterson, P., Jenkins, D. P., Salmon, P. M., & Underwood, P. (2017). 'Remixing Rasmussen': The evolution of Accimaps within systemic accident analysis. *Applied Ergonomics, 59, Part B*, 483-503. doi:https://doi.org/10.1016/j.apergo.2016.09.004

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# 2022 Global Change Youth Research Project Description

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| **Project title:** | **Safe adoption of hydrogen energy** |
| **Project duration, hours of engagement & delivery mode** | Duration of the project<br><br>4 weeks during Winter Vacation and 1 day a week during semester 2, 2022.<br><br>COVID-19 considerations: This project uses novel tools to analyse literature. No lab work or special software is required which means the project can be completed under remote working arrangements. |
| **Description:** | Sustainability and environment was highlighted as a key research priority by the Global Change Youth Research program. Reducing greenhouse gas emissions, to reduce the impacts of climate change a key amongst environmental and sustainability concerns. Low or no carbon hydrogen is emerging as a fuel which could contribute to decarbonising the energy system (International Energy Agency, 2021a). Hydrogen presents opportunities in some harder to abate areas such as heavy industry and long distance transport (International Energy Agency, 2021b). The safe production, storage, transport and use hydrogen needs to be understood (Amyotte & Rigas, 2013) because hydrogen has wide flammability range, low ignition energy and low molecular weight (Yang et al., 2021). Additionally, incidents involving hydrogen are twice as likely to result in fatalities as incidents resulting from natural gas (Yang et al., 2021) Investigating previous incidents to produce insights on how to avoid future incidents is a tried and tested technique (Mirza, Degenkolbe, & Witt, 2011). This project aims to use risk management tools to analyse information stored in publicly accessible incident databases, on incidents involving hydrogen. The HIAD 2.0 incident database administered by the European Hydrogen Safety Panel and the h2tools database administered by the United States Department of Energy have already been identified as candidates for this research. Although information on the number, sector, causes, injury and damage rate, incident location and equipment has received some attention (See European Hydrogen Safety Panel, 2021; Yang et al., 2021) little seems to have been written about what controls were in place at the time of the incident.<br><br>With an overarching aim to generate insights which could reduce the impact or likelihood of hydrogen incidents, information in the incident databases will be investigated and analysed with a view to answering the following questions:<br>• What controls were present in the system at the time of incident?<br>• Which of these controls were effective?<br>• Which of these controls were ineffective?<br>• Which controls were present and effective for incidents where the hydrogen dispersed without igniting?<br><br>Information in the databases will be analysed using management tools such as bow tie and AcciMap. Bowtie is a risk management tool used to identify, communicate and understand the causes and controls associated with high impact risks (Hassall & Lant, 2022). AcciMap was originally used |

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| | to investigate the contributions of different internal and external organisational layers of a company to accidents or incidents (Svedung & Rasmussen, 2002). However, Accimap-like swim lane diagrams can be used to analyse the relationship between controls and organisational layers which manage risk (See Hassall & Lant, 2022). The resultant bowtie and AcciMap may be used to communicate factors which influence hydrogen risk industry and inform hydrogen risk curriculum for engineering students. |
| **Expected outcomes and deliverables:** | The scholar is expected to complete bowtie analyses and AcciMaps using information from existing incident databases. Completing these tasks, will improve the student's ability to use risk management tools. Bow tie is widely used in industry and so may be of benefit to a student after they graduate. Although less commonly used in industry, exposure to Accimap illustrates to the student the value in using different analysis tools and encourages novel thinking.<br><br>This work could result in a journal publication because uses novel techniques to analyse information from existing incident databases and the controls for incidents appear to be a gap in the literature. |
| **Suitable for:** | This project is open to 4th year or masters students who have completed some study in risk management or systems safety. |
| **Primary Supervisor:** | Dr Maureen Hassall<br>Kelly Smith |
| **Further info:** | For further information please contact k.smith3@uq.edu.au |

**References**


Amyotte, P., & Rigas, F. (2013). Applications of process safety concepts to the hydrogen economy. *Chemical Engineering Transactions, 31*, 31-36. doi:10.3303/CET1331006

European Hydrogen Safety Panel. (2021). Lessons learnt from HIAD 2.0. Retrieved from https://www.fch.europa.eu/sites/default/files/documents/Lessons%20learnt%20from%20HIAD%202.0-Final.pdf

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# 2022 Global Change Youth Research Project Description

| Project title: | **Isolation and characterization of cancer cell-derived extracellular vesicles** |
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| **Project duration, hours of engagement & delivery mode** | • 4 weeks (20-36 hrs per week) during Winter Vacation and 1 day a week (4-7 hrs per day) during semester 2, 2022.<br>• On-site attendance is required for practical laboratory activities. Theoretical work (e.g., literature survey, experimental design, etc.) can be done remotely. |
| **Description:** | Extracellular vesicles (EVs) are nanoparticles that are naturally produced and released by cells. EVs are loaded and decorated with various signalling molecules that play important roles in intercellular communication throughout the body, including at distant sites. In the context of cancer, EVs produced by cancer cells send messages to other cells, which may corrupt them and facilitate tumour progression. This project aims to isolate and characterise EVs of high quality and yield produced by various cancer cells *in vitro*. Additionally, the effects of exposing non-cancerous cells to cancer cell-derived EVs will be assessed. |
| **Expected outcomes and deliverables:** | The applicant can expect to gain skills in teamwork, tissue culture, molecular biology techniques, approaches to isolate EVs from biological samples, nanoparticle/EV characterization techniques, experimental research design and planning, and data collection and analysis.<br>Students will be expected to actively participate in experimental planning, analysis, and discussion of results, as well as deliver a final report presenting the methodology and results of their research in a scientific manuscript format. The student may have opportunities to generate publications from their research and to present their findings at scientific conferences. |
| **Suitable for:** | This project is open to applications from motivated UQ-enrolled students who are interested in pursuing a research career (e.g., intend to graduate with an Honours or a Master's degree or apply for a PhD in the future).<br>This is a multidisciplinary project, and no specific background knowledge is required. Desirable qualities include self-motivation, flexibility to learn topics outside of your original field, and good time management. |
| **Supervisors:** | • A/Prof. Joy Wolfram (School of Chemical Engineering, and Australian Institute for Bioengineering & Nanotechnology – AIBN),<br>• Dr. Jenifer Pendiuk Goncalves (AIBN). |
| **Further info:** | If you are interested, please contact Dr. Jenifer Pendiuk Goncalves (j.pendiukgoncalves@uq.edu.au) before applying for this project. |

# 2022 Global Change Youth Research Project Description

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| **Project title:** | **Plant-Based Meats** |
| **Project duration, hours of engagement & delivery mode** | • 4 weeks during Winter Vacation and 1 day/week during Semester 2, 2022<br>• Approximately 30 hours/week during Winter Vacation<br>• The project is lab-based and on-site attendance is required |
| **Description:** | The number of plant-based meat products on the market has grown in recent years as consumers become increasingly concerned about the environmental and ethical issues associated with the meat industry. Additionally, plant-based meats are perceived as a healthy alternative to meat. However, reproducing the sensory experience of eating meat remains a challenge. To facilitate continued growth of the market, it is vital to develop innovations that add value to current products and ensure products are broadly consumer acceptable.<br>Supramolecular chemistry involves the self-assembly of molecules by non-covalent interactions (e.g. hydrogen bonding, metal-ligand complexation, macrocyclic host-guest complexation, ionic interactions, biomimetic interactions, and stereocomplex formation). The self-assembly of soy protein<br>may reduce the need for binders and gums in meat analogues; there is consumer demand for cleaner (additive-free) labels on food products. |
| **Expected outcomes and deliverables:** | Students will be asked to give an oral presentation and produce a report at the end of their project. |
| **Suitable for:** | This project is suited to applications from students with a background or interest in chemistry. |
| **Primary Supervisor:** | Dr Becca Forster |
| **Further info:** | rebecca.forster@uq.edu.au |

# 2022 Global Change Youth Research Project Description

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| **Project title:** | **Mechanical performance of an innovative bacteria-based biodegradable material to replace plastics** |
| **Project duration, hours of engagement & delivery mode** | Duration of the project<br><br>4 weeks during Winter Vacation and 1 day a week during semester 2, 2022.<br><br>Hours of engagement must be between 20-36hrs per week<br><br>COVID-19 considerations: Applicant will be required on-site for the project. |
| **Description:** | The project focuses on delivering a new bacteria-based and fully biodegradable bioplastic material to address the current issues caused by plastic pollution. More precisely, the project will focus on the mechanical performance of these newly developed material. The student will perform industry standard mechanical testing to evaluate commercial relevant properties and compare them with existing plastics as a benchmark. |
| **Expected outcomes and deliverables:** | Through this project, the student will learn about the latest bioplastics advancements and related technologies. They will gain exposure on the processes of bioplastic manufacturing, thermal analysis, rheology and mechanical testing. Students will be expected to conduct mechanical testing and process data through excel spreadsheets. The student will be fully trained and supported in these tasks. |
| **Suitable for:** | This exciting project is best suited to students with a very rigorous and scientific approach. *3rd – 4th year students only.* |
| **Primary Supervisor:** | Luigi Vandi |
| **Further info:** | Please contact supervisor l.vandi@uq.edu.au prior to submitting an application. |