

## **October 2023 Newsletter**

### **Message from the CEO**

Welcome to the October edition of the Future Energy Exports Cooperative Research Centre (FEnEx CRC).

As you will see showcased in this edition, the past few of months have seen some significant progress and milestones achieved by our CRC including:

- The Western Australia State Government providing our flagship project – the Kwinana Energy Transformation Hub (KETH) – with a \$15 million grant via its Investment Attraction Fund (IAF)
- The launch of a new collaborative project with a number of partners from Japan and Australia to develop solutions for industrial-scale shipping of carbon dioxide (CO<sub>2</sub>)
- One of our research fellows – Dr Neil Robinson – receiving a prestigious international award
- Showcasing one of our Foundation Fellows - Dr Mahboobeh Shahbazi
- A number of highly successful international visits which have helped forge new bonds and provide important new insights

Clearly we have an enormous amount happening as our CRC starts to deliver on its milestones.

It is clear that as the world begins to focus more and more on decarbonisation– especially with COP28 almost on us – the FEnEx CRC can play a critical role developing the technologies and know-how needed for the successful delivery of the energy transition.

We look forward to continuing to work with our partners to make this happen!

### **KETH receives \$15 million grant!**

By far our biggest recent news since our last newsletter has been the announcement by the Premier of Western Australia (WA) that our Kwinana Energy Transformation Hub (KETH) project will receive a \$15 million grant from the WA Investment Attraction Fund (IAF).

This funding brings us closer to being able to take a final investment decision on phase 1 of the project which includes a range of hydrogen, training and R&D facilities.

KETH has the potential to be a key facility for delivering the CRC's energy transition goals and once operational it will help place WA well and truly in the international decarbonisation spotlight.

The grant funding announcement has provided a real boost, raising the profile of the project and facilitating material progress towards the next phase of securing industry investment.

Reaching this point reflects a great effort by the many people within the FEnEx CRC and KETH teams that have contributed to getting the project to this stage, with a special mention due to FEnEx CRC Research Fellow Luke McElroy.

Many thanks to the WA Government for its continued support for this important project.

### **Bridging Blue and Green Hydrogen Research Findings**

Researchers at the University of Western Australia have completed the final milestone report for the “Bridging Blue and Green Hydrogen” project undertaken in collaboration with INPEX and the Victorian Government. The project focused on addressing the economic and emissions challenges associated with the production of H<sub>2</sub> through process integration. The goal of the project was to determine an integrated plant scheme for producing both blue and green H<sub>2</sub> so to minimise both the Levelised Cost of Hydrogen (LCOH) and CO<sub>2e</sub> emissions.

“We have an enormous challenge finding the most economically viable way to produce hydrogen,” said Professor Michael Johns, the Research Director at the Future Energy Exports Cooperative Research Centre (FEnEx CRC).

“Blue hydrogen will be critical to scaling up the global hydrogen market and supply chain but what we wanted to explore was if there were any potential synergies with simultaneous green hydrogen production.”

The separate blue and green H<sub>2</sub> production processes and the integrated process designs were simulated in Aspen. Economic and emissions analyses were conducted for H<sub>2</sub> production via (i) autothermal reforming (ATR) of methane with carbon capture and storage (CCS), (ii) coal gasification (CG) of lignite with CCS, (iii) Polymer Electrolyte Membrane (PEM) electrolysis using renewable energy, and the integrated cases of (iv) ATR w/ CCS + PEM electrolysis and (v) CG w/ CCS + PEM electrolysis for combined blue and green H<sub>2</sub> production. The key to the process integration was the use of the oxygen by-product produced by electrolysis during green H<sub>2</sub> production to feed the reforming process (ATR or CG).

The results of the study indicate that combined blue and green H<sub>2</sub> integration did produce reductions in LCOH (relative to green H<sub>2</sub> production) and a reduction in CO<sub>2e</sub> emissions (relative to blue H<sub>2</sub> production). A primary factor limiting the benefits of process integration however was the scale disparity between the H<sub>2</sub> production technologies; ATR and CG with CCS are economically viable at significantly larger production capacities than the scale at which a PEM electrolyser can currently be operated. In addition, ensuring the required continuous supply of oxygen to the reforming process was problematic.

“This project has usefully highlighted difficulties in bridging the gap between blue and green H<sub>2</sub> production, but also provides a foundation for future process integration schemes for more economical and environmentally friendly H<sub>2</sub> production,” Mike said

### **Improving Fugitive Emissions Management in the Australia LNG Industry Report**

The greatly anticipated report on *Improving fugitive emissions management in the Australian LNG industry* will be released next month.

The report reviews and analyses current methods for determining fugitive emissions in LNG plants, building upon the National Greenhouse and Energy reporting (NGER) scheme.

It looks at measurement methods and advancements in measurement technologies, closing with recommendations on improving methods used to measure fugitive emissions and the technologies used.

The report also highlights the importance of having a consistent definition of fugitive emissions. Anyone interested in receiving the report can email [admin@fenex.org.au](mailto:admin@fenex.org.au)

### **HZwo and FEnEx CRC exploring fuel cell manufacturing in Australia**

FEnEx CRC CEO Eric May met with Martin Dulig, Saxony Minister of Economy in Dresden at the Clean Hydrogen Convention held 25-26 October.

Regarded as one of Europe's most important platforms for showcasing hydrogen as a forward-looking energy source, the event also provided Eric with an opportunity to discuss how can hydrogen can help drive the energy transition and the role of FEnEx CRC with a range of prospective new partners.

As a result, FEnEx CRC has now officially joined the Saxon hydrogen industry cluster [HZwo](#), led by Karl Lötsch and chaired by Prof.Dr.-Ing.Thomas von Unwerth from Technische Universität Chemnitz. The CRC's membership will enable a key research project to commence where we explore prototyping HZwo's OpenSource Fuel Cell Stack in Australia. The project will also investigate new methods of onboard hydrogen storage to supply the fuel cells. Prof. Dr.-Ing Markus Richter from Technische Universität Chemnitz will lead research aimed at finding adsorbents able to store sufficient amounts of hydrogen at liquid nitrogen temperatures.

"There is a clear opportunity for Australia and Germany to work collaboratively to accelerate the growth of hydrogen production and use in both countries," Eric said.

"German technology for hydrogen generation and utilisation can play a key role in helping drive the production and export of clean energy from Australia to Germany and elsewhere.

"This first project will explore manufacturing fuel cells under Australian conditions but there are many other ideas that this convention has given me - like how to apply open-source technologies from Germany to the decarbonisation of Australia's mining industry!"

Special thanks to Dr.-Ing Gert Schlegel of HZwo for all his hard work making this event happen.



## Showcasing our talent - Dr Mahboobeh Shahbazi



Each issue we plan to showcase one of our key researchers. This month we want to introduce one of our Foundation Fellows – Dr Mahboobeh Shahbazi – who is based within Queensland University of Technology’s (QUT) Centre for Clean Energy Technologies and Practices, and the Centre for Materials Science.

1. Can you please provide us with some more details on your recent appointment as well as a brief outline of your career to date?

My journey as a research scientist has been anchored in a passion for exploring the intricacies of material science and physics and translating them into practical applications. A hallmark of my research has been in the translation of fundamental physical insights into superconducting and magnetic materials to practical and industrially relevant engagements.

As a result I was awarded a FEnEx CRC Foundation Fellowship and am pleased to be contributing to major industry-funded projects within FEnEx CRC and its Hydrogen Export and Value Chains Programme.

2. Can you briefly describe your area of research?

My research primarily focuses on the design, synthesis and characterization of energy materials, which encompass a wide range of materials such as superconductors, magnetocaloric materials, lithium-ion batteries and solar cells.

The overarching goal of my research is to gain a comprehensive understanding of the practical applications of these materials in various energy-related contexts.

One of my upcoming projects, in collaboration with FEnEx CRC, is titled "Natural Gas and Hydrogen Liquefaction by Magnetic Refrigeration." This project introduces an innovative approach by incorporating magnetocaloric materials into the hydrogen liquefaction process.

Additionally, I am collaborating with my colleague at QUT, Dr Laleh Moghaddam, to develop a new technique to convert lignocellulosic waste biomass, including materials like eucalyptus, banana, and sugar cane bagasse, along with lignin (and/or with plastic waste), into a range of valuable biobased materials such as Liquid Organic Hydrogen Carriers (e.g. methylcyclohexane) and crude bio-oil.

3. What do you see as the greatest challenge to your research and how the FEnEx CRC can help overcome it?

The greatest challenge in my research at the moment is job stability, which can sometimes be a significant hurdle in the academic and research sector.

The FEnEx CRC can play a crucial role in addressing this challenge by providing funding for different research projects and helping researchers secure positions within the industry.

By connecting researchers with industry partners and facilitating the transfer of research findings into practical applications, the FEnEx CRC can significantly contribute to overcoming this challenge and ensuring the sustainability of research in the field of energy materials and related technologies.

There is still much more R&D to undertake on existing or new materials in order to improve energy efficiency and security for our communities.

**Out with the old, in with the new.....not so fast! Rethinking technologies for the energy transition.**

Time and time again the complexities of the energy transition reveal how new and old technologies are both going to be useful and should not be discounted.

It was on a recent visit with a CSIRO-organised Australian hydrogen research delegation to the Republic of Korea, that our CEO, Professor Eric May had the opportunity to witness the Korean approach to hydrogen research and development.

Visiting the Korea Advanced Institute of Science and Technology (KAIST), the Korea Hydro and Nuclear Power Central Research Institute (KHNP), the Korea Institute of Energy Research (KIER), Hyundai, KOMIPO Underground Plant, Korean Institute of Science and Technology (KIST) and Seoul National University (a FEnEx CRC affiliate) it was apparent that no technology would be left unused in an effort to make changes.

“Whilst ‘green’ hydrogen will be Korea’s preference in the long run, it first needs to be affordable and available at scale with no production interruptions,” Eric said.

To establish the necessary market demand, Korea is starting with “grey” hydrogen to get things moving.

“A key insight from this delegation was the need to first establish the infrastructure and technology surrounding hydrogen of any colour at scale, grow demand and replace current use cases is difficult enough. Once this challenge has been met, rapid progress to renewable hydrogen inputs can follow,” Eric said.

“It was also surprising to see that the internal combustion engine is far from dead. While hydrogen transport is mostly viewed as requiring the enabling technology behind fuel cells, Korean companies like Hyundai are also conducting research into hydrogen combustion engines”.

Eric said that on the visit the delegation saw how simple it was to take existing engines, like in the Santa Fe, and replace the injectors delivering petrol or diesel with ones that inject hydrogen.

The great advantage of this approach is the much lower capital cost of the resulting vehicle, which can be about 50% that of the fuel cell equivalent. Simple solutions are available to deal with the disadvantages of hydrogen ICE engines, such as lower efficiency and NOx emissions, and the lower capital cost could significantly promote the uptake of hydrogen-fuelled vehicles in the coming years.

Thanks is extended to all our hosts and CSIRO for coordinating an informative program.



### FEnEx CRC scholars recognised at global thermodynamics event

FEnEx CRC scholars received some fantastic recognition at the International Conference on Chemical Thermodynamics (ICCT) recently held in Osaka Japan.

Held every two years, this event brings together the world's thermodynamic experts and this year's conference covered a wide range of fields focussed on recent research; heat conduction, the thermoelectric effect, understanding equilibrium in living organisms, global warming and energy issues.

Excitingly FEnEx CRC PhD Scholar Liam Tenardi was awarded best poster, while University of Western Australia's Xiong Xiao was presented with the International Association of Chemical Thermodynamics Junior Award for best PhD thesis for his work on the freezing of benzene in LNG production.

FEnEx CRC CEO Eric May also took the opportunity to connect with Osaka Gas, JX Nippon, Mitsui OSK, METI, JERA, Tokyo Gas and JOGMEC during the event and looks forward to continuing discussions on collaboration and project opportunities between our two nations.

FEnEx CRC is currently compiling a bid for Australia to host the 2027 ICCT.



## Prestigious international award



Congratulations to FEnEx CRC's Neil Robinson from UWA for being selected as one of The Way Ahead (TWA) Energy Influencers for 2023!

Being one of only 11 individuals from around the world who inspire and positively influence selected by TWA – a publication of the Society of Petroleum Engineers International which is staffed and managed by young professionals across the upstream oil and gas industry – is a huge honour and testament to the passion and endeavour that Neil puts into all his research.

As one of FEnEx CRC's Strategic Research Fellows, Neil is leading and contributing to a variety of projects examining large-scale hydrogen transport, including the design of materials to enable energy-efficient liquefaction as well as the study of catalytic processes necessary for the use of liquid organic hydrogen carriers.

A major focus of Neil's research is unlocking the secrets of porous materials which is likely to have significant benefit for the emerging carbon capture and hydrogen energy fields, as well as in lowering costs for the existing natural gas sector. He is also examining how pathways within porous materials can be better mapped to improve their use as catalysts in reactions that reduce the energy requirements of industrial-scale chemical reaction processes.

Last year Neil was the recipient of the prestigious National Measurement Institute, Australia Prize at the 2022 Metrology Awards and has also been a finalist in the 2021 IChemE Global Awards. He also represented Australia at the 71st Lindau Nobel Laureate Meeting under an Australia Academy of Science/Science and Industry Endowment Fund Fellowship.

In addition to his work with the FEnEx CRC, Neil is a Research Fellow in the UWA Fluid Science and Resources Research Group where he holds a Forrest Research Foundation Fellowship.

Again congratulations Neil – and we look forward to hearing about your next award which we are sure is just around the corner – so keep us posted!