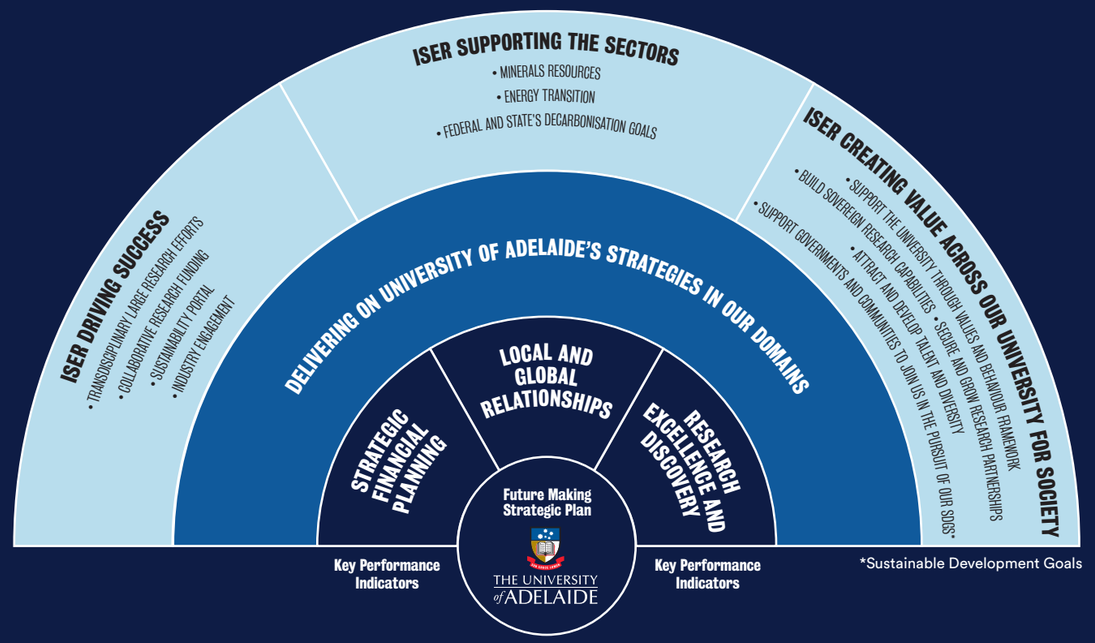
THE UNIVERSITY of ADELAIDE

Annual Report 2022

Institute for Sustainability, Energy and Resources

make history.

"The Institute for Sustainability, Energy and Resources (ISER) is committed to leading, supporting and investing in world-leading research to deliver breakthroughs that will accelerate a global transformation to a sustainable future."



THE ISER UNIVERSE

ISER operates at the international forefront of the sustainability, mineral, energy and resource sectors, showcasing our finest talent in large-scale research and innovation outcomes, with the capacity to pursue higher-risk, cutting-edge projects catalysing the modern energy system.

ISER leads and helps create value through our research outcomes to accelerate and deliver a vision for a more sustainable world. ISER reaches out across the globe to collaborate on delivery of this vision.

ISER supports an important component of the University of Adelaide's Strategic Plan and is driven by key performance indicators, influenced by its own culture and that of the University.

Vision

Developing and accelerating solutions that deliver sustainability, equity and prosperity for the planet and its people, underpinned by breakthrough research.

Mission

To lead globally transformative research that overcomes complexity, drives change, and creates value for a more sustainable future.

Our goals

- **Building sovereign capability:** Play a strong role in the creation of new industries and research that advances sovereign capability through enhancing key associated industry partnerships
- **Research excellence and discovery:** Deliver and celebrate outstanding performance and exceed the goals of University Foci And Magnets for Excellence (FAME) Strategies. Be the umbrella for the University's highly cited researchers in our sectors and grow a global cohort of highly cited titleholders
- **Translation:** Translate cutting-edge research into impact through multidisciplinary collaborations with local and world-leading partners whose focus is on improving United Nations Sustainable Development Goals (SDGs)
- **Diversity and inclusion:** Contribute to improve gender balance, equity, diversity and inclusion in industry and the University through mentorship and professional development of students, staff and industry leaders
- **Talent development:** Provide professional and further education for those wanting to hone their knowledge and emphasise sustainability credentials and creation of social value
- **Community engagement:** Support governments at all levels to reshape their policies and encourage our partners to join us in the pursuit of SDGs. Together with stakeholders, consider a pathway to creating a globally recognised certification for carbon-positive industries in our sectors. Actively work to contribute to philanthropy and other University advancement efforts.

CONTENTS

What is ISER?

ISER is the brand champion of University of Adelaide-wide initiatives and a key portal of research capabilities within sustainability, energy and resources.

ISER leads large-scale collaborative research efforts across our academic ecosystem in the energy, sustainability and resources domains.

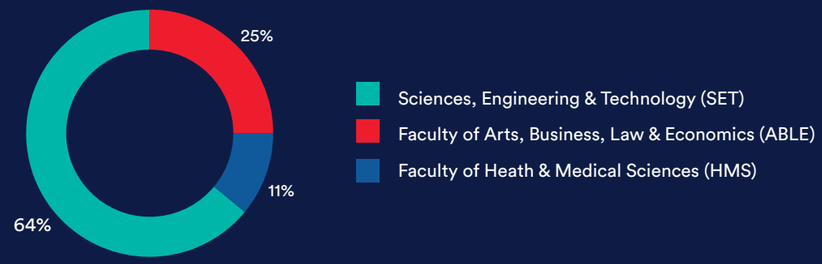
Who are ISER's stakeholders?

- Academics and researchers
- Energy, sustainability, and resources sector industry groups
- Energy, resources, and minerals companies
- Organisations pursuing Environmental, Social and Governance (ESG) goals
- The State Government of South Australia
- The Australian Government and funding bodies.

AT A GLANCE

AFFILIATES

128 affiliates across all 3 faculties: Faculty of Sciences, Engineering and Technology (SET), Faculty of Arts, Business, Law and Economics (ABLE) and Faculty of Health and Medical Sciences (HMS)



$10.7B

Contribution to the state economy

The ISER sector – South Australian resource companies contribute $10.7 billion to the state economy

The latest economic contribution analysis undertaken by the South Australian Chamber of Mines & Energy (SACOME) identified that 15 local resource companies contributed over $10.7 billion in direct and indirect spending to the South Australian economy in 2021-22 – equivalent to 8.3% of the Gross State Product (GSP), with $1 in every $12 generated by the sector.

2022 HIGHLIGHTS

Launch attended by The University of Adelaide Vice-Chancellor and Chancellor, Peter Malinauskas MP Premier of South Australia, Professor Caroline McMillen Chief Scientist of South Australia, and other Parliamentary and University representatives. More information.

Launch of the Sustainable Development Goals Portal to find experts to help our stakeholders reshape technologies, products, policies and practices that support local and global development goals. More information.

Eight researchers associated with ISER are among the most influential scientists from 69 countries undertaking great work that has a direct benefit to society. More information.

AT A GLANCE

HIGHLY CITED RESEARCHERS

Fourteen University of Adelaide researchers were named for their outstanding work in the Clarivate annual global List of Highly Cited Researchers. Eight of those researchers are associated with ISER.

In 3 fields of chemistry, environment and ecology, and materials science:

- Design of novel chemicals for more efficient batteries, electrocatalysis and photocatalysis for clean energy production – **Professor Shizhang Qiao,** ARC Australian Laureate Fellow, School of Chemical Engineering and Advanced Materials.

In 3 fields of chemistry; environment and ecology and engineering:

- Research of novel catalysts for energy conversion and environmental remediation – Professor **Shaobin Wang,** School of Chemical Engineering and Advanced Materials.

In 2 fields of chemistry and environment and ecology:

- Environmental science, green catalysis, functional materials, advanced water purification technologies – **Dr Xiaoguang Duan,** Senior Lecturer, School of Chemical Engineering and Advanced Materials.

In 2 fields of computer science and engineering:

- Automation and control systems, human-machine collaboration, autonomous and robotic systems, and artificial intelligent systems – **Professor Peng Shi,** School of Electrical and Mechanical Engineering.

In the field of chemistry:

- Design of better energy materials to support the energy transition – **Associate Professor Yan Jiao,** Deputy Head, School of Chemical Engineering and Advanced Materials
- Advanced electrocatalysts for energy conversion processes like hydrogen evolution reaction – **Associate Professor Yao Zheng,** ARC Future Fellow, School of Chemical Engineering and Advanced Materials.

Cross-field:

- Synthesis of photocatalysts for producing energy fuels and value-added chemicals using renewable solar energy – **Dr Jingrun Ran,** Lecturer, School of Chemical Engineering and Advanced Materials.

In the field of materials science:

- Design and application of electrode and electrolyte materials for energy storage and conversion, including rechargeable batteries, hydrogen storage, and fuel cells – Professor **Zaiping Guo**, School of Chemical Engineering and Advanced Materials.

TOP 10 PUBLICATIONS

Ranked by Altmetric Attention Score

Christian Doonan, Johannes Osterrieth, James Rampersad, David Madden, Nakul Rampal, Luka Skoric, Bethany Connolly, Mark Allendorf, Vitalie Stavila, Jonathan Snider, Rob Ameloot, et al. 'How reproducible are surface areas calculated from the BET equation'. Advanced Materials (2022)
– Altmetric score 998

Derrick Hasterok, Jacqueline A. Halpin, **Alan S Collins,** Martin Hand, Corné Kreemer, Matthew G Gard, **Stijn Glorie.** 'New maps of global geological provinces and tectonic plates'. Earth-Science Reviews (2022)
– Altmetric score 690

Alexander Edgar; Ioan V. Sanislav; Paul H G M Dirks; **Carl Spandler.** 'Metamorphic diamond from the north-eastern margin of Gondwana: paradigm-shifting implications for one of Earth's largest orogens'. Science Advances (2022)
– Altmetric score 181

Jenny C Mortimer, Matthew Gilliham. 'SpaceHort: redesigning plants to support space exploration and on-earth sustainability'. Current Opinion in Biotechnology (2022)
– Altmetric score 118

Tracey Dodd, Tim Nelson. 'Australian household adoption of solar photovoltaics: a comparative study of hardship and non-hardship customers'. Energy Policy (2022)
– Altmetric score 75.

Ranked by Scopus Citation Count

Wei Ren, Cheng Cheng, Penghui Shao, Xubiao Luo, Hui Zhang, **Shaobin Wang,** and **Xiaoguang Duan.** 'Origins of electron-transfer regime in persulfate-based nonradical oxidation processes'. Environment Science & Technology (2021)
– Scopus citation count 129

Sailin Liu, Ruizhi Zhang, Jianfeng Mao, Yunlong Zhao, Qiong Cai, **Zaiping Guo.** 'From room temperature to harsh temperature applications: fundamentals and perspectives on electrolytes in zinc metal batteries'.
Science Advances (2022)
– Scopus citation count 54

Xianlong Zhou, Jieqiong Shan, Ling Chen, Bao Yu Xia, Tao Ling, Jingjing Duan, **Yan Jiao, Yao Zheng, Shi-Zhang Qiao.** 'Stabilizing Cu^{2+} ions by solid solutions to promote CO_2 electroreduction to methane'. Journal of the American Chemical Society (2022)
– Scopus citation count 52

Lin Chen, Yixuan Wang, Shuai Cheng, Xiaoli Zhao, Jinqiang Zhang, Zhimin Ao, Chaocheng Zhao, Bin Li, Shuaijun Wang, **Shaobin Wang,** Hongqi Sun. 'Nitrogen defects/boron dopants engineered tubular carbon nitride for efficient tetracycline hydrochloride photodegradation and hydrogen evolution'. Applied Catalysis B: Environmental (2022)
– Scopus citation count 51

Chun Zhu, **Murat Karakus,** Manchao He, Qingxiang Meng, Junlong Shang, Yu Wang, Qian Yin. 'Volumetric deformation and damage evolution of Tibet interbedded skarn under multistage constant-amplitude-cyclic loading'. International Journal of Rock Mechanics and Mining Sciences (2022)
– Scopus citation count 44

INTRODUCTION

DEPUTY VICE-CHANCELLOR (RESEARCH) and PRO VICE-CHANCELLOR (RESEARCH EXCELLENCE)

Professor Anton Middelberg, Deputy Vice-Chancellor and Vice-President (Research)
Professor Laura Parry, Pro Vice-Chancellor (Research Excellence)

The University of Adelaide has a strong commitment to research excellence, distinguished by its international standing, dedication to innovation and excellence in research and teaching. More than 4000 research staff and students are working together, supported by modern infrastructure and an innovative culture, to tackle research challenges and deliver positive impacts both locally and globally.

As a University, we have a long history of 'collaborative innovation' that benefits our partners, our state, our nation and the global community. It is a principle that we hold dearly and one that is central to our goal of making history.

The research institutes are a fundamental element of our approach to collaboration both within the University and externally with our many partners. The institutes provide critical opportunities for our staff and students to take a multidisciplinary approach to responding to sector and community challenges.

In late 2022, we established the new role of Pro Vice-Chancellor (Energy Futures) within the Division of Research and Innovation. We are pleased that Professor Michael Goodsite agreed to take on the exciting task to consolidate the University's position and to drive collaboration with our partners in renewable energy technologies and sustainability. The University and the nation will benefit from the considerable opportunities being developed by the State Government and through our own research.

The year 2022 saw development of the University's FAME Sustainability Strategy, the implementation of which is being led by Professor Goodsite, who will have, where appropriate, oversight of the University's sustainability initiatives on behalf of the Vice-Chancellor and the Deputy Vice-Chancellor (Research). We are grateful that Professor Goodsite will also continue to hold the complementary role of ISER Director.

The appointment of the new ISER Advisory Board demonstrates our commitment to working closely with stakeholders and we welcomed the Hon. Trish White AM as inaugural Chair. During her 15-year political career, Ms White served as a senior South Australian Government cabinet minister in portfolios such as Transport, Infrastructure, Urban Development and Planning, Science, and Education. Ms White is currently Executive Director of a consultancy working with ISER's sectors and was bid CEO of the HiLT CRC.

OUR GUIDING STRATEGIES

University Strategic Plan - Future Making

This Strategy focuses on creating national outcomes through our research excellence and ecosystem to deliver solutions for the greatest challenges of our time. It is strategically aligned to national and State priorities. The University has an impressive track record in 5 key sectors: Defence, Cyber and Space; Health; Minerals and Resources; Energy and Sustainability; and Agrifood and Wine. Multi-sector capabilities stretch across mathematics, sensors and sensing, AI and machine learning (ML).
More information.

DIRECTOR AND ADVISORY BOARD CHAIR REPORT

Professor Michael Goodsite

Our annual report for 2022 continues our longstanding practice of delivering meaningful, short and concise information to stakeholders. We are especially pleased to have met all University KPIs once again, demonstrating that ISER strongly contributes to the University's research funding outcomes.

Other outcomes in 2022

This year, ISER demonstrated a strong commitment to the sustainable transition of the global mineral and resources sector to a high-tech and clean-energy world. This is the guiding principle behind our work in critical minerals, technology, geology, geochemistry, resources, electrical/electronic and civil engineering, creating new innovations in hydrogen, solar and wind energy production.

The transition from Institute for Minerals and Energy Resources (IMER) to ISER was formalised during Sustainability Week 2022 at the University. In addition, a Sustainable Development Goals portal was created during the year to link University experts with industry and government. These leading researchers specialise in reshaping technologies, products, policies and practices that support local and global development goals.

ISER unites collaboration partners in international research and development expertise with our own strategic know-how and intention to innovate in every facet of our activity. We are especially proud of our ability to influence state policy, as evidenced by the report developed in 2022 'SAPC Inquiry into South Australia's Renewable Energy Competitiveness'.

ISER also coordinated the development of the newest FAME Strategy, focused on Sustainability, and led large-scale collaborative research efforts across our academic ecosystem.

Bid leadership to benefit the University, State and nation

Through ISER, in 2022 the University was the bid sponsor for the national Cooperative Research Centres (CRC) Copper for Tomorrow and Scaling Green Hydrogen, building on the previous win for the Heavy Industry Low-carbon Transition (HiLT) CRC.

Women in STEM and diversity

The energy and resources sector recognises that women and people from diverse backgrounds continue to be underrepresented. ISER will foster initiatives to reverse this situation where possible, through our focus on gender, equity, diversity and inclusion – see page 16 for more information.

ISER for IMPACT

Please see our features in this report on aspects of ISER impact during 2022. As an example of our sector's impact on society, copper was recently estimated to contribute $3.3b in 2021-22 to the South Australian economy, and resources companies contributed $10.7b.

Once again, we are grateful for the dedication of our ISER team and our Advisory Board, as well as colleagues across the University. We also thank those companies who have supported the ongoing challenge to modernise sustainability and energy systems.

The Hon. Trish White AM, ISER Advisory Board Chair

As the inaugural Chair of the new ISER Advisory Board, I am excited to contribute to forward thinking for the energy and resources sector, and to welcome my Advisory Board colleagues Alex Blood, Sam Crafter, Fiona Hancock, John O'Brien, Professor Ian Overton and Gavin Yeates; as well as University internal members, Professor Bronwyn Gillanders and Steve Larkin.

ISER's Advisory Board comprises representatives of industry, government, the community and the University, and distils the multi-sector specialist expertise of these leaders in the mineral and energy resources sector.

The Board offers an external perspective on ISER's activities, plus valuable insights from members of global business entities. ISER's foundation aligns with the University's Research Centres and Research Institute framework. We are working together to evolve the impact of ISER globally with our State as a 'Living lab'.

Developing future energy systems

2022 ACTIVITY

Achievements and awards

Frontiers Planet Prize

Professor Zaiping Guo was one of 3 selected scientists to represent Australia by the Frontiers Research Foundation whose goal is to accelerate scientific solutions for healthy lives on a healthy planet. Professor Guo's research focuses on the design and application of electrode and electrolyte materials for energy storage and conversion, including rechargeable batteries, hydrogen storage, and fuel cells.

To promote sustainability science, the Frontiers Planet Prize is for scientific breakthroughs that have the greatest potential to stabilise our planet's ecosystem. The winning scientists can use the 1m Swiss Francs prize money (AU$1.6m) in any way they choose to accelerate the development of their breakthrough science.

Professor Guo was chosen by a jury of 100 leading sustainability scientists based on the potential of the applicant's scientific breakthrough to be deployed globally to keep the planet's ecosystem within any one or more of the 9 planetary boundaries.
More information.

Commendation for Innovation and Collaboration

The PRIF Mining Consortium team 'Unlocking Complex Resources' received this award in the resources sector for Innovation and Collaboration, at the 11th Annual Premier's Awards in Energy and Mining held on 8 December 2022.

This award recognises the excellence of PRIF Mining Consortium showcasing vision, opportunity and/or transformational change. It has been recognised by the University as a remarkable milestone.
More information.

Australia's Superstars of STEM

ISER's Dr Rachelle Kernen and Dr Alice Jones affiliated with ISER were among the 7 outstanding women researchers from the University of Adelaide who were recognised for outstanding contributions to STEM.

Dr Kernen's research applies her expertise in sedimentology, stratigraphy, and salt-sediment interaction to subsurface carbon dioxide and hydrogen storage and critical mineral deposits. Dr Jones' research focus is around coastal or 'blue' carbon ecosystems (mangroves, seagrasses and saltmarshes) and the important role these ecosystems play in reducing the impacts of climate change by accumulating and storing large amounts of carbon from the atmosphere and the oceans.

Since being created by Science and Technology Australia in 2017, Superstars of STEM has made a powerful contribution to start to tackle the serious gender inequity of visible diverse role models featured in the media as experts in STEM.
More information.

2022 Australian Museum Eureka Prizes

University researchers were among 14 finalists in the 2022 Eureka Prize.

Of relevance to ISER, the Extreme Heat and Health Adaptation Team, including Professor Peng Bi, developed a heat health warning system. Heatwaves are becoming more frequent and intense due to climate change, posing significant health risks for Australians, particularly the elderly and chronically ill. This research spans across SDG 3: Good Health and Well-Being and SDG 10: Reduced Inequalities.

University researchers collaborated with government agencies and migrant communities to develop and implement the warning system. Communicating warning messages can reduce the likelihood of heat-related illnesses and injury and improve workplace safety during heatwaves. More information.

Known as Australia's most comprehensive national science awards, the Eureka Prize honours excellence across the areas of research and innovation, leadership, science engagement, and school science.
More information.

ISER engagements in 2022

South Australia Investment Conference, February

SDG 17: Partnerships for the Goals

The University's Pro Vice-Chancellor (Energy Futures), Professor Michael Goodsite was a keynote speaker at this event. He discussed making the most of the green investment boom and the important role played by the higher education sector in upskilling and reskilling a future workforce required to meet new environmental and energy challenges.

'Science Meets Parliament' Hydrogen online forum, February-March

SDG 16: Peace, Justice, and Strong Institutions

ISER participated in this event presented by Science and Technology Australia. It offered bespoke training to forge deeper connections between Federal parliamentarians and those working in science and technology. Focusing on building relationships between STEM experts and policymakers, the national gathering included some 450 STEM leaders.
More information.

Australian Hydrogen Conference, Adelaide Convention Centre, May-June

SDG 7: Affordable and Clean Energy

ISER sponsored and participated in this conference that presented the hydrogen sector's eminent energy leaders exploring the latest emerging projects, challenges, opportunities and lessons. The conference expanded on the 2021 event, and latest insights were shared among hundreds of hydrogen and energy executives from across Australia who discussed advances in technologies fast-tracking the hydrogen transition. The conference was backed by the Australian Hydrogen Council.
More information.

Sustainability Week, University of Adelaide, August

SDG 13: Climate Action
SDG 4: Quality Education

ISER took part in and organised a panel discussion 'Low Emissions Future: Who, what, when, where & why?' at the University's Sustainability Week. This year's theme was Empowerment, which encompassed empowerment as a consumer, as a future professional or leader, and as a global citizen.

The free 5-day event brought together students, clubs, staff and special guests for a series of workshops, panels, films and other activities to foster positive discussion and practical sustainability on and off campus.
More information.

HiTEMP Forum3, National Wine Centre, Adelaide, September

SDG 7: Affordable and Clean Energy
SDG9: Industry, Innovations and Infrastructure

ISER sponsored and participated in the third international forum on High Temperature Minerals Processing (HiTeMP-3), along with the Centre for Energy Technology, the Heavy Industry Low-carbon Transition (HILT) CRC, and Mission Innovation's Net Zero Industries (NZI) Mission. The 2022 forum built on the outcomes of previous HiTeMP forums and identified next steps for decarbonising heavy industry. World-leading experts participated in discussions to further shape a carbon-constrained future and prepare for the new, low-carbon economy.
More information.

Royal Adelaide Show, University of Adelaide exhibition, September

SDG 14: Life below Water
SDG 15: Life on Land

The University's researchers Volker Hessel and Nam Tran shared their knowledge with students, farmers and the wider community at this exhibition, co-sponsored by ISER.

It demonstrated how an on-farm fertiliser manufacturing system with renewable materials (air and water) and renewable energies can transform businesses, minimise environmental and landscape impact and improve communities.

The initiative was sponsored by the Royal Horticultural Society, and co-sponsored with ISER by the University's Environment Institute, the Faculty of Sciences, Engineering and Technology, School of Chemical Engineering and Advanced Materials, and the School of Architecture and Built Environment.

Australian Hydrogen Forum, Sydney, November

SDG 17: Partnerships for the Goals
SDG 8: Decent work and economic Growth

ISER chaired the fourth annual forum which examined how the industry will progress from feasibility studies and memoranda of understanding to large-scale commercial projects. This year's theme was 'Moving from Feasibility to Profitability'. There were attendees and speakers from across the energy supply chain discussing current information and analysis on development of the industry, interesting discoveries or small-scale studies. More information.

Ingenuity 2022, Adelaide Convention Centre, November

SDG 13: Climate Action
SDG 4: Quality Education

ISER participated in Ingenuity – creating our technology future – the annual flagship event for the University's Faculty of Sciences, Engineering & Technology. It is an exciting platform and the largest event of its kind for students to present their work to a wide range of audiences.

The event unites all of the faculty's disciplines across the 8 schools, delivering a showcase of more than 300 student projects, information displays and achievements. There were 2,500+ attendees, including primary and high school students, industry representatives, University staff and students, and the public.
More information.

Barossa Australia Sustainability Forum, November

SDG 12: Responsible consumption and production
SDG 11: Sustainable Cities and Communities

ISER's Paula Angerstein spoke at the second industry forum of its kind, which explored a roadmap for collaborative sustainability by bringing together leaders. Speakers shared information about Vision 2050 – Net Zero in the Barossa, regional water security, the need for an emissions reduction roadmap for the Australian wine industry, and sustainable wine growing. Professor Goodsite was a panel member and spoke about ISER's work in sustainability.

AC21 International Forum on Higher Education for a Sustainable Society, December

SDG 13: Climate Action
SDG 4: Quality Education

Professor Greg Metha, with support from ISER, represented the University at this event in Nagoya, Japan.
The vision of AC21 is to promote cooperation in education and research between members, bridging different societies. AC21 is focused on helping people to understand and share values, knowledge and cultures for better quality of life, fostering co-existence beyond national and regional boundaries.
More information.

IMPACT

Fortescue Future Industries, Sparc Technologies and the University of Adelaide partner to tackle the future of clean energy

Assisted by ISER, in February 2022 the University became party to the creation of Sparc Hydrogen Pty Ltd Joint Venture, known as Sparc Hydrogen, with partners Sparc Technologies Ltd (ASX: SPN) and global green energy company Fortescue Future Industries Pty Ltd (an entity of Fortescue Metals Group Ltd (ASX: FMG).

Sparc Hydrogen is seeking to deliver a unique process with the aim of producing commercially viable green hydrogen via photocatalysis – named the Sparc Green Hydrogen Project.

The green hydrogen technology has been developed by Professor Greg Metha and team, and Flinders University.

ISER's Professor Michael Goodsite said that this exciting project aims to further develop the process of thermo-photocatalysis, which uses the sun's radiation and thermal properties to convert water into hydrogen and oxygen.

"Adopting this process to produce green hydrogen means that renewable energy from wind farms and/or photovoltaic solar panels and expensive electrolysers are not needed."

Chemistry Professor Greg Metha patented a device in 2019 that makes hydrogen directly from solar energy and water – with game-changing efficiency. His research team is leading Sparc Hydrogen's mission to produce commercially viable green hydrogen through a process known as thermo-photocatalysis.

No electrolysers or electricity is needed for Greg's new single-step approach, only sunlight, water and a catalyst. Which makes it a much more affordable operation.

If this technology can be successfully scaled up, it has the potential to diminish our reliance on fossil fuels, including in heavy industries.

"Innovation requires a certain level of investment. And while funding for zero-carbon fuels seems like a no-brainer – I mean, we're talking about the future of humans here – scientists don't always get this kind of backing.

"There's lots of incredible work going on in universities that industry leaders aren't aware of. The University of Adelaide is doing all sorts of research on lowering the carbon footprint of steelmaking, alumina, and cement manufacturing through the Heavy Industry Low-carbon Transition Cooperative Research Centre (HILT CRC)," Greg says.

"I'm a really strong supporter of engagement between academia and industry. That's how we're going to get somewhere."

Quotes credit: InDaily

See video Hydrogen Headway – Research Tuesdays.

"As such, capital and operating expenditure is anticipated to be significantly lower than electrolysis and other forms of hydrogen production currently in use," Professor Goodsite said.

This technology can potentially be adopted remotely and for onsite use, reducing the reliance on long distance hydrogen transportation or electricity transmission.

Sparc is also set to commercially manufacture graphene-based additives using manufacturing equipment, which will be trialled and ordered. A manufacturing site will also be located.

Sparc has a strategic relationship and exclusive licensing agreement with the University of Adelaide, considered a world leader in graphene and renewable energy research.

University of Adelaide Executive Director, Innovation and Commercial, Dr Stephen Rodda said the joint venture was "a perfect example of the University's internationally regarded research being put on a path to achieving a significant commercial outcome.

"We are committed to partnering with industry to support the transfer and development of new technologies. This is a priority activity for the University. We have a long-standing track record of successful partnerships, and we will continue to invest in them long into the future," he said.

Critical to the success of any partnership is the alignment of goals and objectives. Sparc and FFI are committed to the partnership, with clearly aligned objectives to invest the resources needed to give this technology every chance to succeed.

University of Adelaide Vice-Chancellor and President, Professor Peter Høj, said, "We are proud to be the leading university involved in this venture, applying our research and innovation in responding to one of the great challenges of our times: the development of green energy solutions for our planet."
More information.

Copper for Tomorrow CRC – for a sustainable future

Copper is essential to global decarbonisation efforts and a vital input to clean energy technologies, with no ready substitute. It is also essential in the production of renewable technologies such as solar PV, wind turbines, bioenergy systems, electricity networks and battery storage.

Copper is used in everyday items like electrical wiring, electronic devices and motors and in alloys for currency, household fixtures and cooking pans.

Worldwide governments' challenging timelines to achieve emissions reductions are expected to result in the largest increase in demand of primary copper in human history – 300% by 2050.

Forecasts predict a looming supply shortfall, which will present opportunities for expanding and growing copper production, creating an economic investment boost. This will create jobs for mining companies and the mining equipment, technology and services (METs) sector.

During 2022, on behalf of the University, ISER led the development and planning for the bid Copper for Tomorrow cooperative research centre (CRC), which was finalised and submitted for government assessment in March 2023.

ISER was also the umbrella group fostering interdisciplinary collaboration for the Australian Critical Mineral Research Centre, a national group for multidisciplinary research key mineral programs.

"So that we can transition to a clean and sustainable economy, we will need more copper in the next 30 years than has ever been mined in history – plus we'll need to double current global production," says ISER's Professor Michael Goodsite.

"There is already an international shift in demand for copper and lithium, which Australia has in abundant resources. These are examples of resources our country will transition to extracting for a more sustainable future," he said.

The dedicated CRC will deliver research, education and knowledge to transform the industry as a leading supplier of green copper to minimise impact. It will add value to the community, particularly in sensitive regional areas where primary production takes place, in order to deliver the copper essential for a sustainable future.

The Copper for Tomorrow CRC will have 3 leading research programs – ESG Fundamentals, Mining and Processing – plus investigate commercialisation opportunities and education and training to share information and collaborate. More information.

Challenges in copper production

The current approach to copper production is energy and water intensive, increasing as grades decline, and producing ever more emissions and waste products. Future demands for copper can't be met through recycling alone, and exploring for new deposits is challenging and time consuming. What's more, markets in the future green economy may not buy copper that has not been sustainably produced.

The sustainable copper paradox examines how we increase the production of copper needed for a green energy society, while also processing lower-grade ores and meeting environmental, social and corporate governance (ESG) goals. Copper For Tomorrow CRC unites industry and researchers to solve this urgent challenge so that the copper industry can meet sustainability targets and remain profitable.

Scaling Green Hydrogen CRC

DRIVING THE RAPID EXPANSION OF GREEN HYDROGEN'S ROLE IN THE GLOBAL ECONOMY

There are great expectations for green hydrogen to accelerate the transition from fossil fuels to greener alternatives, achieving crucial net-zero emission targets and protecting our planet and all who inhabit it, now and into the future.

The Scaling Green Hydrogen Cooperative Research Centre (CRC) aims to become the largest single initiative in Australia focused on supporting the vital scaling up of the emerging our green hydrogen sector to allow us to realise these expectations.

During 2022, on behalf of the University, ISER led the development and planning of the bid for the Copper for Tomorrow Cooperative Research Centre (CRC), which was finalised and submitted for government assessment in March 2023.

How the Green Hydrogen CRC will help

"The challenge is multidimensional," says ISER's Professor Goodsite. "Australia needs to develop solutions for storage, transport and distribution of hydrogen – and one solution won't fit every challenge. We also need to adapt electrolyser technologies from global settings to Australian conditions, working on specific solutions and local production. The CRC will lead this work and unite all players across the system."

Other challenges are to:

- collaborate across electricity, water, chemicals, transport, infrastructure, and manufacturing sectors with systems approaches
- link production of green hydrogen to offtake markets such as green chemicals, sustainable fuels and green steel
- grow a domestic green hydrogen industry with local workforce, supply chains, standards and best-practice safety
- develop Australia's small-to-medium enterprises (SMEs), emerging entrepreneurs, and the research sector to create a global hydrogen equipment, technology and services (HETS) sector.

Next steps

While Australia has always been a global energy powerhouse – currently coal, oil and gas are the star candidates – we also have the renewable energy to keep supplying energy to the world during and after the clean energy global transition. Green hydrogen is a key pillar.

But this won't help all industries – for example, we can't produce fertilisers and explosives without hydrogen, and batteries are not suitable for long distance and heavy transport such as ships and airplanes.

Scaling Green Hydrogen CRC is in the process of raising $5 million per annum from the main stakeholders (including $4 million per annum from industry participants) for the 10-year life of the CRC. The goal is to achieve an additional $50 million matched Commonwealth funding to safeguard this critical green fuels initiative. More information.

What is the problem or challenge?

Some 100 million tonnes of hydrogen are used each year to make chemicals and refine transport fuels, and it all comes from fossil fuels, with large amounts of CO_2 emissions.

As we move to renewable energy, questions are being asked – like how do we store energy from the sun and wind? What about the sectors who can't easily transition to renewables: fertilisers, heavy transport, aviation and shipping?

The world is looking to green hydrogen to address these challenges, because of its versatility and suitability. But, while we know how to make green hydrogen, and the goodwill around green hydrogen is near-universal, scaling up – from very limited now to large-scale global impact, within 20 years – occupies the minds of many investors and policymakers.

The largest operating electrolyser in Australia is just 1.25 MW. Scaling to as much as 1 TW (that's a million times bigger!) is not just about adding more and bigger electrolysers. For example, the feedstocks – electricity and water sectors – will have to be massively scaled and coupled with electricity up to double the current amount.

The new CRC will help build complex, multisectoral and systemic cooperation. There is currently no effective strategy on how big, how fast, how soon and who will pay for this. This CRC will minimise risk from the transition through collaboration and government co-funding.

Electricity's share of global energy demand is expected to more than double by 2050 from the current 20%.

Gender, equity, diversity and inclusion

The University is committed to welcoming and supporting all community members, regardless of gender, age, race, religion, ability or sexuality. Various frameworks, procedures are in place to support diversity, inclusion and safety, such as inclusive language guidelines, equal opportunity policy. More information.

ISER's involvement in these events meets our goals (SDGs) of:

- SDG 5: Gender Equality
- SDG 10: Reduced Inequalities

Superstars of STEM

Dr Rachelle Kernen and Dr Jessica Bohorquez, amongst 7 outstanding female University researchers, were part of the latest cohort of 60 women nationwide to raise the public profile of science, technology, engineering and mathematics (STEM).

Dr Kernen is from the former Australian School of Petroleum and Energy Resources and is a leading researcher and educator in earth sciences, specifically in the fields of evaporite sedimentology and stratigraphy.

She interprets data from rocks that form the ranges in Australia, which is used to find critical minerals needed to build solar and wind farms. These rocks give us information about where carbon dioxide and hydrogen can be stored, which reduces greenhouse gas emissions and can be used as clean fuel, all of which help fight climate change.

One of the other participants, Dr Jessica Bohorquez is from the School of Civil, Environmental and Mining Engineering. Her research focuses on water pipeline inspection and monitoring techniques using pressure transients and artificial intelligence.

She is also an advisor at Inside Infrastructure (a Ricardo company) supporting water utilities and resource companies in their water management focusing on hydraulic modelling for systems design and operation.

Since being created by Science and Technology Australia in 2017, Superstars of STEM has made a powerful contribution to begin tackling the serious gender inequity of visible diverse role models featured in the media as experts in STEM.

Professor Katrina Falkner, Executive Dean of the Faculty of Sciences, Engineering and Technology, said that having more than 10% of the national intake was a fantastic result for the University.

"We are extremely proud of our 7 Superstars of STEM, who are amazing role models for women and non-binary people by increasing the visibility of STEM as a career of choice," she said.

"They will be smashing stereotypes and leading the way for the next generation of STEM Superstars."

Minister for Industry and Science, Ed Husic MP, congratulated the newest Superstars of STEM on stepping into the public arena to help inspire the next generations of diverse young Australians into STEM.

"The need to boost diversity in our science, technology, engineering and mathematics sector is urgent," he said.

"There are huge skills shortages that can be addressed if we put our minds and collective effort to it – which means we have to draw deeply on our nation's expertise from all corners of the community."
More information.

ISER sponsored and supported events

- **Women in STEM Careers (WiSC) 2022 program**

  Held annually from March, this is a talent identification pipeline program for participating organisations. The sessions incorporate workshops, lectures, panel sessions, practical activities and industry networking events. There are personal development sessions where students undertake emotional intelligence, strengths and resilience training, development activities in personal branding, job application writing and interview techniques, plus career-focused industry panel sessions. Throughout the program, industry partners can communicate directly with students and offer one-on-one mentoring.
  More information.

- **Championing diversity and inclusion at AusIMM's International Women's Day (IWD) Event Series 2022**

  Featuring empowering keynote speakers and inclusive networking opportunities, ISER sponsored a table of guests at this Adelaide luncheon, held in collaboration with leading industry partners including Newmont, Ausenco, Epiroc and Byrnecut. The IWD theme, 'Break the Bias' focused conversations on improving the experiences of women in the resources sector.
  More information.

- **WOMEESA writers' corner**

  Four-week writing retreat series at the Barr Library Writing Studio for informal coaching and support from Drs Rachelle Kernen and Lucy McGee.

RESEARCH CENTRES SUPPORTED BY ISER

Centre or group name	Summary of focus	Director	Faculty
Centre for Global Food and Resources (GFAR)	Conducts world-class innovative interdisciplinary research, using a whole-of-systems approach to address economic, policy, agribusiness and social issues affecting global food systems.	Associate Professor Patrick O'Connor	ABLE
Centre for Energy Technology (CET)	Develops innovative technologies for sustainable, secure and affordable energy to help accelerate society's transition to carbon neutrality.	Professor Gus Nathan	SET
Mawson Geo Centre	Studies the tectonics of the planet, applies an exploration philosophy to understanding earth processes and their control on resource endowment.	Professor Graham Heinson	SET
Andy Thomas Centre for Space Resources (ATCSR)	Brings together the University of Adelaide's collective exploration, mining, manufacturing and engineering research strengths to address the challenges faced by long-term planetary exploration, while ensuring the near-term application here on Earth.	Professor John Coulton	SET
Centre for Materials in Energy and Catalysis (CMEC)	Develops novel advanced materials and catalysts— and innovative approaches to their use— for sustainable, industry-relevant energy generation, storage and conversion to achieve greater efficiencies and cost-effectiveness, and minimise environmental impact.	Professor Shizhang Qiao	SET
Centre for Radiation Research, Education and Innovation (CRREI)	Delivers creative, timely solutions and services to the many industries involved in radiation-related activities.	Professor Tony Hooker	SET
Australian Critical Minerals Research Centre (ACMRC)	Builds critical mass of people and knowledge from early prospectivity analyses to resource definition and mineral processing in critically important minerals, essential to our transition to a high-tech and clean energy world.	Associate Professor Carl Spandler	SET
Institute for International Trade (ITT)	Brings together leading academics, experienced trade practitioners and negotiators to address key challenges faced by businesses and governments seeking to expand trade and investment opportunities across the globe.	Professor Peter Draper	ABLE

* Key: Faculty of Sciences, Engineering and Technology (SET) and Faculty of Arts, Business, Law and Economics (ABLE)

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