Climate Change
– A Global Risk

Renewable Energy Generation and Storage
– A Local Risk

Emerging Risk Report

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Emerging Risk Report

Unimutual's Risk Manager, Simon Iliffe looks at the adoption of renewable energy infrastructure and technology in the fight against rising global temperatures and the undeniable impacts of climate change. Universities are not only advancing research into renewable energy technology but also leading the charge by delivering a range of renewable energy and sustainability projects aimed at both reducing their own carbon footprint but also contributing to Australia's commitment to the Paris Agreement.

The tertiary education sector has not only suffered its fair share of climate change/weather- related property losses, but it has also seen several large losses associated with renewable energy technology. Part one of this two-part emerging risk report examines the impetus for advancement in renewable energy technology, the different types of renewable energy and those adopted by Australian universities, and the emerging risks associated with renewable energy generation and storage.

In part two, Unimutual's Senior Risk Engineer Greg Burton will delve into the technical aspects of the risks emerging from renewable energy projects undertaken by Australian universities, with a particular focus on solar generation and energy storage.

The impetus

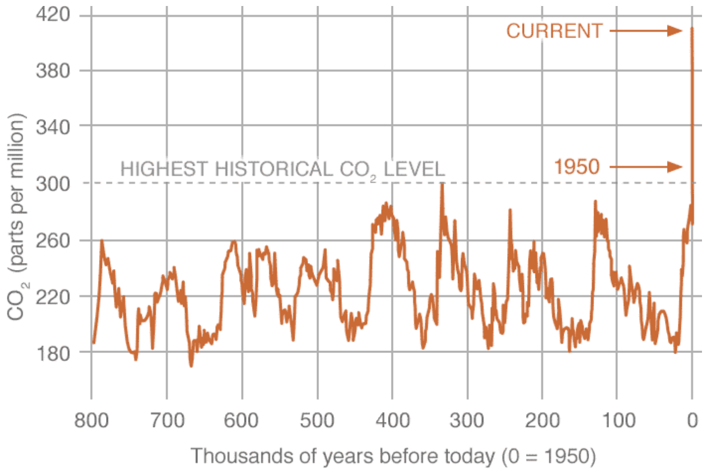
While the climate crisis has polarised the public and paralysed world politics for decades, there is overwhelming scientific agreement that human-caused climate change is not "fake news" – it is real, and one of our most pressing global risks. Scientific evidence for warming of the climate system is *unequivocal*, according to the Intergovernmental Panel on Climate Change.

The current warming trend is of particular significance because most of it is extremely likely (greater than 95% probability) to be the result of human activity since the mid-20th century and proceeding at a rate that is unprecedented over decades to millennia (IPCC Fifth Assessment Report).

Over the last century, the burning of fossil fuels like coal and oil has increased the concentration of atmospheric carbon dioxide (CO2). This happens because the coal or oil burning process combines carbon with oxygen in the air to make CO2. To a lesser extent, the clearing of land for agriculture, industry, and other human activities has increased concentrations of greenhouse gases by reducing the ability of the environment to naturally capture and store carbon.

Ice cores drawn from Greenland, Antarctica, and tropical mountain glaciers show that Earth's climate responds to changes in greenhouse gas levels. Carbon dioxide from human activity is increasing more than 250 times faster than it did from natural sources after the last Ice Age.

There is no question that increased levels of greenhouse gases must cause Earth to warm in response. The chart below demonstrates a dramatic increase in carbon dioxide in the atmosphere in recent decades.



Picture: NASA

Global emission reduction targets

The Paris Agreement, which was adopted at the 2015 United Nations Climate Change Conference and entered into force on 4 November 2016, aims to keep global temperature rise well under 2C, preferably within a maximum rise of 1.5C. Australia ratified the Paris Agreement on 10 November 2016, promising to reduce its emissions by 26 to 28 per cent from 2005 levels by 2030. To date, 195 countries have signed and 189 have ratified the Agreement.

Recently, EU leaders have agreed on a more ambitious goal for cutting greenhouse gases - reducing them by 55 per cent by 2030.

China, Japan, South Korea, and US president Joe Biden - 70% of Australia's major trading partners - have committed to a target of net zero greenhouse gas emissions by or near 2050. The mid-century target is backed by all Australian states, but the current federal government continues to resist, remaining non-committal.

Hope of achieving or exceeding the 2050 target lie in part with the research breakthroughs in renewable energy technology, led by Australian universities.

How committed are we to make necessary changes?

Investment in renewable energy technology and projects by industry and government is an important part of the fight against climate change.
In 2019, Australia met its 2020 renewable energy target of 23.5% and 33 terawatt-hours (TWh). Australia produced 378.7 PJ of overall renewable energy (including renewable electricity) in 2018 which accounted for 6.2% of Australia's total energy use (6,146 PJ).

Renewable energy grew by an annual average of 3.2% in the ten years between 2007-2017 and by 5.2% between 2016-2017. This contrasts to growth in coal (-1.9%), oil (1.7%) and gas (2.9%) over the same ten-year period. It is estimated that Australia produced 55,093 gigawatt- hours (GWh) of renewable electricity in 2019, which accounted for 24.0% of the total amount of electricity generated in Australia.

RENEWABLE ENERGY GENERATION[1]

TECHNOLOGY	GENERATION (GWh)	PERCENTAGE OF RENEWABLE GENERATION	PERCENTAGE OF TOTAL GENERATION	EQUIVALENT NUMBER OF HOUSEHOLDS POWERED OVER COURSE OF THE YEAR
Wind	19,487	35.4%	8.5%	4,240,013
Hydro	14,166	25.7%	6.2%	3,082,150
Small-scale solar	12,269	22.3%	5.3%	2,669,440
Large-scale solar	5141	9.3%	2.2%	1,118,596
Bioenergy	3314	6.0%	1.4%	721,005
Medium-scale solar	716	1.3%	0.3%	155,867
TOTAL	**55,093**	**100.0%**	**24.0%**	**11,987,070**

Picture: Clean Energy Australia Report 2020

Further, more renewable energy will be built in New South Wales than in Victoria and Queensland combined after the NSW government committed to support 12 gigawatts of wind and solar and 2 gigawatts of energy storage. A 20-year NSW electricity infrastructure roadmap recently released aims to lower the cost of electricity, create jobs in regional areas and avoid the state having to rush to build new generation as ageing coal plants close in the years ahead.

The scheme involves reverse auctions to award long-term contracts for three different types of technology:

- wind and solar farms to be built in three regional renewable energy zones,
- long-duration storage that can provide back-up power for eight hours or more, likely to come from pumped hydro or batteries, and
- fast-start "firming" generation that ensures stability in a grid that increasingly runs on variable renewables, likely to come from batteries or gas.

As ageing coal-fired power plants require increasingly expensive upgrade investments, the move away from this technology is starting to ramp up with nearly 20 per cent of the electricity in NSW and Queensland and a third of the electricity in Victoria over the past few months being generated from renewable sources.

The Victorian government is supporting 928 megawatts and promised at least another 600 megawatts through its renewable energy target as it aims to reach 50 per cent renewable energy power by 2030. The Queensland government also has a 50 per cent clean energy goal for 2030.

The global push to cut emissions could open opportunities in green steel, hydrogen, and aluminium, created using renewable energy. This presents huge opportunities for translational research in Australian universities. Refer to opportunities post COVID-19 article here.

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Check out the UTS report https://www.uts.edu.au/research-and-teaching/our- research/institute-sustainable-futures/our-research/energy-futures/100-renewable-energy- australia.

Types of renewable energy in Australia

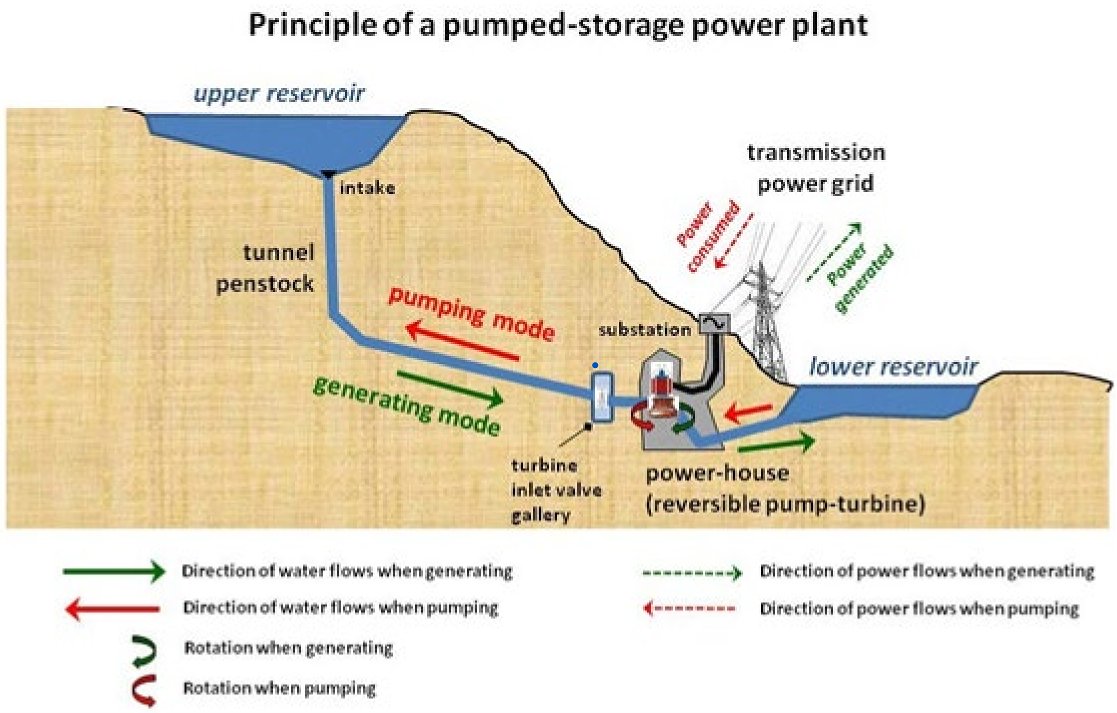
Hydro

When people think of renewable energy, solar panels and wind turbines immediately spring to mind. But the biggest renewable energy project in Australia commenced in 1947 uses none of these – it uses water. There are currently more than 100 hydro power plants in Australia.

In 2019, hydro power supplied 25.7% of Australia's renewable electricity generation or 6.2% of Australia's total electricity generation. This marked the first year that hydro was not the country's largest source of renewable energy, having been overtaken by both wind and solar.

Hydro Tasmania operates 30 power stations and 15 dams, with a total generating capacity of 2,600 MW, and generates an average of 9,000 GWh of electricity per year. There are also plans to upgrade Tasmania's hydropower system to give it the capability to function as pumped hydro storage under the 'Battery of the Nation' initiative.

Snowy 2.0 is a major pumped-hydro expansion of the existing Snowy Scheme and a $4b investment in renewable power, capable of providing 2,000 megawatts of power on demand. It leverages the existing Snowy Scheme, which means it does not require new dams and is a closed loop system that 'recycles' water.



https://www.ourworldofenergy.com/images/other-renewables-energy/vignette_image_10_1.jpg

Solar Photo Voltaic

Solar power in Australia is a fast-growing industry. As of June 2020, Australia's over 2.4 million solar PV installations had a combined capacity of 18,583 MW of which 3,290 MW were installed in the preceding 12 months. In 2019, 59 solar PV projects with a combined capacity of 2,881 MW were either under construction, constructed or due to start construction having reached financial closure. In 2019, solar accounted for 7.5% of Australia's total electrical energy production.

Wind

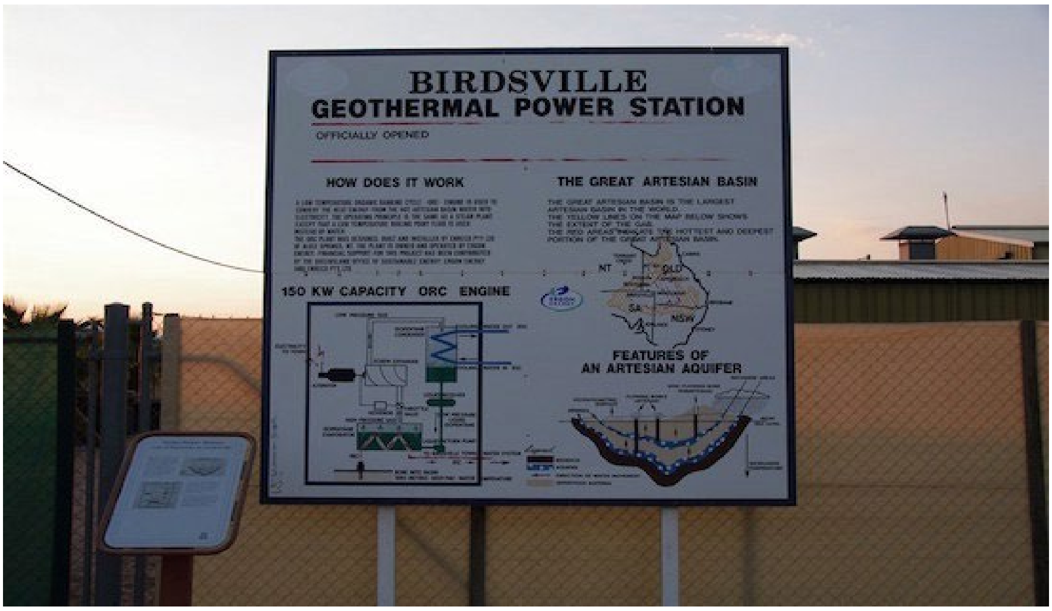
In 2019, wind power supplied around 35.4% of Australia's renewable electricity and around 8.5% of Australia's total electricity. Nine new wind farms were commissioned in 2018 and as at the end of 2018, 24 wind farms with a combined capacity of 5.9 GW were either under construction or financial commitment.

Geothermal

Unlike the intermittent nature of most renewable energy sources, geothermal can be used for baseload or peaking.

Most of the world's current utilisation of geothermal energy occurs in areas of active volcanism. Geothermal resources in Australia are unconventional as they rely on a combination of high heat generating rocks (particularly granites) within the upper part of the crust and a thermally insulating blanket typically provided by thick layers of fine-grained sediments to trap the heat.

Currently, geothermal energy is a natural resource which is not widely utilised as a form of energy in Australia. However, there are known and potential locations near the centre of the country in which geothermal activity is detectable. Exploratory geothermal wells have been drilled to test for the presence of high temperature geothermal activity and a 1MW pilot project at Innamincka in South Australia did successfully produce power. Unfortunately, a commercial scale facility was not considered viable, based on the remote location requiring construction of a long transmission line to deliver power to end users.



Picture: Stephen L, [Exploreoz]

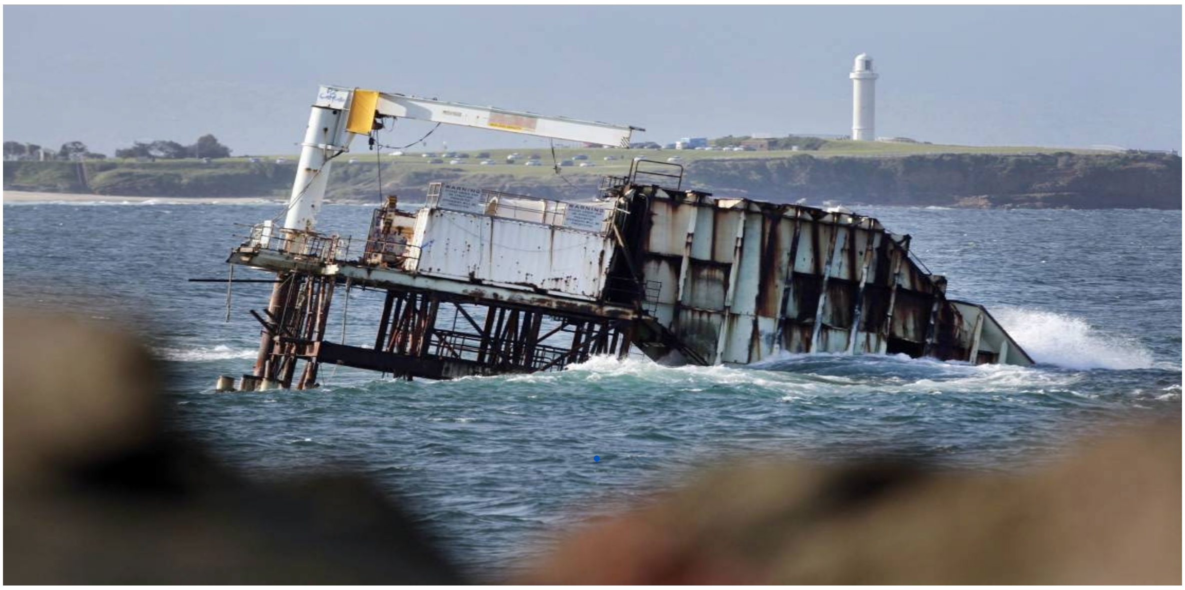
South Australia has been described as "Australia's hot rock haven" and this emissions free and renewable energy form could provide an estimated 6.8% of Australia's base load power needs by 2030. According to an estimate by the Centre for International Economics, Australia has enough geothermal energy to contribute electricity for 450 years.

Interestingly, a geothermal power plant did operate at Birdsville for several decades, utilising heat from a hot sedimentary aquifer system but was decommissioned in 2018 in favour of a switch to distributed solar and storage.

Wave and tidal

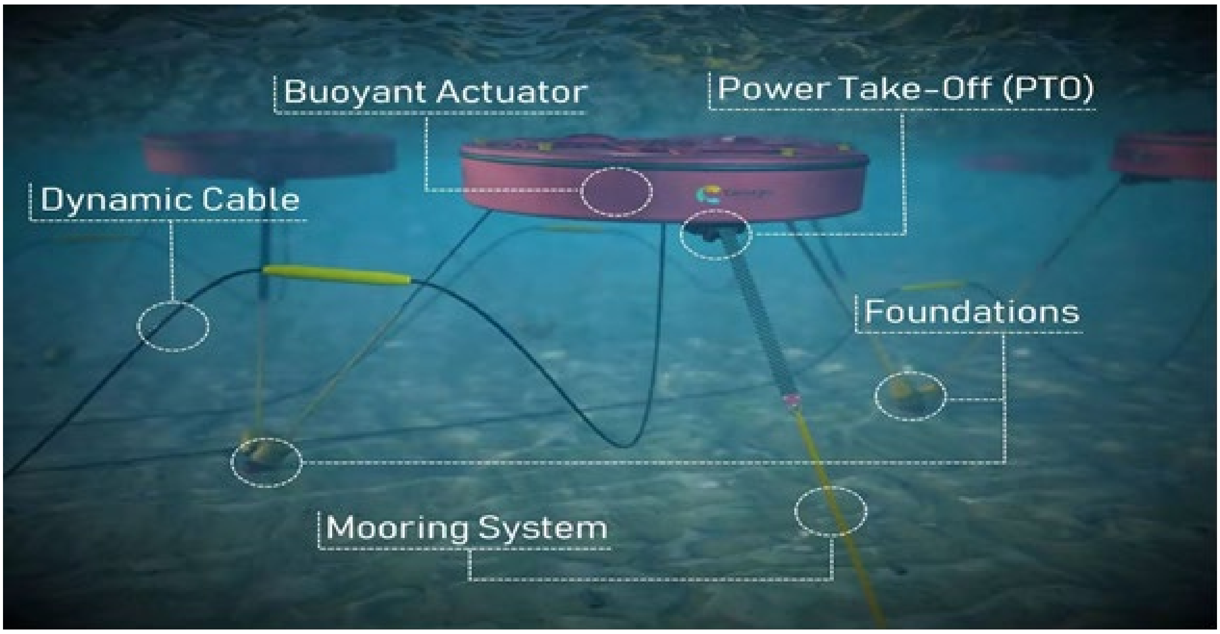
Several projects for harvesting the power of the ocean have had mixed success.

Oceanlinx trialled a wave energy system at Port Kembla, unfortunately as you can see in the photo below, it was ripped from its moorings in a storm and sank, near a local surf break called Oily’s in May 2010. The technology focused on the oscillating water column principle, and several prototype generators were developed, deployed, and tested in Port Kembla, New South Wales.



Picture: Andy Zakeli, [Illawarra Mercury]

Carnegie Corp of Western Australia is refining a method of using energy captured from passing waves. CETO is a unique, fully submerged, point absorber type wave energy technology. A submerged buoy sits a few metres below the surface of the ocean and moves with the ocean's waves. This orbital motion drives a power take-off (PTO) system that converts this motion into electricity

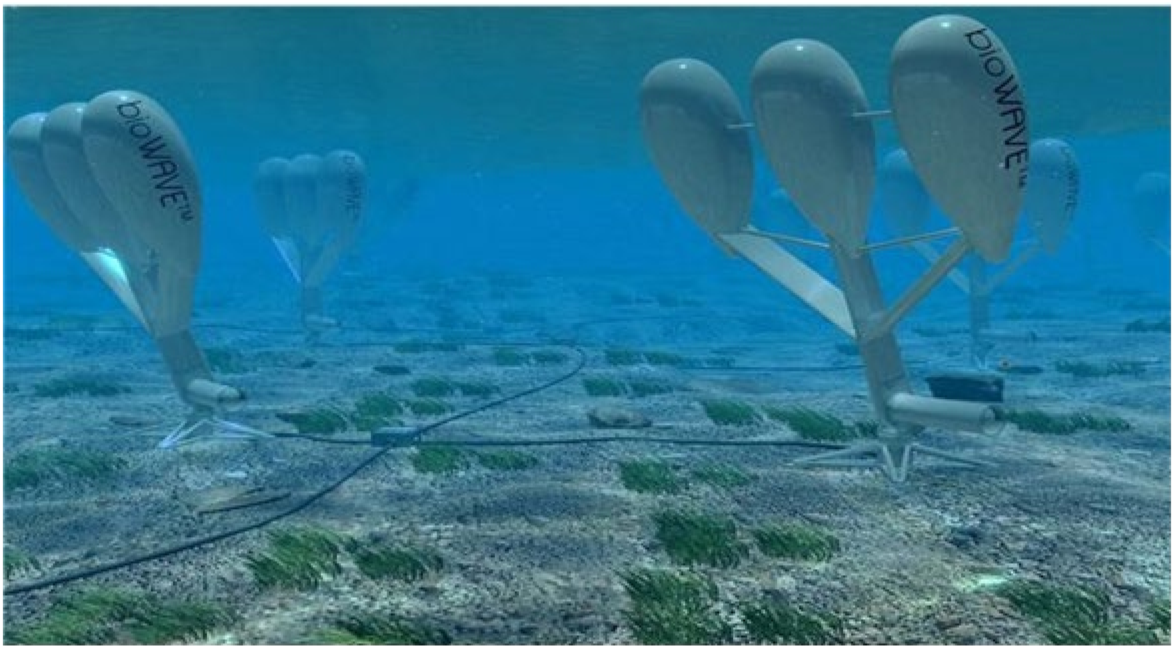


Picture: [Offshore energy]

Australian company BioPower Systems is developing its bioWAVE system anchored to the seabed that would generate electricity through the movement of buoyant blades as waves pass, in a swaying motion like the way sea plants, such as kelp, move.

A trial was successfully completed off the coast of Port Fairy in Australia and the company plans to scale up to market-ready megawatt class design in the near future.

With over 200 wave energy devices in various stages of testing and demonstration, CSIRO research suggests that wave energy could contribute up to 11 per cent of Australia's energy (enough to power a city the size of Melbourne) by 2050, making it a strong contender in Australia's renewable energy mix.



Picture: BioPower Systems' BioWave, via Genitron

Bioenergy

Bioenergy is a form of renewable energy that uses organic renewable materials (known as biomass) to produce heat, electricity, biogas, and liquid fuels. The most cost effective and environmentally beneficial sources of biomass are typically wastewater, municipal waste, and waste streams from the agricultural, forestry and industrial sectors.

Biomass can be converted to bioenergy using a range of technologies depending on the type of feedstock (raw material), scale/size of the project and form of energy to be produced. Conversion technologies include combustion, pyrolysis, gasification, transesterification, anaerobic digestion, and fermentation, or may be linked to processes such as biorefining.

Some conversion processes also produce by-products that can be used to make useful materials such as renewable bitumen and even biomass-based concrete. Additional benefits include emissions reduction, waste disposal, providing support for rural economies, and improving air quality.

Renewable energy in the university sector

The majority, if not all Australian universities are adopting renewable energy generation to some degree, primarily investing in solar generation via rooftop arrays or solar farms. There is also a wealth of research being undertaken throughout the sector across the range of emerging renewable energy technologies from wave and wind to solar and more efficient batteries.

An example of universities pooling resources and expertise to solve some of the challenges facing not only the sector but also the country is the **NUW Alliance**. The NUW Alliance comprises four leading Australian research-intensive universities – the University of Newcastle, UNSW, the University of Wollongong, and Western Sydney University.

NUW Energy represents the largest and most compelling Australian research cohort to be addressing current energy issues. Representing a global network of leading industry partners and allied research agencies, NUW Energy enables simple, streamlined, and direct access to world-class research expertise, removing the traditional barriers that are inhibiting collaboration between academic, industry and government.

NUW Energy represents more than 200 discrete areas of world-class energy research capability and unprecedented access to 30 distinct, world-leading research facilities, centres and institutes of research and innovation in NSW.
The overarching objectives of the NUW Energy collaboration include the development of:

1. integrated network technology to address future energy demands,
2. close cooperation between researchers and industry to ensure NSW is at the forefront of the development of advanced energy solutions, and
3. the opportunity to undertake high-quality research underpinned by the needs of the energy sector that drives global best practice and offers enhanced educational opportunities for industry and students.

What are the risks associated with renewable energy?

Risks associated with renewable energy projects can occur at various stages of a project's lifecycle, from project justification and design to construction and throughout the operational and maintenance stages. The other suite of risks to be addressed is energy storage risks. The following is a snapshot of the risks which have potential to manifest during each stage of a renewable energy project.

Project justification and design

Strategic risk: Does the renewable energy project assist the university to achieve the objectives of its strategic plan. Any combination of the conditions or risks listed in this section could combine to cause the project to not meet strategic objectives.

Financial risk: Risk of insufficient access to capital or return on investment due to component life being less than anticipated or financial investment instruments failing to deliver intended outcomes.

Political/regulatory risk: Risk of a change in public policy, for example subsidies policy, affecting plant profitability.

Market risk: Risk of an increase in the price of commodities and other inputs or decrease in the price of the electricity sold.

Location and future exposure risk: Risk of the location being subject to flood, storms (particularly hail) or bushfire in the future due to climate change impacts. Locations with constantly high ambient temperature may also reduce the efficiency of arrays.

Design risks: Risk of either under or oversizing projects could result in projects not meeting demand or in excessive payback periods, beyond that of component life. For example, for large scale solar rooftop arrays, additional weight of arrays and mounting brackets could impact the structural integrity of a roof. In high wind locations the angle and positioning of panels can also present structural integrity risks.

Technology risk: Risk of components generating less electricity over time than expected or early obsolescence of key components as they become superseded by advancements in design and technology.

Specification risks: Risk of specifying substandard quality components reduces output and the life of the project, increases failure probability and the potential for fire and or property damage. Materials used in switch room construction could present asset integrity risks.

Construction risk

Supply risks: Access to Rare Earth Metals is vital for renewable energy technologies, particularly solar panels. Solar panels require tellurium, one of the rarest elements on Earth. Production of many essential elements is concentrated in just a few countries. China in particular, mines 93 percent of the world's rare earth elements. If China's ports were impacted by a natural disaster or choose not to export, world trade and the global economy would feel the repercussions.

In addition, some critical and rare minerals are by-products of much larger mineral operations, meaning that these by-products are vulnerable to market fluctuations. If the copper price falls, for instance, then the production of its critical by-products will also be at risk. Michelle Kerr | March 20, 2019 Risk and Insurance Magazine.

Building and testing risk: Risk of property damage or third-party liability arising from mishaps during building or testing of new plants. Cost overruns, project delays

Environmental risk: Risk of damage to the environment caused by the power plant, and the liability arising from such damage.

Quality and substitution risks: Risk of specified components being substituted with lower quality, non-standard compliant components by the contractor. Risk of substandard workmanship

DLP risks: Risk of non-completion of specified works resulting in sub optimal performance or damage.

Operational and maintenance risks

Operational risk: Risk of unplanned plant closure, for example owing to unavailability of resources, plant damage or component failure.

Spare parts supply chain risks: Risk of delays to plant repair and increased downtime due to spares being unavailable.

Fire: Risk of fire due to use of substandard materials or workmanship. Fire and Rescue departments across the country reported a significant increase in the number of fires associated with roof top solar installations. These fires have been initiated by a range of causes including wiring, improper DC isolators loose terminals, harnesses not plugged together properly, moisture ingress, insulation degradation either from impact, rodents or other animals and UV exposure.

Environmental risk: Risk of damage to the environment caused by the power plant, and the liability arising from such damage.

Weather-related volume risk: Risk of a fall in volume of electricity produced owing to lack of wind or sunshine.

Cyber security risk: Growth in connected devices (via the Internet of Things) and distributed energy resources is also expanding the potential cyberattack surface of electricity systems.

Climate change and natural catastrophe risk – Increasing temperature, hotter days variability in weather conditions can reduce the efficiency of solar generation. Risk of damage due to hail, wind, flood, or bushfire are also real risks.

Energy storage risks

Location risk: The location of the Battery Energy Storage System (BESS) presents risks to the BESS and adjacent structures. Poorly ventilated locations present a risk of ambient heat build-up. Location of a BESS within a building presents risks to the building arising from the potential for fire and explosion.

Fire and explosion risks: The risk of fire and explosion is a well-documented risk in relation to BESS installations, particularly those that utilise batteries containing organic electrolyte, typically used in Lithium-ion batteries. Fires are typically associated with thermal runaway events that might be initiated by chemical reactions, short circuits, heat build-up either internally or from an exposing fire, or a combination of these conditions. Addition of oxygen to a closed room where a thermal runaway has occurred, and a fire is progress can initiate an explosion and fireball.

Electrical risks: Batteries store energy and represent a significant electrical hazard if incorrectly designed, fabricated, installed, or operated. A BESS will have sufficient energy to cause an arc flash if it suffers a short circuit or fault. An arc flash can reach very high temperatures that can melt metal and cause fires and explosions. Higher battery energy storage capacities have a higher risk of severe arc flash.

Environmental and contamination risks: Some compounds produced during the failure of a cell can be extremely toxic. The clean-up, de-contamination and disposal of damaged equipment may require specialised equipment and skills.

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