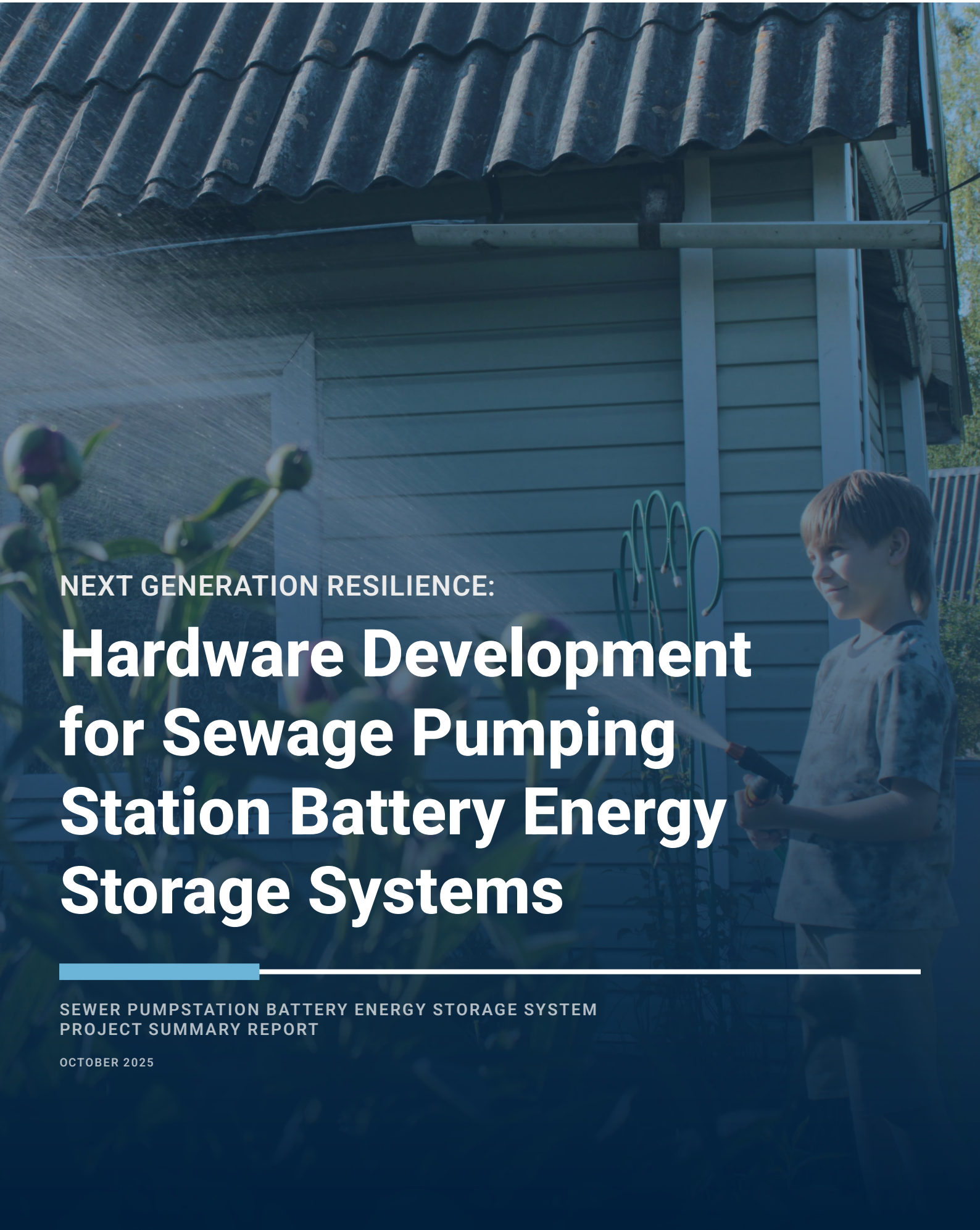
Shoalhaven Council's Water Utility WATER

SafeREnergy
ARC RESEARCH HUB FOR SAFE AND RELIABLE ENERGY

APQRC
AUSTRALIAN POWER QUALITY RESEARCH CENTRE

UNIVERSITY OF WOLLONGONG AUSTRALIA



NEXT GENERATION RESILIENCE:

Hardware Development for Sewage Pumping Station Battery Energy Storage Systems

SEWER PUMPSTATION BATTERY ENERGY STORAGE SYSTEM
PROJECT SUMMARY REPORT

OCTOBER 2025

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Executive Summary

This report represents the final project outcomes report for the University of Wollongong, as a research Node within the ARC Research Hub for Safe and Reliable Energy, together with their project partner Shoalhaven Water. The ARC Research Hub for Safe and Reliable Energy was created with funding from the Australian Research Council (ARC) and contributions from six Australian universities and ten industry partners. The SafeREnergy Research Hub aims to address safety and reliability issues, and environmental impact of current energy storage and conversion technologies. Expected outcomes include innovative integrated energy conversion and storage technologies and new energy materials and devices designed for different scale applications, benefiting the Australian economy, and potentially transforming the energy industry landscape.

Sitting within the new Energy Storage and Conversion Applications research stream of the Hub, the "Battery Energy Storage for Sewage Pumping Station Energy Resilience" was an innovative and highly collaborative project to field trial battery energy storage for municipal pumping stations. For a modest budget, over a three-year period the partners successfully developed, integrated, and deployed ten battery energy systems into small-scale utility pumping sites at Shoalhaven Heads. With tangible project outcomes, the project has substantially met its initial objectives.

For Shoalhaven Water, the project was conceived around four strategic outcomes, or themes, for its business operations.

The project has demonstrated these strategic outcomes, with further details of the project outcomes described in the following report. As a secondary outcome, the project resulted in significant knowledge transfer, practical learnings, and upskilling of staff across both organisations.

Background

Energy Resilience of Municipal Pumping Stations

Municipal water authorities in regional Australia are responsible for the drinking water supply and sewage treatment processing for towns and communities across a wide range of geographic regions and natural environments. The flooding and bushfire emergencies in NSW during recent years have highlighted the importance of resilient infrastructure, as the frequency of natural disasters increases with climate change. Failure of sewage pumping stations can lead to discharge of untreated sewage to the environment, with serious impacts for local communities. In the utilities sector there is an increasing appreciation of the complex interdependency between water and energy critical infrastructure, which is sometimes referred to as the water-energy nexus. At the same time, the electricity grid is undergoing a rapid decarbonization of energy generation, and an evolution of the electricity grid towards a distributed architecture. Electricity costs are a significant percentage of the operating costs for water utilities, which is driving an increasing investment in on-site renewable electricity generation, which combined with the use of energy storage technology allows for increased flexibility in the operation and scheduling of pumps, and enhanced resilience during grid failures. This is being enabled by technical advances in electrochemical energy storage, particularly for stationary applications such as critical infrastructure, with higher energy capacity and improved safety and reliability, along with the emergence of next generation digital technology for monitoring, control, and optimization.

Shoalhaven Water is the authority responsible for operating and maintaining the water distribution network (WDN), including water treatment and sewage infrastructure within the Shoalhaven City Local Government Area, on the South Coast of NSW. In a unique pilot project, the Australian Power Quality Research Centre (APQRC) at the University of Wollongong are collaborating in the design and trialling of innovative battery energy storage systems aimed at improving the energy resilience of sewage pumping stations. The pilot project has received funding from the Australian Research Council (ARC), Research Hub for Safe and Reliable Energy, which is promoting research into battery technologies that are focussed on enhanced safety and reliability. The pilot project is located at Shoalhaven Heads, which is a coastal community on the Shoalhaven River north of Nowra.

The project involves a three-year field trial of battery energy systems at ten pumping stations to evaluate the performance and resilience of various existing and emerging technologies, with active involvement of students and graduates across several research disciplines. Lithium-ion batteries are now a ubiquitous energy storage solution for stationary applications, commercially available for several decades and field proven with advantages that include a high energy density and round-trip efficiency. The first phase of the pilot project utilizes lithium-iron phosphate (LFP) technology which is a robust and safe battery chemistry well suited to this application. Due to concerns over the long-term cost and environmental impact of lithium extraction for battery manufacturing, research and commercialization efforts are focussed on sodium ion batteries as an alternative. Sodium has similar chemical properties to lithium, and the working principle of sodium ion batteries (SIB) is similar to lithium-ion batteries (LIB), though a significant advantage is the natural abundance of sodium compared to lithium. Due to these similarities, the manufacturing knowledge which was developed over many years for LIB can be applied to SIB. In the long term, it is expected that SIB can replace LIB for a wide range of applications.

PARTNERS

Shoalhaven Council's Water Utility WATER

SafeREnergy ARC RESEARCH HUB FOR SAFE AND RELIABLE ENERGY

APQRC AUSTRALIAN POWER QUALITY RESEARCH CENTRE

UNIVERSITY OF WOLLONGONG AUSTRALIA

Objectives

01 BESS Installations

Development of a robust, compact and inexpensive battery storage system platform which can be retro-fit into legacy pump control panels, with the ultimate aim to install Battery Energy Storage Systems at up to ten (no fewer than seven) Sewage Pumping Stations (SPS) within the catchment of Shoalhaven Heads, NSW.

02 Energy Storage Performance

Develop an understanding of the long-term performance, safety and reliability requirements for a sewage pumping station or distributed infrastructure deployment. This involves long term data gathering to monitor performance, such as energy throughput, capacity degradation rates, cell imbalance, alarms, and faults.

03 Operation and Control Strategies

Development of advanced operation and control strategies for distributed pumping stations using energy storage and variable speed drives. This addresses the problem of optimal operational management of distributed municipal pumping stations and aims to operate the system at the point of maximum efficiency and minimal O&M cost to the utility.

04 Grid Services

Investigation of grid-interactive modes of operation such as demand response, market participation, and other grid services, including the aggregated utilisation of distributed battery assets

05 Reslience-Based Frameworks

Extending conventional reliability-based planning and design methodologies based on probabilistic analysis by utilizing resilience-based frameworks for assessment of distributed infrastructure. Resilience includes notions of resourcefulness and adaptability, which are important when considering High Impact Low Probability (HILP) events, e.g., natural hazards.

Strategic Outcomes

Disaster Resilience

Coastal communities in rural and regional areas are often reliant on their power supply from long rural feeders, which are more prone to faults and power outages, often during storms or extreme weather events. As expected, over the course of the trial several pumping sites experienced unplanned power outages of up to several hours duration. Monitored site data by the network operators at the South Nowra control centre has confirmed that the battery energy systems successfully ran the pumps during these outages, and then transitioned automatically back to grid power after the outage.

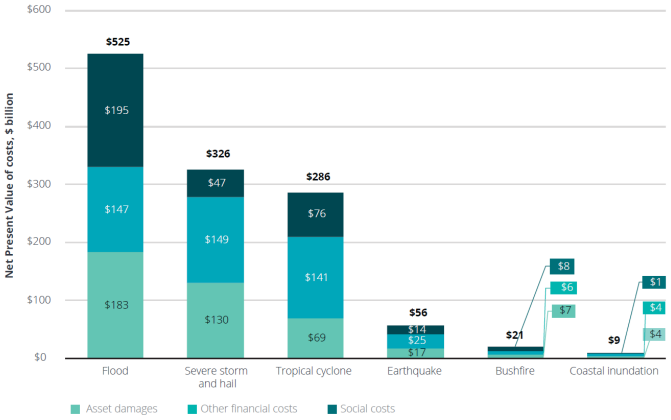


FIGURE 1. VALUE OF ECONOMIC COSTS OF NATURAL DISASTERS BETWEEN 2020-2060. OVER THE NEXT FORTY YEARS, THE COST OF NATURAL DISASTERS TO THE AUSTRALIAN ECONOMY IS EXPECTED TO BE AT LEAST $1.2 TRILLION IN PRESENT VALUE TERMS (DELOITTE ACCESS ECONOMICS REPORT, 2021).

Cost Savings

During extended power outages, it has been normal operating procedure for the water utility to deploy mobile diesel generation plant to run the pumps. This represents an accumulated business cost, which can amount to a significant expense for the utility over years. Cost savings include saving on staffing costs, usually out of hours which can become the predominant component for outages and includes individual call out costs, which are direct costs due to outages. Over the 3-year course of the field trial, the battery energy systems successfully mitigated against the need to despatch mobile diesel generators to the trial sites on several occasions. Cost savings can be difficult to quantify, annual financial reporting will ascertain the level of savings in operating expenses.

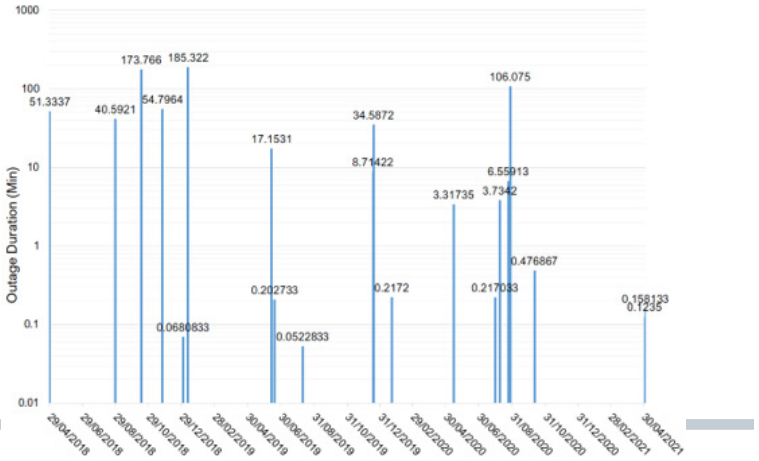


FIGURE 2. HISTORICAL POWER OUTAGES 2018-2021, MATTHEWS ST SEWAGE PUMPING STATION.

Strategic Outcomes

Student Pipeline

Over the three-year project duration, there was engagement and completion of three cohorts of Summer Scholarship Students. A total of eight students successfully completed the program. In each case, this involved a 12-week intensive research project, including a component of industrial experience, working on project activities. This included field work at the Shoalhaven Heads pilot sites. The summer students were co-supervised by APQRC staff and Shoalhaven Water personnel. The students gained real world insights into the operations of a water utility.

08 SUMMER SCHOLARSHIP STUDENTS

RESEARCH TOPICS

Strategic Outcomes

Energy Resilience

The project saw development of comprehensive and cost-effective battery energy storage systems (BESS) for sewage pumping stations. A diagram of the BESS is below. Using this arrangement the grid power consumption can be decoupled from the pump power, also enabling bidirectional power flow to the grid. The objective is to operate the system along the maximum efficiency curve and to minimize the energy consumption, and therefore operating cost, of the pumping station. The battery consists of ruggedized lithium iron phosphate cells (LFP), which in the future might be replaced with sodium ion batteries (SIB).

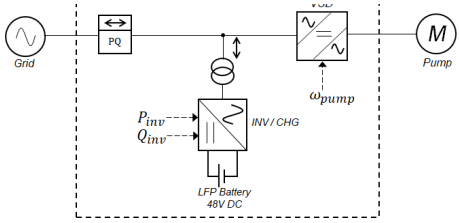


FIGURE 3. PUMP CONTROL SYSTEM BLOCK DIAGRAM.

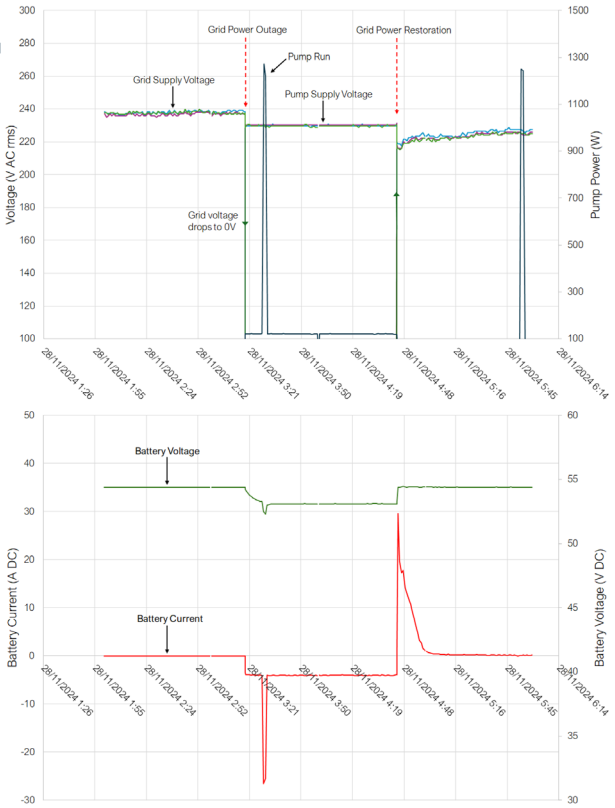


FIGURE 4. BATTERY ENERGY SYSTEM PERFORMANCE DURING A POWER OUTAGE, MATTHEWS ST SEWAGE PUMPING STATION.

Innovation

This project has involved innovation in several key areas:

- Modernization of control and asset monitoring systems at legacy sewage pumping sites that integrate battery energy storage systems.
- Modelling, analysis, and design of battery energy storage systems for sewage pumping stations.
- Development of a rapid deployment methodology for retrofitting energy storage systems to sewage pumping stations.
- Testing and operating regimes for pumping systems incorporating energy storage.
- The application of LFP batteries for energy resilience of sewage pumping systems.

Summary

> The BESSs project has delivered tangible benefits and real hardware improving infrastructure resilience, environmental protection, and regional innovation capacity.

In an innovative and unique pilot study, over a three-year period the project partners successfully developed, integrated, and deployed ten LFP battery energy storage systems into small-scale utility pumping sites at Shoalhaven Heads. This is the first such project by a water utility in Australia. For a modest budget and with tangible project outcomes, the project has met its design objectives. As a secondary outcome, the project resulted in significant knowledge transfer, practical learnings, and upskilling of staff across both organizations. Despite the fact that all sites are operational, there are a number of ongoing activities related to the project. The future work includes:

- Further integration of BESS information into the Shoalhaven Water SPS SCADA, including calculated metrics such as "expected battery time remaining", alarms, and an automated testing regime. Continued access to site data is required for the University of Wollongong.
- Battery capacity optimization and site re-allocation based on simulated testing across all sites. The purpose here is to determine optimal battery module numbers for each site and the inventory of spares that need to be maintained at the depot.
- Investigation of battery self-supplied and grid-interactive modes. This is contingent on negotiated electricity tariff arrangements at the sites.
- Further development of the SBRC pumping system demonstration panel and experimental BESS for the electrical test area within the building materials laboratory.
- Expansion of the pilot project to similar catchments such as Berry.
- Explore funding options for a doctoral student project, with an industry-focussed topic related to battery storage and pumping systems.

IMPACT OF BESS IMPLEMENTATION

Recent power outages have demonstrated the effectiveness of the newly implemented Battery Energy Storage Systems (BESSs) across Shoalhaven Heads sewer pump stations. Previously, operational staff were required to manually visit up to 10 sites with a generator, prioritizing each station to prevent overflow and maintain service continuity.

PROJECT BENEFITS & OUTCOMES

The project successfully evaluated the performance, safety, and reliability of developed battery technologies and compared emerging technologies with commercially available systems. Undergradute research placements were supported by the project, strengthening industry-academic collaboration. The project saw enhanced operational efficiency and service continuity for Shoalhaven Water and established a blueprint for expansion of the design to other Shoalhaven Water critical assets.

Additionally the project has provided energy resilience for Shoalhaven Water assets, increased industry-academic collaboration for UOW and partners, a testing bed for future battery technologies and summer placements for undergraduate students.

Ultimately, the project has delivered tangible benefits with a minimum resilience of 4 hours of backup power per site during grid outages, reducing the risk of sewage overflows and service disruptions.

Shoalhaven Water
A Group of Shoalhaven City Council

Project Title:

Sewer Pumpstation Battery Energy Storage System

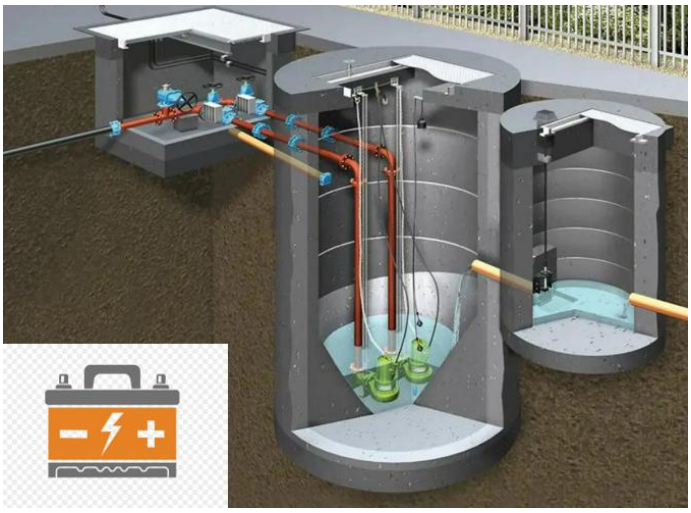
Next Generation Resilience

IMPACT STATEMENT

Summary:

Shoalhaven Water, in collaboration with the University of Wollongong and the ARC-funded SafeREnergy Hub, has delivered a pioneering energy resilience initiative by installing ten Battery Energy Storage Systems (BESS) at sewer pumpstations in the Shoalhaven Heads catchment.

The project has delivered tangible benefits a minimum resilience of 4 hours of backup power per site during grid outages, reducing the risk of sewage overflows and service disruptions.



Project Outcomes

1. Provided a minimum of 4 hours of backup power per pumpstation during grid outages.
2. Evaluated the performance, safety, and reliability of developed battery technologies.
3. Compare emerging technologies with commercially available systems.
4. Supported undergraduate research placements, strengthening industry-academic collaboration.
5. Establishment of a living testbed for future battery innovations.
6. Enhanced operational efficiency and service continuity for Shoalhaven Water.
7. Blueprint established for expansion of the design to other Shoalhaven Water critical assets

Project Benefits:

- Energy resilience for Shoalhaven Water Assets
- Increased industry-academic collaboration with UOW and other partners
- Test bed for future battery technologies
- Summer Placements for undergraduate students

Project Team:

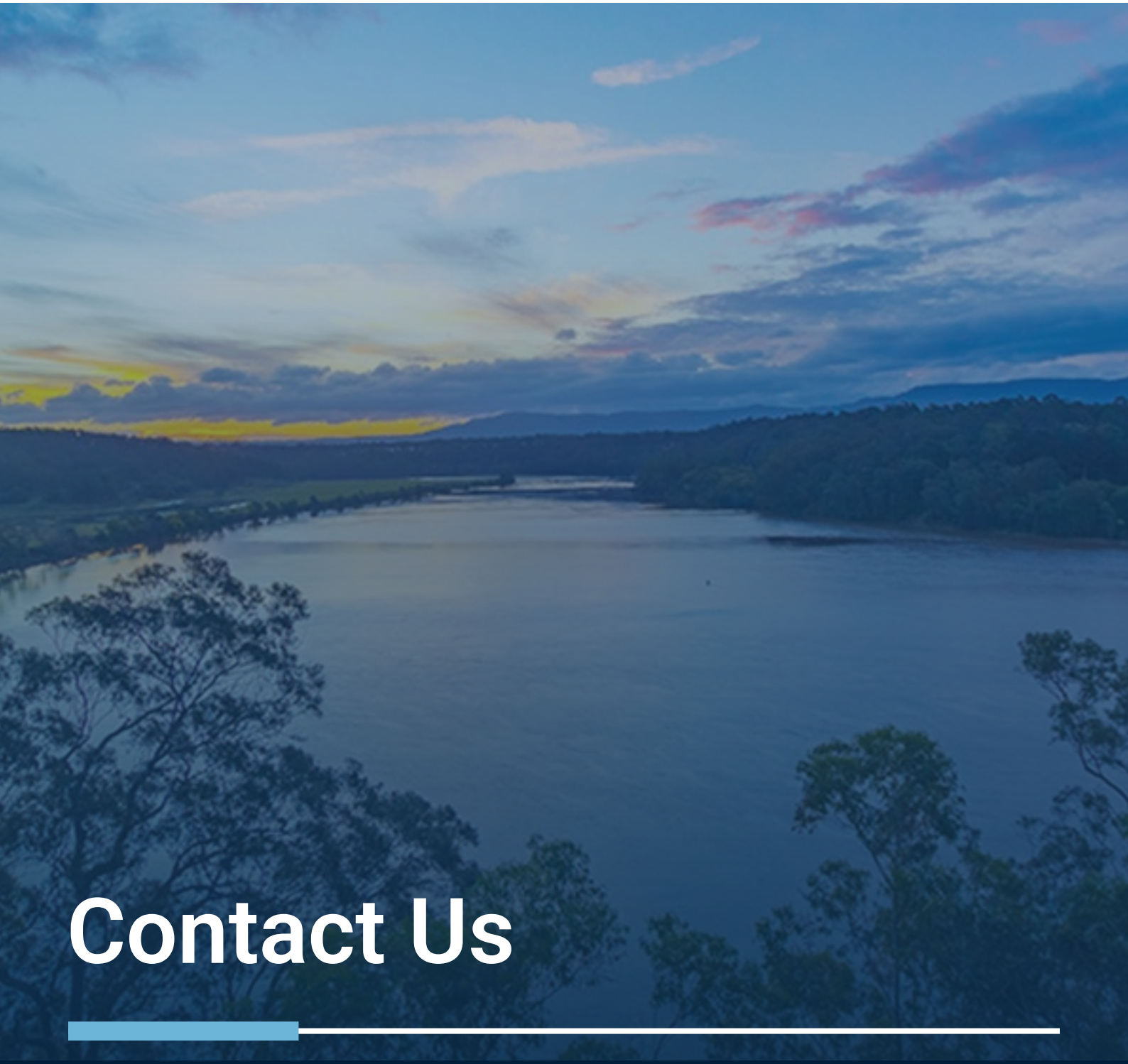
Andrew McVey, Section Manager, Water Operations and Maintenance
Allan Gilkes, Unit Manager, Digital Control
Craig Ellis, Unit Manager, Mechanical/Electrical,
Andrew Truran, Business Analysis Consultant
Duane Robinson, Director, *APQRC*
Sean Elphick, Research Coordinator, *APQRC*
Edward Smith, Research Fellow, APQRC

Shoalhaven Water *University of Wollongong*
APQRC - Australian Power Quality and Reliability Centre

Impact of BESS Implementation on Sewer Pump Station Operations

Recent power outages have demonstrated the effectiveness of the newly implemented Battery Energy Storage Systems (BESSs) across Shoalhaven Heads sewer pump stations. Previously, operational staff were required to manually visit up to 10 sites with a generator, prioritizing each station to prevent overflow and maintain service continuity. 4

With the development of the BESSs project has delivered tangible benefits and real hardware improving infrastructure resilience, environmental protection, and regional innovation capacity.



Contact Us

SHOALHAVEN WATER

(02) 4429 3214

shoalwater.nsw.gov.au

AUSTRALIAN POWER QUALITY RESEARCH CENTRE

(02) 4221 4737

uow.edu.au/apqrc

pqrc@uow.edu.au