Off-grid power solution for water chlorination in Logan City – An Australian first

City of Logan

LOGAN CITY COUNCIL

Contents

Entry form

Awards for Excellence 2018

Nomination Form

Logan City Council

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ADDRESS

Off Grid Power Solution for Water Chlorination in Logan City - An Australian First

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I submit an application for the following award:

- ○ Innovation
- ○ Sustainability
- ○ Teamwork
- ○ Collaboration
- ○ Community Shaping
- ○ 'Doing more with Less'
- ○ Workplace Wellbeing
- ○ Above and Beyond*

*The individual nominated for the Above and Beyond Award does/does not know they have been nominated.

Entry Form and Fee

An ***Entry Form*** must be completed with each submission. There is an initial entry fee of $250.00 and $200.00 for subsequent entries for councils who wish to submit multiple entries. A tax invoice will be issued upon receipt of the nomination.

Submission Requirements

Entries must be received in full by 5.00pm on Thursday, 8 March, 2018. The delivery address is: Administration Officer – Excellence Awards, LGMA Queensland, Level 7 Quay Central, 95 North Quay, Brisbane, Queensland 4000. The email is admin@lgmaqld.org.au.

Entries must include: Four (4) hard copies, One (1) electronic copy and 3-5 high-resolution photographs

Nomination Checklist

- ✓ I have attached four hard copies of each Entry; and
- ✓ I have attached (USB) or emailed at least one electronic copy of each Entry together with 3-5 high-resolution photographs; and
- ✓ I understand that parts of the nomination, including photographs, may be used in LGMA Qld promotion and advertising relating to the Awards and also in LGMA Qld member publications.

Nominator:

NAME	TITLE	SIGNATURE
Daryl Ross	A/Director Road and Water Infrastructure	

Project overview

This micro power grid and electro-chlorination system is an Australian first

Logan City Council has combined emerging solar power and battery storage technologies to deliver a reliable, safe solution for water disinfection at a 20ML reservoir in the City of Logan's fast growing south west.

The $3 million solution, which includes two 2.2kg/h electro-chlorinators powered by 323 solar panels and a 95kwh capacity Tesla Powerpack, is maintaining local drinking water quality 24 hours a day. This micro power grid and electro-chlorination system is an Australian first application.

Council's Logan Water Infrastructure Alliance (LoganWIA) identified the solution for water disinfection at Round Mountain Reservoir. LoganWIA is a public and private sector enterprise involving Council, Downer, Cardno and WSP.

Key challenges for LoganWIA were that the reservoir is not serviced by a sealed road and the nearest electricity supply is 3.9km away. Wet weather access along the 3.1km access track is limited.

LoganWIA's assessment of water disinfection options concluded that the most sustainable solution was electro-chlorination with 28 days of brine storage (salt water used for chlorination) on site. A key advantage was that salt could be delivered using a 4WD vehicle on the existing unsealed track; eliminating a major road upgrade. The regime would be powered using solar panels on the reservoir roof, with energy stored in a battery inside the control room.

The project achieved a $1.9 million capital cost saving and almost $50,000 in annual operational cost savings for Council. It also delivers on a key priority in Council's *Corporate Plan 2017–2022 – "a carbon neutral and green city".*

Round Mountain Reservoir showing the relatively remote location at present

Nomination

Category statement

Few infrastructure projects can be truly called ‘cutting-edge’. However, Logan City Council’s decision to move beyond conventional technologies to improve water quality for residents in a rapidly growing part of the City of Logan is just that.

The Round Mountain Reservoir water chlorination project combines solar power, commercial battery storage technology and an electro-chlorination process. This is an Australian first application. It was the first off-grid system powered by Tesla Powerpack products in the country, and the first known installation of large capacity electro-chlorinators to treat a public water supply network nationally.

Features of these cutting-edge technologies, as applied at Round Mountain Reservoir, include:

Solar array: On the reservoir roof, 323 photovoltaic solar panels generate 87kW of energy in peak periods.

As the roof was not originally designed to take the weight and wind load of solar panels, careful design of the panel layout and walkways was needed to ensure the arrangement met structural design code requirements.

The solar array is sized to capture at least seven hours of sunlight a day and generate enough power to produce 32kg of chlorine a day for water disinfection.

Tesla Powerpack: Unlike residential battery systems, the Tesla Powerpack is a scalable storage solution for commercial applications. The battery at the reservoir has a capacity of 95kWh, and the unit runs automatically with minimal maintenance. It incorporates a cloud-based battery management system to balance energy demand and supply and is sized to allow two electro-chlorinators to run non-stop in all weather, if required.

Electro-chlorination: An electric current is applied to salt and water (brine) using an electrolyser and rectifier, creating a weak solution (0.6%-0.8%) of sodium hypochlorite and hydrogen gas. With the gas removed, dosing pumps deliver sodium hypochlorite to reservoir outlet water to disinfect it. At full production, the system uses 1,000kg of salt a week. The on-site brine tank holds 28 days’ supply before topping up, with four weeks of bagged salt also stored on site.

The use of these technologies did not represent the lowest capital cost of all options that LoganWIA considered (described in the next section). However, the solution was considered the most sustainable as it offered the best overall Net Present Value (NPV) due to lower operational and maintenance costs over the minimum 10-year design life of the infrastructure.

Delivery of the project itself was efficient, with all project milestones met and delivery of the project completed within budget. The project's planning phase began in February 2015, with commissioning of the new electro-chlorinators, solar array and Tesla Powerpack completed by December 2017. The project cost was $3 million.

Achievements and outcomes

In 2014, the 20ML Round Mountain Reservoir was activated to provide drinking water for residents in Flagstone, Yarrabilba, North Maclean, Spring Mountain and Woodhill. These suburbs are part of the City of Logan's fast growing south west region which features two Queensland Government-designated Priority Development Areas.

Technical achievements

As these areas will not be fully developed in the next decade, water from Round Mountain Reservoir was being retained in the network longer than is desirable. Council was concerned that nitrification of the network was resulting in low residual chloramine concentrations and a water quality that did not meet desired standards of service. Water testing confirmed this, and a solution for supplementary dosing to provide a free chlorine residual was required.

LoganWIA conducted a *Chlorinator Options Study* in 2015/16 to identify and assess several disinfection regimes from technical and whole-of-life cost perspectives. Key considerations for LoganWIA were that the reservoir is not serviced by a sealed road and the nearest electricity supply is 3.9km away. Wet weather access along the 3.1km access track is limited, with Council vehicles regularly becoming bogged.

The unsealed access road to Round Mountain Reservoir

Technical achievements

Four options were considered for chlorine dosing at Round Mountain Reservoir: sodium hypochlorite, electro-chlorination, chlorine gas and calcium hypochlorite. Chlorine gas was ruled out as a potential disinfectant at the project's initial stakeholder workshop due to health and safety requirements, and Council operators' lack of experience with chlorine gas systems. The remaining options were:

- Option 1: Sodium hypochlorite dosing with on site chemical storage, potentially with a new 3.1km sealed access road
- Option 2: Electro-chlorination (dosing of sodium hypochlorite which is made on site using salt) with on site brine storage, potentially with a new 3.1km sealed access road
- Option 3: Calcium hypochlorite dosing with on site chemical storage and a new 3.1km sealed access road

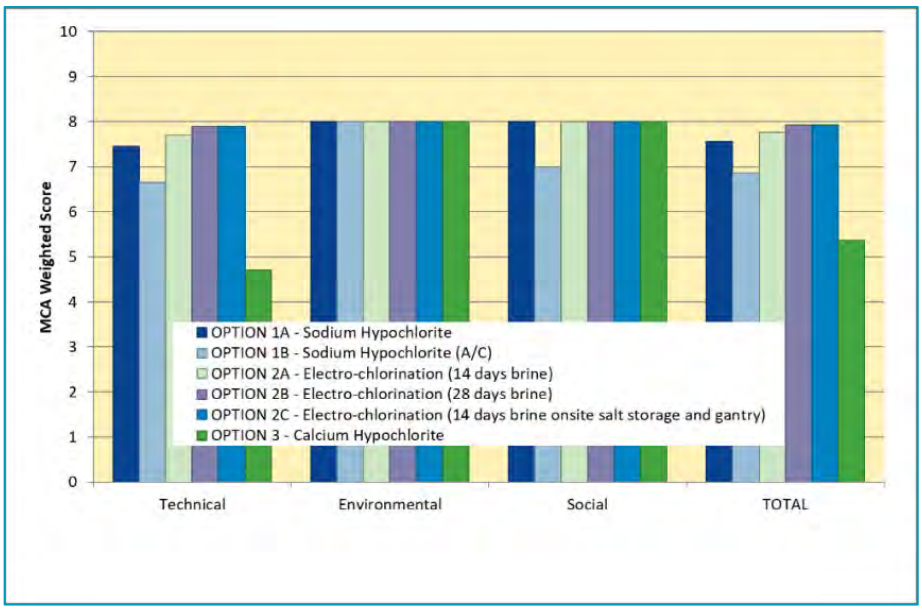
Several sub-options were considered which included variations on chemical or brine storage capacities on site and associated road upgrades to improve the reliability of chemical deliveries. Power sources were also investigated but it was recognised that mains power was unlikely to be available within the minimum 10-year design life of the infrastructure. As such, solar panels were identified as the most appropriate energy source.

All sub-options were evaluated to determine the most cost-effective, reliable solution for Council. This included a financial analysis of options and a non-cost Multi-Criteria Assessment (MCA) to evaluate reliability, water quality, incident risk, vulnerability, operational health and safety, operability and maintainability, constructability, and construction and operational impacts on the environment and community. The table below shows the results of the financial evaluation and the graph on the next page shows the MCA results as agreed by stakeholders at the project's MCA workshop.

Capital cost and 10-year NPV comparison (2016 $AU)

	OPTION 1A *Sodium hypochlorite, 14 days storage, road upgrade*	**OPTION 1B** *Sodium hypochlorite, 14 days storage, no road upgrade*	**OPTION 2A** *Electro-chlorination, 14 days brine storage, road upgrade*	**OPTION 2B** *Electro-chlorination, 28 days brine storage, no road upgrade*	**OPTION 2C** *Electro-chlorination, 14 days brine storage, extra salt storage, no road upgrade*	**OPTION 3** *Sodium hypochlorite, 28 days brine storage, no road upgrade*
Total Capital Cost (2016 – 2025)	**$3,314,760**	**$1,389,848**	**$3,918,221**	**$1,603,290**	**$1,597,290**	**$3,145,308**
Capital NPV	$3,298,958	$1,345,872	$3,903,718	$1,588,787	$1,582,787	$3,133,312
Operation and Maintenance NPV	$1,457,420	$1,463,810	$1,054,270	$996,520	$1,054,270	$4,006,230
Total NPV	**$4,756,378**	**$2,809,682**	**$4,957,988**	**$2,585,307**	**$2,637,057**	**$7,139,542**

Technical achievements



Multi-criteria analysis results summary

LoganWIA's *Chlorinator Options Study* concluded that the most reliable, safe and cost-effective option was an electro-chlorination regime with 28 days of brine storage and no road upgrade (Option 2B). This option required a solar power supply system, electro-chlorinators, water quality analysers and a chlorine dosing system to produce at least 32kg of chlorine per day to treat up to 12.7ML/d of chloraminated water. Council approved the new system for design and construction in 2016/17.

During the subsequent design, construction and commissioning period (concluding in December 2017), technical challenges were overcome to achieve a balance between cost and reliability of the system. The five main challenges and outcomes were:

- **Availability of sunlight throughout the year** to meet the average 198kWhr/day power demand of the new water chlorination system. Modelling showed that late summer was a critical period when water temperatures were high, chlorine levels were low and sunlight hours were shortening. During a day in this period, high solar power outputs could be achieved in the middle of the day but fell off sharply in the morning and afternoon. To address this, LoganWIA decided to install two smaller capacity electro-chlorination units rather than one very large unit to maximise the hours of operation. This allowed the first unit to start up as soon as there was sufficient output from the solar array.

- **Design of the solar array** to be secure and cost-effective. LoganWIA determined the only secure location for the solar panels was the reservoir roof. However, as the roof was not originally designed to accommodate solar panels and access walkways, structural assessments and clever design were required *(cont.)*

Technical achievements

The number of panels was increased slightly (to 323 panels) to offset performance reductions due to them being installed flat on the roof, and the panels were offset from the ideal north/south configuration. Increasing the number of panels was cheaper than placing them on stands with the perfect orientation. The array can produce 87kW of power, and space has been left to add extra panels in future.

- **Performance and cost of battery storage** to store energy for the new chlorination system. The original design concept considered lower capacity electro-chlorinators running 24 hours a day to produce the 32kg of required chlorine. This concept was scrapped when the battery capacity needed to operate these high-powered devices was estimated. A more cost-effective approach was to produce sufficient chlorine during daylight hours using larger capacity electro-chlorinators. When only the site's water analysis and chlorine dosing equipment was operating, power demand dropped from 198kWh to 26kWh. As such, it was decided that sufficient battery storage was needed to operate the facility on low power mode for up to three days with no feed in from the solar array. A 95kWh Tesla Powerpack commercial battery was installed to meet this demand.

- **Performance and cost of electro-chlorination** to produce 32kg of chlorine using eight hours of sunlight per day. Large capacity electro-chlorination facilities are uncommon in Australia and this is the first known installation to treat a public water supply system. The initial request for proposals offered to the market asked for a 4kg/hr electro-chlorination unit to produce 32kg of chlorine using eight hours of sunlight per day. Negotiations with vendors investigated the option of duty/duty arrangements to take advantage of solar power generation at the morning and evening limits of each day. Changing the configuration from one 4kg/hr electrolyser to two 2.2kg/hr electrolysers resulted in a 25% increase in the cost of the required electro-chlorination capacity. This option was preferred as it provided some redundancy when the electro-chlorination system was not being operated at full capacity.

- **Cost of chemical storage** at the reservoir site. The production of chlorine on site depends on bright sunlight. As such, the chlorination system is at risk of failure if the volume of stored chlorine is depleted in an extended period of low sunlight. LoganWIA conducted a storage tank mass balance analysis to estimate the frequency of failure of various tank storage sizes using historical sunlight data obtained over the last 16 years. The analysis found that increasing the tank storage from three days of storage (12,000L) to five days of storage (20,000L) reduced the frequency of storage depletion from 5.3 events a year to 2.5 events per year.

Impacts on Council and the community

This innovative project has had many positive impacts on Logan City Council and community members in the city's south west. Key impacts are described below.

Economic impacts

- A value for money project, with $1.9 million in capital costs and $50,000 per year in operating costs saved compared with more conventional options. Cost savings allow Council to redirect funds to other vital programs.
- A robust facility which will operate for at least a decade and support the development of Queensland Government Priority Development Areas (PDAs). These PDAs will become a new economic hub in the region, with housing and jobs for 200,000 people.

Social impacts

- A continuous supply of high quality drinking water. Reliability comes from the battery back-up (at least three days' power supply) and storage of 28 days of brine, bagged salt and five days of sodium hypochlorite on site.
- No direct access to the solar panels on the reservoir roof, avoiding risks of vandalism or theft.
- A safer work environment for Council operators, with no high voltage equipment and use of salt, not chemicals, for chlorination. The electro-chlorinators produce low strength hypochlorite which is not classified as a hazardous material by Safe Work Australia.

The Tesla Powerpack battery inside the reservoir control room

Impacts on Council and the community

- No construction of a 3.1km road to the reservoir, which could cause disruption to surrounding residents and local traffic.
- Minimal ongoing traffic impacts, as salt can be delivered to the reservoir using a standard 4WD vehicle (not chemical tankers).

Environmental impacts

- Use of 100% solar energy to operate the chlorination system, avoiding depletion of finite resources.
- A sustainable asset that does not create greenhouse gas emissions, and delivers on Council's *Corporate Plan 2017-2022 Priority GR1: "A carbon neutral and green city".*
- No wildlife habitat removal for road construction or powerline installation.

Reputational impacts

- A positive national media and industry profile for Council, with articles in mainstream newspaper, television and online publications (an example is provided in the Appendix) and engineering, water, energy and sustainable development magazines and online publications.
- Interest in the project by peak industry bodies such as the Climate Council as part of its Cities Power Partnership. Representatives of the Climate Council visited Round Mountain Reservoir with City of Logan Mayor Luke Smith in early 2018 to learn more about the project, with a view to promoting Council's approach to other local government organisations.

One of the two electro-chlorinators at Round Mountain Reservoir

How outcomes were measured

LoganWIA and Council's water network operations team have directly measured several key outcomes of this project using quantitative methods. These methods and outcomes are summarised below.

Cost-related outcomes

- **Capital cost savings** were measured as part of a capital cost and 10-year Net Present Value (NPV) comparison of options in 2015/16. An estimated $1.9 million capital cost saving was achieved compared with other more conventional chlorination options which required a road upgrade for chemical deliveries.

- **Operational cost savings** were also measured as part of the capital cost and NPV comparison. There was approximately $50,000 in annual operating costs saved due to the use of solar power, not mains power, to operate the chlorination system.

Non-cost related outcomes

- **A high quality, safe water supply for residents** was measured via routine water quality testing in the Round Mountain Reservoir water supply zone. The new chlorination system has maintained chlorine dosing 24 hours a day since commissioning. This has resulted in chlorine residuals being detected for the first time in many parts of the Logan South water supply zone, significantly reducing any potential health risks to consumers.

- **Reliable provision of chlorinated water** was measured during commissioning testing and regular monitoring of equipment, inputs and outputs during operation of the new infrastructure. The combination of solar panels and Tesla Powerpack is exceeding Council's expectations in terms of the reliability of the system. Since commissioning, the charged battery capacity has never dropped below 65kW despite overcast weather, and it generally does not fall below 70kWh by the end of the night time draw down. There has been a slight degradation of maximum charge over time. However, this is expected and charging rates will be monitored over time to ensure that the performance remains within specifications. A standby generator for the system is unlikely to be required in the short to medium-term.

  Similarly, the electrolysers are producing sodium hypochlorite at the manufacturer's recommendation of 0.6% concentration and the two electrolysers are producing sufficient sodium hypochlorite to meet daily chlorine dosing requirements. The chlorination facility's control system calls for production of sodium hypochlorite as soon as the storage tank drops below 95% and the Tesla Powerpack has reached 75% of full charge.

This normally takes place about 30 minutes after sunrise. The only time the electrolysers have worked at full capacity was during commissioning.

The success of the solar powered electro-chlorination system can also be measured by the reliable availability of chlorine in the chemical storage tank. The mass balance analysis undertaken during the design phase had predicted that there would be days of significant draw down on stored chemicals when overcast weather prevented the operation of the electrolysers. The analysis predicted that the storage would be depleted two or three times a year when running at full capacity. In practice, Council operators have found that the number of solar panels provides sufficient power to charge the battery even in poor weather. This allows at least one of the electrolysers to operate for a few hours each day, maintaining good levels of chlorine in the storage tank. The level in the tank has not fallen below 70% since commissioning.

- **Operator safety** was measured via LoganWIA and Council workplace health and safety monitoring (project-based and ongoing). No Lost Time Injuries occurred at Round Mountain Reservoir during the delivery of this project or subsequently during operation of the new infrastructure.

Current status

The new water chlorination system at Round Mountain Reservoir was commissioned in stages between October and December 2017. All aspects of the system have operated efficiently since this time, with chlorine dosing maintained 24 hours a day.

Routine water testing has detected chlorine residuals for the first time in many parts of the Logan South water supply zone – exactly the outcome Council was looking for. As noted in the previous section, performance of the solar panels and Tesla Powerpack have so far exceeded Council's expectations. Similarly, the electrolysers are producing hypochlorite in line with specifications, and levels of available chlorine in the chemical storage tank have not fallen below 70%.

The black storage tank holds five days' supply of hypochlorite

Ability to transfer the initiative to other areas or Councils

This initiative is immediately transferrable to other Councils and water utilities around Australia.

As Logan City Council has demonstrated, using solar power and commercial battery storage technologies to power public infrastructure delivers energy security, protection against rising commercial electricity prices, and value for money in the mid to longer-term. It also aligns with many Councils' corporate objectives to help the nation meet its international greenhouse gas emission reduction targets.

One way for Councils to take a step towards off-grid power solutions for infrastructure is to participate in the Climate Council's Cities Power Partnership, as Logan City Council has. This free national program, launched in July 2017, already has 70 member Councils. The partnership facilitates knowledge sharing between Councils and provides training opportunities, access to national and international experts, and identifies potential grants and renewable energy incentives. It also provides a platform to share success stories about energy efficiency, renewable energy, and carbon offsetting to a national audience.

Why this project stands out

The Round Mountain Reservoir micro-power grid and electro-chlorinator is an Australian first application. Council's LoganWIA has demonstrated that emerging technologies can be harnessed by the public and private sectors to achieve cost-effective, whole-of-life solutions for utilities.

The project has received national media attention for its ground-breaking nature and contribution to sustainable infrastructure. This has included recognition by the Climate Council as part of its Cities Power Partnership program.

Stand out attributes of the Round Mountain Reservoir chlorination project include:

- A reliable off-grid power supply and chlorination system to maintain drinking water quality 24 hours a day for at least a decade.
- A sustainable asset that does not create greenhouse gas emissions, and delivers on *Council's Corporate Plan 2017-2022 Priority GR1: "A carbon neutral and green city".*
- High reliability due to the 28 days of brine storage, bagged salt storage and five days of sodium hypochlorite storage on site, and battery back-up power for the dosing equipment.

- Value for money, as the $1.9 million capital cost of upgrading the 3.1km access track to the reservoir was avoided.
- Low operational costs – at least $50,000 a year less than other options – as solar power provides 100% of the energy needed to run the electro-chlorinator.
- A low maintenance asset which is safe to operate.

Close up of the solar array and walkways on the top of the reservoir roof

Media release

Cutting edge technology provides off-grid power solution in Australian first

Logan City Council has combined emerging solar power and Tesla Powerpack to deliver a reliable, safe solution for water disinfection in the city's fast growing south west corner.

In a project delivered by Council's Logan Water Infrastructure Alliance, Australia's leading battery and solar provider, CSR Bradford, has installed the first off-grid system powered by Tesla Powerpack products in Australia for any application. The project has already delivered the Logan City Council a capital cost saving of $1.9 million and operational cost savings valued at almost $50,000 per year.

The Tesla-supported micro-power grid and electro-chlorinator is providing around the clock solar-power to help maintain local drinking water quality 24 hours a day. Up to 200,000 people will benefit from the solution by the time the region is fully developed.

City of Logan Mayor Luke Smith said innovation was high on Council's agenda and Council was committed to leading by example and turning words into action.

Mayor Smith said the 20 Megalitre Round Mountain Reservoir was brought into service in 2014 to provide drinking water for residents in Flagstone, Yarrabilba, North Maclean, Spring Mountain and Woodhill.

"This is set to be one of the fastest growing areas in South-East Queensland over the next two decades but with that growth comes the issue of building assets larger than are needed right now," Mayor Smith said.

"We were concerned until demand increases, water stored in the network may age and not stay at the highest possible quality.

"We decided there was a need for a dedicated water chlorination station at the reservoir.

"The reservoir site is not connected to mains power or accessible via a sealed road so an innovative approach was required to maintain water quality from the reservoir."

Mayor Smith said a number of options were investigated, with a solar powered electro-chlorination facility confirmed as the preferred technology and CSR Bradford was engaged to supply and install the system.

CSR Bradford Business Manager, Ashleigh O'Brien said the project was the first off-grid commercial solar and battery system in Australia powered by Tesla Powerpack, and showcased the growing potential for Australian assets to achieve energy security through solar and battery technology.

"CSR Bradford is incredibly proud to be playing its part in providing a solution which will see solar and battery technology play a greater role for commercial assets" she said. "The electro-chlorinator is powered by 323 solar panels and a 95kWh capacity Tesla Powerpack, that will help provide water quality 24 hours a day".

Appendix

Australian Financial Review article

Logan Council takes its water 'off-grid'

Mark Ludlow's article in the *Australian Financial Review* on 27 September 2018 (extracted below) is an example of the national interest in this project.

Logan Council takes its water 'off-grid'

Logan City Council mayor Luke Smith had a dilemma when trying to connect the city's new water treatment system to the electricity grid: spend $2 million to connect the chlorination plant to Queensland's electricity network or the council could go "off-grid".

Logan Council, which looks after 300,000 residents in the fast-growing city between Brisbane and the Gold Coast, decided to ditch the grid and install Australia's first off-grid solar and battery system power by Tesla Powerpack.

Apart from projected savings of $50,000 a year in operating costs, the 323 solar panels and 95-kilowatt-hour capacity battery has opened up new possibilities for local councils and government agencies across the country who want to take the edge off rapidly increasing power bills.

"For us, to have this technology in early allows us to continue that innovation phase as we deliver sewage treatment plants of the future or more reservoirs like this for our growing population," Councillor Smith told *The Australian Financial Review*.

We have to find solutions like this in isolated areas for the protection of water for our residents. It's set up as a self-contained micro-power grid."

The Tesla Powerpack system for the 20-megalitre Round Mountain Reservoir and water treatment and chlorination system was delivered by battery and solar provider CSR Bradford and will be officially commissioned by Logan City Council on Wednesday.

The reservoir does not need power to pump water to local residents – using the height of the reservoir to push the water through the pipes – only for the chlorination process which costs about $50,000 a year. The $1.9 million capital cost included connecting to the grid as well as road infrastructure to the site.

With Logan expected to experience population growth of 37 per cent over the next 20 years, Councillor Smith said the council, through its Logan Water Infrastructure Alliance (a public and private sector enterprise involving Logan City Council, Downer, Cardno and WSP Parsons Brinckerhoff), would be looking to use off-grid solutions for more water treatment plants.

All our sewage and water treatment plants are energy intensive and we spend quite a lot of money on them. For us to start on a small project like this to keep it off the grid is actually giving us a way forward that we can make those larger plants more cost effective and energy efficient. It has become a test case for other facilities we are going to build," he said.

"This will be an example to other councils around Australia, whether it be regional councils or councils in the city that need to save some dollars. But it certainly does provide solutions for councils that aren't near as much electricity as we are."

Local Government Association of Queensland executive director Greg Hallam said they were helping the 77 councils across the state become smarter with their energy use, including 21 sites for geothermal and solar thermal facilities. Through their own company, the first geothermal facility in Winton in Central West Queensland will be opened in December which will allow all council assets to be taken off-grid, with another four sites to follow in 2018.

"Energy is a massive cost for councils. We have taken the rights to all geothermal power in Queensland so we're an energy company in our own right now," he said.

A report by solar consultancy SunWiz last week found households were embracing battery storage with 7000 (with a total capacity of 55 megawatts) installed in the first half of this year – a figure expected to more than double in the second half of the year to a total of 17,500 – despite the price point not dropping as quickly as roof-top solar systems.

CSR Bradford business manager Ashleigh O'Brien said companies were starting to move to battery and storage units to counter double-digit price rises in recent years.

"We're getting a lot more interest from companies. I think it's likely to follow the trend of residential storage products," Ms O'Brien said.

"Business owners are also facing rising energy costs and looking at ways to reduce their running costs. As solar and battery solutions come down I think those offers are becoming more attractive.