

For Official Use Only

Final Report

Smart Cities and Suburbs Program

Project number	SCS59454
Grantee name	Curtin University
Project title	Resilient Energy and Water Systems, Fremantle
Progress period	17/11/2017 to 19/06/2019

1. Eligible Expenditure Summary

- a. Please provide a breakdown of expenditure for the reporting period. All figures should be rounded to the nearest dollar.

Evidence: A more detailed spreadsheet of actual expenditure items and invoices, receipts etc. should accompany this report.

	Eligible Expenditure Expenditure on eligible items as described in section B of the Grant Agreement and 5.5 in the Programme Guidelines (\$, GST excl.)	Project Investment Eligible expenditure + any ineligible project-related expenditure (such as in-kind contributions) (\$, GST excl.)
Total - Project	\$7,519,432.92	\$7,899,419.85

- b. Is the expenditure incurred for this project in accordance with the project budget in the grant agreement?

Yes No

If no, explain the reason and planned remedies for any underspend or overspend.

Planning approval conditions created a delay to construction beginning on site at Knutsford Lot1819 for the East Village civil works.

The City of Fremantle's King Square admin building has not progressed to an appropriate stage for RENEW Nexus project inclusion within the RENEW Nexus project timeline therefore previously committed contribution was not available.

2. Project Activities

a. Please complete the following table.

No	Milestone Title and description	Agreed completion date	Actual /anticipated completion date	Milestone progress (% complete) as at reporting period
1	Project Start	17/11/2017	17/11/2017	100 %
2	Project Initiation	29/06/2018	29/06/2018	100 %
3	Procuring and Testing Systems	31/10/2018	31/10/2018	100 %
4	Bringing together the Sustainable Assets and Harvesting the Data	28/02/2019	28/02/2019	100 %
5	Metrics Analysis and Water Systems Under Construction	1/05/2019	1/05/2019	100%
6	Project Completed	22/05/2019	22/05/2019	100 %

b. Were all the activities as specified in the grant agreement completed?

Variations noted below

Yes No

If no, explain why.

Variations as referred to in key eligible activities

No 3 Smaller battery bought after modelling the location site (1 MWh to 670 kWh)

No 3 Solar Kings Square (100kW) fell outside the project timescale

No 4 Installation of 14 buildings (500 kW) replaced by P2P trading of 20 prosumers and consumers with existing solar but new monitoring across Fremantle

No 4 Water trading modelled and prepared through to Proof of Concept. No actual water trading before the end of project.

c. Briefly outline the key project activities.

The RENew Nexus Plan Trial

- Up to 40 households are trading solar PV energy generated from their own rooftops with their neighbours in this new blockchain-enabled trial, across the regulated grid in the City of Fremantle.
- We think these households are among the first in the world to be taking part in a trial of this kind where households are given the flexibility to determine how much they are willing to buy and sell solar energy for, and then make the real time purchase via the platform.

- Power Ledger's technology, using the blockchain, creates a marketplace where customers can buy and sell electricity from and with each other whilst setting the prices they choose.
- A partnership between Curtin University, Synergy, Wester Power, Power Ledger and energyOS enabled the peer-to-peer trading trial to happen across the regulated grid whilst also providing participants access to their real time solar PV generation and energy usage via the energy dashboard.

RENeW Nexus Water

- Water usage is monitored at 36 households in the City of Fremantle by ultrasonic smart meters connected to Curtin University via the Telstra NB-IoT network.
- Besides monitoring the use of scheme water, the project collects usage data from rainwater tanks, greywater recycling systems and private groundwater bores.
- A partnership between Curtin University, Murdoch University and Water Corporation facilitated the installation of the meters and the collection of water usage data.
- The collective work of Curtin University, Murdoch University and energyOS has allowed the participants to view their own water usage data on a water dashboard integrated with the energy dashboard offered by energyOS. The participants can use the dashboard to track their water usage from all sources (i.e., scheme water, rainwater tank, greywater recycling system, groundwater bore), better understand their usage patterns, and take informed decisions on their future water consumption.
- The intent of RENEW Nexus Water is to shed light on the usage of alternative water sources (i.e., rainwater, greywater and groundwater) at residential scale and how the usage of these new alternative water sources is changing the reliance on scheme water as well as the overall demand on Perth water resources (i.e., both deep and shallow aquifer, desalination plants).

Battery System at East Village at Knutsford

- Housed in a shipping container, the 670 kWh battery supplied by BT Energy and purchased by Power Ledger has been installed at the East Village at Knutsford site.
- The battery is being powered by an off-site 250kW PV array.
- Once residents begin moving in to East Village, they will be able to sell the excess solar they generate from their rooftops to the battery.
- The battery will be used to store the excess renewable energy and allow residents to draw upon it during non-daylight hours at night.
- The battery will be used to offset peak demand requirements from the grid, resulting in a reduction in the reliance on non-renewable forms of generation.

East Village at Knutsford

- East Village at Knutsford will be Fremantle's most sustainable new development, featuring the latest blockchain technology to deliver energy and water savings, renewable energy revenues, innovative water systems and a range of all electric homes with adaptable spaces for home offices.

The Legacy Living Lab at East Village at Knutsford

- The Legacy Living Lab (L3) will provide a data visualisation hub for project and industry partners.

- d. Collaboration: List the number of participants/partners in the project (exclusive of the Grantee). Briefly, describe the nature and extent of each party's contribution/collaboration to the project.

Participant type	No.	Contribution/Collaboration
Local government agency or body	1	<p>City of Fremantle - The City of Fremantle act in a project advisory/advocacy role assisting in community engagement and introductions to local developments and existing community assets requiring upgrade.</p> <p>Western Power – Support and enable the project trial to be actioned across the network. The RENEW Nexus project provided the trial platform for a new network charge tariff that Western Power are investigating for implementation.</p> <p>Synergy - Support and enable the project trial to be actioned across the network. The RENEW Nexus project provided the trial platform for a new energy tariff that Synergy are investigating for implementation. Provide energy metering devices for data collection and implementation trial.</p> <p>Water Corporation - Support and enable the project trial to be actioned across the network. Provide water metering devices and installation for data collection and implementation trial.</p> <p>Landcorp - Implementing alternative water and energy systems that are connected to smart technology at East Village at Knutsford. Providing land for community battery and planning the development for East Village at Knutsford.</p>
Private sector organisation	2	<p>Power Ledger - Power Ledger will provide the transactional layer for the renewable assets as well as the ownership model for the battery.</p> <p>CISCO - Supporting the project as part of its strategic partnership with Curtin University called Innovation Central Perth.</p> <p>energyOS – Digital services platform and program set-up, and license fee for platform for project timeline. Enabling participants access to their energy and water usage dashboard.</p> <p>Josh Byrne Associates - Coordinating the development of the Energy Strategy for East Village at Knutsford so that it works for both the development and for the RENEW Nexus project. Detailed modelling to enable the above coordinator to assess the options for that strategy.</p> <p>KZN Group - Project data management inception workshop.</p> <p>Telstra – Provided the NB-IoT communication network.</p>
Australian research organisations	3	<p>Murdoch University - Provide research support on alternative district water supply and storage schemes that will be used to provide water, capacity and ancillary services to each other and the grid.</p> <p>Curtin Institute for Computation - Provide data analytics required to generate insights from the project, and the set up of a new database for the exported data.</p> <p>Data 61 – Provide a strategic foresight component to the analysis.</p>

Not-for-profit organisation	4	
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- e. Community engagement: To what extent has the community been engaged in your project?

Number and type of consultation activities:

Call to action – An EOI for prosumer participants via an electronic poster with a link to an online registration form was shared across social media and City of Fremantle community pages, targeting the City of Fremantle resident community.

A drop in information session for EOI form respondents to engage with the potential participants and inform them about the project was attended by more than 50 residents and all consortium partners. Feedback was requested to inform future community engagement sessions. Strong feedback responses were received and taken in to consideration for future events.

An energy presentation and workshop engagement session for all participants.

An energy presentation and workshop engagement session introducing the RENeW Nexus Plan trial and inviting participants to spread their inclusion in the project.

A platform demonstration session for all participants.

A water presentation and workshop engagement session for all participants.

Final community session to share the outcomes from the RENeW Nexus project.

Email communication through a project email has enabled communication to community participants about the project to be continuous and up to date.

Coordination around metering device installs and site assessments has enabled further engagement opportunities with individual community members.

Community members and industry professionals were invited to participate in the strategic foresight report being written by Data61 via interviews and a workshop style session.

Number of citizens engaged in consultations:

50+ residents attended the drop-in information session

80+ participants responded to the EOI for the City of Fremantle Participant Trial and 60 properties are included in the meter data collection.

Number of citizens using new/improved services:

60 properties within the City of Fremantle are able to view their energy usage, generation, import and export as well as their water usage and storage, and start to understand where they could act as a prosumer to trade export energy and/or water to consumers participating in the trial implemented across the network. Consumer participants have access to the same monitoring equipment and the opportunity to trade with prosumers for local renewable energy across the network, via the virtual transactional layer.

3. Project Outcomes and Benefits

- a. Briefly outline the key project outcomes.

The key objective of the project was to demonstrate the benefits of integrating various technology platforms to deliver energy and water efficiency outcomes. Distributed energy and water resources including renewable generation and storage, combined with blockchain enabled energy trading technology in an autonomous micro-grid environment as well as across the regulated grid, to help bring modern, reliable and low carbon energy supplies to local and emerging economies in a way that's sustainable, affordable and contributes to local economic development.

This project has enabled research and data analysis to support and inform the transition to a new energy and water network as well as unique collaboration between academia, industry and Government at many levels.

The RENeW Nexus Plan Trial

Installed energy and water metering devices across residential properties in the City of Fremantle giving them access to an energy and water usage dashboard. Collection and analysis of energy and water usage, generation, import and export data from residential properties enables the project team to better understand the participants systems of practice and the impact this has on their ability to peer-to-peer trade excess renewable energy locally.

The project launched and enabled a global first electricity peer to peer trading trial enabling dynamic pricing across the regulated network, via the virtual transactional layer.

- Using Western Power's existing electricity network with retailer Synergy, Power Ledger's platform has enabled households to buy and sell excess rooftop solar energy in real-time, with residents able to view electricity usage in 30 minute intervals.
- Western Power's smart meter data was fed into Power Ledger's blockchain trading platform and then exported to Synergy's billing system, to ensure an accurate recording of the energy trading and provide billing to the participants.
- The trial has been an effective collaboration between industry and University researchers with the partnership between Curtin, Synergy and Western Power and new(er) service providers Power Ledger and energyOS.
- The trial has demonstrated a successful integration between Western Power and Synergy metering and billing processes with the Power Ledger platform.
- Since the trial started, Power Ledger has processed almost 50,000 transactions on its platform monthly and tracked over 4 megawatt hours of peer-to-peer renewable energy trades.
- The majority of participants did not continuously engage in dynamic pricing and preferred to "set and forget".

RENeW Nexus Water

New generation ultrasonic smart meters utilising an NB-IoT communication network provided have been deployed for sub-metering of the rainwater, greywater, bore water and mains water supplies across the City of Fremantle. This has allowed researchers and occupants to receive data in real time on their digital devices. Analysis of this data has provided insights into both the efficiency and potential opportunities for greater penetration of alternative water supplies, and wastewater reuse, into the residential water sector.

Collection and analysis of water usage, generation and import data from residential properties enables us to better understand how to manage the implementation of hybrid water systems at the residential and system scale.

Battery System at East Village at Knutsford

The project partners installed a 670kWh community battery at East Village at Knutsford. The battery has been configured to import and store electricity for the purpose of minimising the electricity consumed from the grid. The system allows for peer-to-peer trading to buy and sell their excess power between each of the dwellings and the battery.

An off-site 250kW solar PV array will virtually charge the community battery with its excess energy as part of the commitment to provide the East Village construction site and eventual strata managed residential properties with 100% renewable energy.

East Village at Knutsford

Every one of the 36 townhouse sites has a 7,000-litre rain-water tank installed, which have been installed below the driveway and carport. These tanks have been determined by detailed modelling to understand the right size tank to make the most of winter rainfall in Perth, to optimise the rainfall when it starts at the end of autumn runs through winter and into spring. The aim has been to size the tanks to get the most of that infrastructure, in relation to the cost and also in terms of energy intensity of construction and instillation.

Water from the rainwater tanks will supply the toilets and washing machines, which is the safest way to use rain that comes off roofs, similar to other projects such as the nearby WGV by LandCorp. However, in this case, the rainwater will also be run through the solar energy powered heat pump hot water systems, to sterilize that water and provide that water back into the home for use in the showers.

This is a first Department of Health approval for a Western Australian multi-lot residential development. These features supplement scheme water supply to the highest indoor water use in Perth homes. In the Perth context as the house blocks become smaller and the proportion of garden water use reduces, it makes it even more critical to start focusing on providing fit for purpose alternate water sources indoors as well.

In terms of non-drinking water for irrigation, a strata bore is being installed just alongside the battery. The strata bore will be owned and operated by the strata company. It will supply groundwater from the superficial aquifer to every single lot to be used for irrigation, both for irrigation systems and also for hand watering of gardens. With the taps properly colour coded and labelled for hand watering. This is very important for smaller courtyard style gardens, where people like to hand water pots plants and cottage style gardens.

Importantly, the strata bore is using groundwater that is being recharged through locally harvested and infiltrated stormwater: 100% of the storm water that will fall within this development site, will infiltrate back into the ground within the site, including the one in 100 rainfall events. The overall approach to water management is referred to as water sensitive urban design, where the stormwater that falls on the ground, firstly in paved areas will infiltrate through strips of porous paving. Those early flows go into the subsoil and recharge soil moisture, to be used by trees and other landscaping.

Bigger rainfall events will flow over land into rain gardens, where they can help recharge water around the larger established trees. Once that subsoil is saturated, the water then infiltrates down into the aquifer. Any additional flow is directed into shallow infiltration galleries, dispersed all throughout the site, which recharges the clean water into the ground water. This all aims to provide a positive recharge to the groundwater, allowing for managed extraction of the groundwater for irrigation even in Perth's dry climate.

The mains water demand is thus significantly reduced as it is not being used for toilets, washing machines, and showers when there's rainwater available to substitute it. Demand is further reduced through highly efficient fixtures and appliances that are specified into the homes, to make sure that water is used as efficiently as possible.

The Legacy Living Lab at East Village at Knutsford

An electric vehicle (EV) and charge station has been installed at East Village at Knutsford. The EV charge station is powered by the community battery and solar PV array.

The systems at east Village allow for detailed monitoring of the data on energy, water use, and microclimate, and this provides the opportunity for a virtual system that overlays all of these physical systems. To take advantage of all this monitoring there will be a purpose-built Living Lab facility that has been constructed at the Fleetwood Construction yards. This facility will house a state-of-the-art data visualisation set up, established by Curtin University, where there will be the opportunity to see real-time data from the systems at East Village, but will also provide an opportunity to network into other Curtin University projects including WGV, and Josh Burn's house project.

This data will be able to be visualised, and accessible to industry partners, the Government, and to the community in a way that's never been done before. Above the living lab data hub centre will be an innovation maker space, where the doors will be open to innovators and future thinkers, to continue to progress from the work completed in RENEW Nexus in new ways of thinking about how we make cities better.

- b. Briefly describe how the project achieved one or more of the following:
- improved the liveability and sustainability of cities, suburbs and towns through the application of smart technology solutions to economic, social and environmental challenges;
 - increased openly available public and private data sets to support citizen engagement, unlock innovation, and create new business opportunities;
 - increased innovation and capability in local governments through collaboration and smart city innovation ecosystem development;
 - contributed to development of smart city standards and improvement of regulation impacting the roll-out and use of smart technology.

The community participants involved in this project have increased access to renewable utilities via the trading platform, as well as an energy and water usage dashboard. Participants are able to use digital services to monitor their solar PV generation and energy usage, also their mains and bore water usage and rainwater or greywater tank utilisation across their property.

Community participants who did not previously have access to local renewable energy, due to either lack of financial capital or inadequate roof space (for example), have been able to source it from distributed renewable energy assets in their community via the Power Ledger trading platform. The active role of the community as an integrated network of consumers and prosumers across the regulated grid has provided the first trial of its nature in WA and globally. The dynamic pricing set up of the RENEW Nexus Plan trial enabled consumer and prosumers to set their own buy and sell rates for peer-to-peer traded energy.

The RENeW Nexus Plan trial has been an effective collaboration between industry and University with the successful partnership between Curtin, Synergy and Western Power and new(er) service providers Power Ledger and energyOS.

East Village at Knutsford provides a first Department of Health approval for a Western Australian multi-lot residential development where the rainwater will be run through the solar energy powered heat pump hot water systems, to sterilize that water and provide that water back into the home for use in the showers. Water from the rainwater tanks will also supply the toilets and washing machines. These features supplement scheme water supply to the highest indoor water use in Perth homes.

The community battery at East Village at Knutsford, the on-site and off-site solar PV systems along with the ability to peer-to-peer trade within the strata managed system enables a commitment to provide the East Village construction site and eventual strata managed residential properties with 100% renewable energy.

- c. Deployment: What types of technology has your project deployed? How is the technology being applied?

Type/s: Blockchain technology

Application/s: Peer-to-peer renewable energy trading platform

Type/s: Cloud based software platform

Application/s: Digital services for energy and water generation and demand

- d. Innovation: Please indicate how the application of technology (knowledge, software or hardware) is innovative as defined by the Program Guidelines (section 5.3). The application of smart technology is (select the one that best describes the technology applied to your project):

- New to the organisation, local government area or city
- New to the region
- New to the country
- Entirely new
- Extending an existing smart technology in a novel way
- Delivering outcomes not previously realised in the community

- e. Data: How is your project using data and/or making it available? (Choose one or more)

- By making data sets open

Describe how:

- By generating, storing, communicating and processing data

Describe how:

Processing the meter data received to Power Ledger's REST API through an environment-specific trading algorithm. Storing the transaction data on the blockchain.

- By analysing and presenting data to support improved governance and decision making

Describe how:

Providing end users with more transparency on their energy prices during the day, along with the ability to set their own peer-to-peer prices, allowed them to make better decisions on when to turn on appliances and consume more renewable energy.

- By creating new tools for key stakeholders (e.g. citizens)

Describe how:

The Power Ledger platform provided a new tool to participants that displayed innovative graphics and visuals on their energy usage, and allowed prosumers to trade their excess rooftop solar generation with their neighbours rather than selling it back to the grid. Additionally, the smart meter data provided the project partner's insights into the consumption behaviour of participants and the platform provided opportunity to explore the appetite for using blockchain technology to transact energy across the network.

- Other

Describe how:

- f. Standards and regulation: How is your project using standards and/or addressing regulatory issues? What regulatory barriers did you come across and what did you do as a consequence? Has any change occurred to the regulations or standards as a consequence?

Through RENEW Nexus we have further understood the complexity of the energy transition period that we have entered. It is not the regulation and tariff structures that make it difficult for peer-to-peer trading of energy to deliver customer savings and system wide benefits, but the underlying cost structures of delivering electrons across the SWIS in WA. The grid energy generation is a small component of the kWh charge, with network, capacity and other costs taking up the largest percentage of the costs.

Introducing further large scale renewable energy on to the grid or managing the growing percentage of residential distributed renewable energy could benefit from the use of digital services including energy demand management, battery utilisation and peer-to-peer trading.

The project worked within the existing regulatory framework and using any relevant technical standards, which was largely made possible due to the involvement of the state owned retailer, Synergy, and the state owned network operator, Western Power. Without their involvement peer-to-peer trading across the network could not have occurred in Western Australia.

A future investment in AMI will enable Western Power to develop the current technological systems involved in the metering and billing process for energy, including the ability to provide more frequent data delivery alike to the smart metering devices installed as part of this project.

- g. Explain how your project will continue to have an impact now that the grant project has finished. Include any relevant feedback received from participants or flow on benefits you expect.

Curtin University will continue to monitor solar PV generation, energy and water usage at the participant homes whilst they continue to use the energyOS dashboard. This will provide a richer dataset for research that will assist the industry and Government entities ability to understand the benefit of digital services, beyond the project timeline whilst continuing to provide a service to the community members.

The RENEW Nexus Plan trial, that has enabled residential energy customers to peer-to-peer trade excess solar PV energy, is currently being proposed for a second phase beyond RENEW Nexus. The project partners are preparing to recruit further participants so to continue to understand the outcomes and benefits of peer-to-peer trading distributed renewable energy across the regulated grid in WA.

Feedback received during the RENEW Nexus Plan trial from participants provided valuable insights into their use of and interactions with the technology. Survey results from those participating in the trial showed that motivations for joining the trial were not financial in nature; reducing energy costs was given a lower priority compared to wanting to learn more about P2P trading, wanting to take part in something new and innovative, and wanting to use more sustainable energy sources to help the environment.

Two direct quotes from trial participants that were submitted with the survey to explain why they wanted to take part in it:

'To be part of an emerging technology as an early adopter. Help in the best way I can to prove the concept of peer to peer trading. Help provide data to prove the concept.'

'To enable better sharing of renewable energy across the grid.'

This trial has allowed consumers to be more conscious about their energy use and learn more about innovations in renewable energy technology. One participant noted that he changed his pond and spa pumps to turn off before sunset when energy prices would reach peak pricing. A goal of the trial was to educate consumers and provide transparency on the energy prices during different times of day so that consumers could change their behaviour and take advantage of cheaper, greener energy. The goal of educating consumers and providing transparency to the energy industry using new technology will continue to be actively pursued well after the trial concludes.

The community battery at East Village will continue to be charged by the off-site solar PV array to power the ongoing construction of East Village and eventual strata managed residential homes. East Village is committed and contracted to being powered by 100% renewable energy through construction and beyond.

Upon completion and occupancy, East Village will include the incorporation of key passive solar design features and 5kW PV panels on each of the dwellings and the integration of that system with the onsite 670kwh battery. The battery has been configured to import and store electricity for the purpose of minimising the electricity consumed from the grid. The system allows for peer-to-peer trading to buy and sell their excess power between each of the dwellings and the battery. All homes will be totally electric and incorporate provision for overnight electric vehicle charging and provision of a fast charging facility.

All three of the water sources at East Village are metered with smart metering devices and they're wired up to the digital platform that Power Leger has developed within RENEW Nexus, to make sure that we can track very closely the water use. The mains water use and the strata bore water use will be billed accordingly by the strata manager but at a lower price than they would pay for mains water. The metering and sensors mean that ongoing evaluation can occur of the whole

water balance of the site – thus documenting what is being used, what is infiltrating into the groundwater and most importantly, the reduced amount on the mains water supply network.

The Legacy Living Lab (L3) will provide a data visualisation hub for project and industry partners. RENEW Nexus data will be displayed and made available through visualisation within the building. L3 will also provide the opportunity for community to learn from example and see demonstrations of smart home technology as well as innovative building products, some to be utilised at East Village. The electric vehicle will play a role in this demonstration platform at L3.

Although the project has reached completion, the technology used will continue to challenge the existing energy and water systems in Australia and also around the world, to take a fundamentally different approach to how and where energy is produced, sold and consumed as well as managing demand for both energy and water.

The existing energy system is in the midst of a transition. Having the ability to generate power from our rooftops, from renewable sources, to manage personal and system level demand as well as being able to store energy for use later provides further opportunity for the overall system. Peer-to-peer (P2P) trading aims to optimise this energy and provide everyone with access to low-cost, low-carbon energy.

‘Digital technologies like big data, analytics and machine learning, blockchain, distributed energy resource management, and cloud computing, can help overcome some of the key challenges in the energy sector – most notably intermittency, aging grids, balancing distribution-connected generation, managing consumer self-generation, and coping with increasing system complexity.’

- h. Please attach any reports, publications or material that resulted from the project.

4. Certification

I  ^{s47F} being a person duly authorised by the grantee hereby certify that:

- the information listed above is accurate, complete and not misleading and that I understand that giving of false or misleading information is a serious offence under the *Criminal Code 1995* (Cth).
- the grant was spent in accordance with the grant agreement
- I am aware of the grantee’s obligations under their grant agreement, including the need to keep the Commonwealth informed of any circumstances that may impact on the objectives, completion and/or outcomes of the agreed project
- I am aware that the grant agreement empowers the Commonwealth to terminate the grant agreement and to request repayment of funds paid to the grantee where the grantee is in breach of the grant agreement.

 ^{s47F}
 SignedDate 24th June 2019
 Project Manager, Curtin University Sustainability Policy Institute