LOW CARBON LIVING CRC

RP3033u1 – Utilisation project

Legacy Living Lab –visualisation of smart data and peer-to-peer trading of local renewable energy and alternative water systems from WGV and beyond

Authors	Rebecca Lange, Gregory M. Morrison
Title	Legacy Living Lab – visualisation of smart data and peer-to-peer trading of local renewable energy and alternative water systems from WGV and beyond
ISBN	
Date	July 2019
Keywords	Living Lab, Peer-to-Peer Energy Trading, alternative water systems, smart data, visualisation
Publisher	
Preferred citation	

Australian Government
Department of Industry, Innovation and Science

Business Cooperative Research Centres Programme

Acknowledgements

This research is funded by the CRC for Low Carbon Living Ltd supported by the Cooperative Research Centres program, an Australian Government initiative

Disclaimer

Any opinions expressed in this document are those of the authors. They do not purport to reflect the opinions or views of the CRCLCL or its partners, agents or employees.

The CRCLCL gives no warranty or assurance, and makes no representation as to the accuracy or reliability of any information or advice contained in this document, or that it is suitable for any intended use. The CRCLCL, its partners, agents and employees, disclaim any and all liability for any errors or omissions or in respect of anything or the consequences of anything done or omitted to be done in reliance upon the whole or any part of this document.

Peer Review Statement

The CRCLCL recognises the value of knowledge exchange and the importance of objective peer review. It is committed to encouraging and supporting its research teams in this regard.

The author(s) confirm(s) that this document has been reviewed and approved by the project's steering committee and by its program leader. These reviewers evaluated its:

- originality
- methodology
- rigour
- compliance with ethical guidelines
- conclusions against results
- conformity with the principles of the Australian Code for the Responsible Conduct of Research (NHMRC 2007),

and provided constructive feedback which was considered and addressed by the author(s).

Executive Summary

The WGV and other projects in the CRC LCL have created rich data for energy and water systems in exemplar low carbon precincts. The stored and dynamic data have been retained through other projects. The utilisation of the data in a real-life situation through visualisation has been the subject of this project. The visualisation will be through an array of dedicated screens in the Legacy Living Lab, a Circular Economy building, which will be positioned on the East Village (Fremantle) precinct in September 2019. The project considers the design of the visualisation facility through use cases, which are interviews with selected stakeholders from education, industry and society. In a continuation the data is now being prepared for visualisation which is attractive for the lab as a innovation, learning and meeting space. The output for the utilisation project is a fully functional facility for industry, society and academia in place by October 2019.

Introduction

Projects RP3033 and RP3043 have seen the establishment of living labs at White Gum Valley (WGV) and a new site on Knutsford (East Village site). The East Village site is being designed for 35 homes with the latest technologies in solar-battery storage (a 600 kWh battery has been tendered and is in place) and with the world's first development featuring peer-to-peer trading of renewable energy across the grid and shared alternative water systems (also featuring peer-to-peer trading).

A new Living Lab concept – called Legacy – is under construction and will be positioned on the Knutsford site to showcase the technologies and techniques that have gone into the CRC LCL's Living Labs. Legacy will be constructed in such a way as to facilitate later moving it to Curtin University or another site in three years.

Legacy represents the next generation of Living Labs and is a prototyping facility driven by the demands of a partner consortium and built with adaptability, flexibility and with a clear business model for innovation. Legacy will function as a place for innovation and demonstration by the sponsors, as an open learning house for Curtin and for Landcorp for customer interaction.

This utilisation project will enhance the Legacy offering by providing a facility for the visualisation of smart energy and water data from WGV that will form part of the displays accessible within the Lab and provide a showcase for the research that has been carried out during the CRC. The CRC LCL utilisation project enables the preparation and connection of the visualisation room on-line. In the Living Lab the spatial characteristics of the energy and water data will be visualised using filtered data from meters in WGV, at the East Village site and across Fremantle. The data will be sourced into an AWS (Amazon Web Service) server and delivered into an API (Application Programming Interface) from where the de-identified data can be sent to the researchers and approved stakeholders.

Legacy Living Lab

The Legacy Living Lab facility has the following mission: Visualisation of smart data and peer-to-peer trading of local renewable energy and alternative water systems from WGV and beyond.

The Legacy Living Lab (L3) is a visualisation hub as well as a housing prototype to showcase alternative building materials, modular construction and the value to circular economy from the White Gum Valley, RENeW Nexus and beyond. L3's first life cycle will commence in 2019 on the East Village site at Knutsford (Figure 1).

L3 is the host of the Western Australian node of the iHUB Network, formed by Curtin University, Swinburne University, University of New South Wales, Monash University, and The University of Queensland. This nationally networked digital platform will enable integrated analytics, assessment and engagement with a focus on urban decision-making.

The iHUB facility will be the focal point of the visualisation capability of L3 supporting research and stakeholder engagement targeting a wide range of government agencies, practitioners, industry and end-users.

Research and stakeholder engagement

Research utilisation

L3 and the visualisation facilities will be a hub of research activities looking into the utilisation of renewable energy and water usage across related projects such as WGV and RENeW Nexus. Furthermore, L3 represents a test bed for research itself exploring the concept of circular economy, showing how the use of conventional building materials can be improved for e.g. better energy efficiency and demonstrating how material can be re-used and re-purposed. Research on L3 will utilise the data collected on and available at the lab (e.g. its energy usage) to gain insights on how the lab is performing as a building in different seasons as well as under different utilisations (e.g. as a showroom, teaching facility or co-creation space).

Many elements which contribute to the circular economy research at L3 will be hidden from sight and we will work together with researchers from Curtin university on visualising this information using AR/VR technology. Implementing this technology will enable visitors to L3 to see behind the walls and dashboards to explore the sustainability objectives that have been implemented on the site.

Having the visualisation pods in conjunction with the table displays lends itself well to exploring data in detail at different scales. This will be used for future research to explore the water balance at different scales – household, precinct, city - investigating the impact of different behaviour on water resources. Furthermore, we will explore the correlations of energy and water use with weather and seasons and overlay our findings on geographical maps. This will allow is to study any influence the location might have and whether there is any correlation between consumer profile, behaviour, and location which could potentially have an effect on the distribution of p2p energy trading.

Visualisation examples

Visualisation examples that have been developed for both water and energy are shown below.

The water data has been collected from September 2018 with ongoing measurements. Figure W1 shows the expected seasonal changes of water demand rising over the summer months and dropping with the winter sprinkler ban. For all sites combined we also show the average water usage throughout the day (Figure W2) and for sites with hybrid system we also show the water usage break down by water source each month (Figure W3).

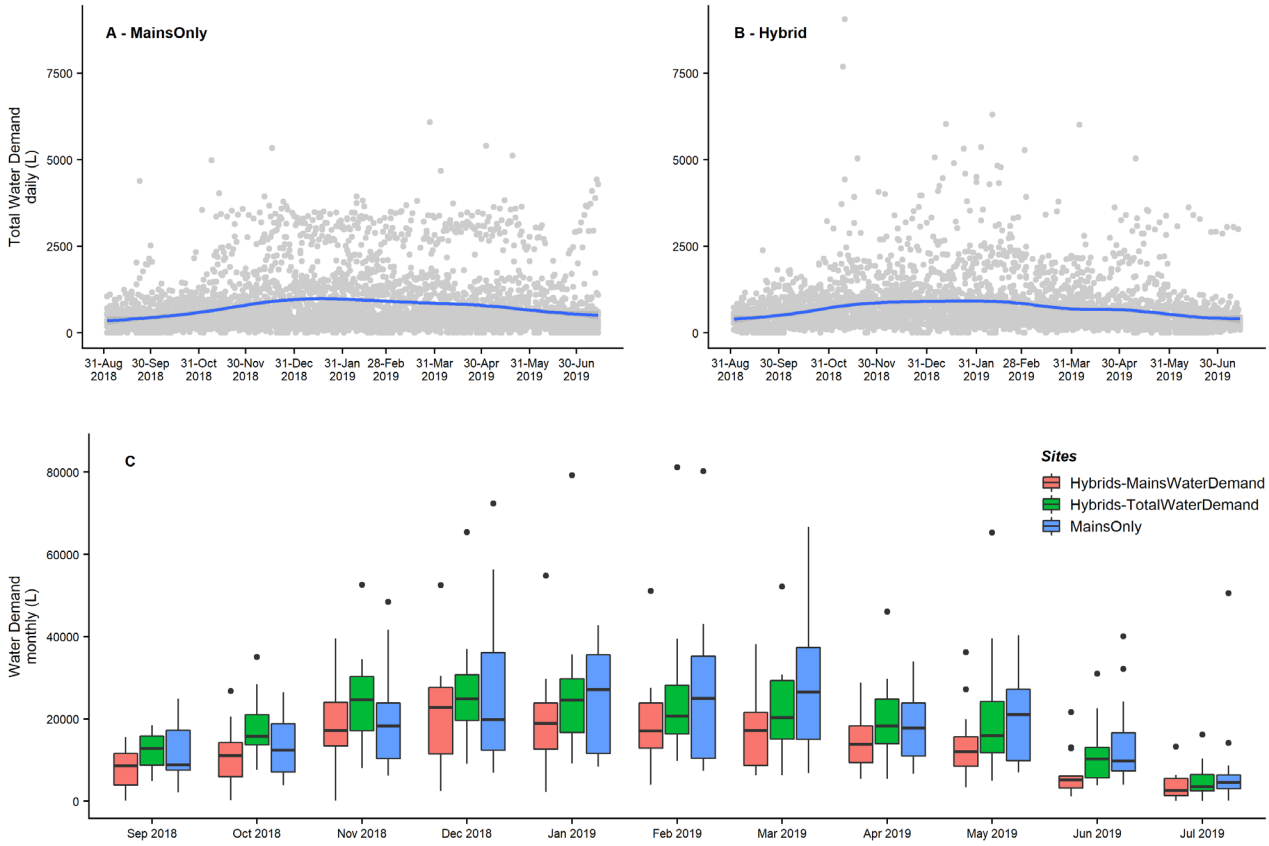

Figure W1. Expected seasonal changes of water demand rising over the summer months and dropping with the winter sprinkler ban

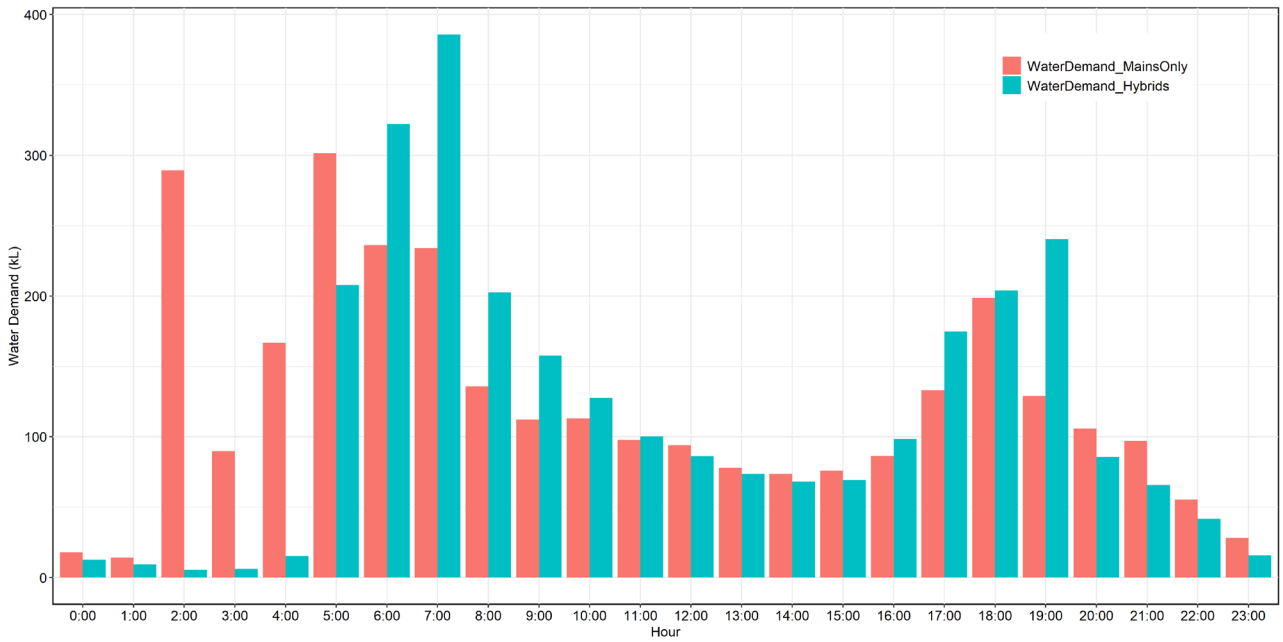

Figure W2 All sites in a Fremantle trial combined to show diurnal average water usage

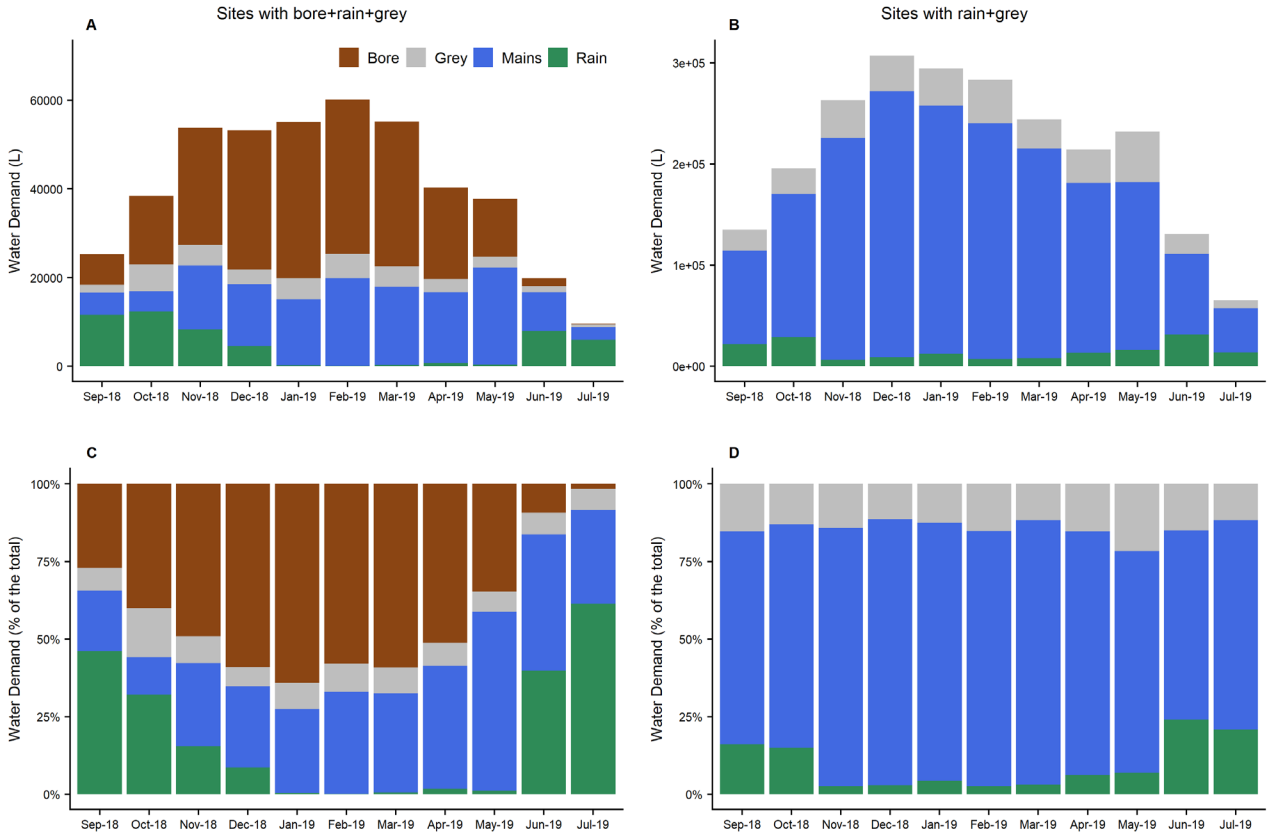

Figure W3. Sites with a hybrid system, demonstrating water usage breakdown by water source each month

The energy data has been collected since August 2018 and many participants are also part of the water trial. Figures E1 and E2 show a first draft of a possible dashboard to be visualised at Legacy. The subplots show the energy average energy demand over 12 months aggregated by consumer and prosumer. For our cohort prosumer on average consume more energy and are potentially a big strain on the power grid as their peak demand from grid increases more steeply than that of consumers (large subplot on the left of the dashboard). The next subplot (top right) shows the average aggregated potential for trading energy over the 12 months of data collection. The three curves are the energy imported from grid (demand), the energy exported to grid (supply) and the energy to trade which is the lesser of either the energy supplied or the energy demanded. The plot highlights that during the day most of the energy supplied has no buyers within our cohort. The last subplot (bottom right) shows the average aggregated daily energy production of households with solar PV grouped by the size of the solar PV. Figure E2 demonstrate the interactive nature of the plots, displaying the statistics of the boxplot ranges when hovered over the data points.

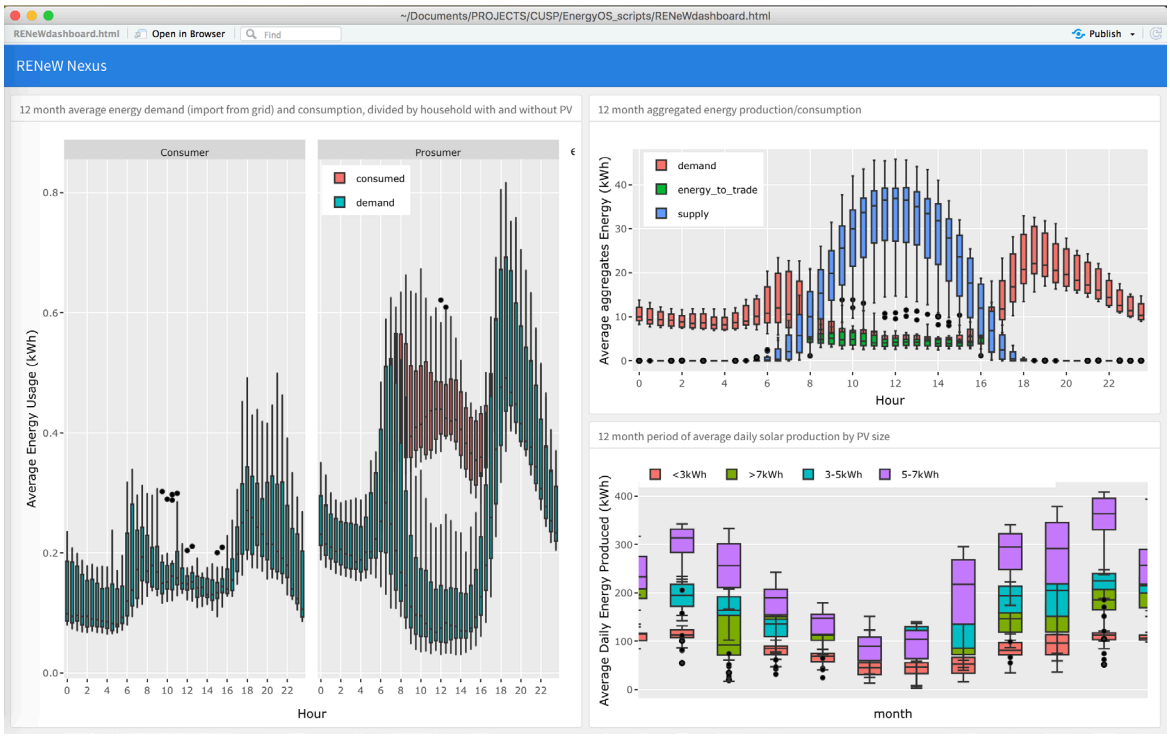

Figure E1 Energy dashboard for monitored homes to be visualised at Legacy

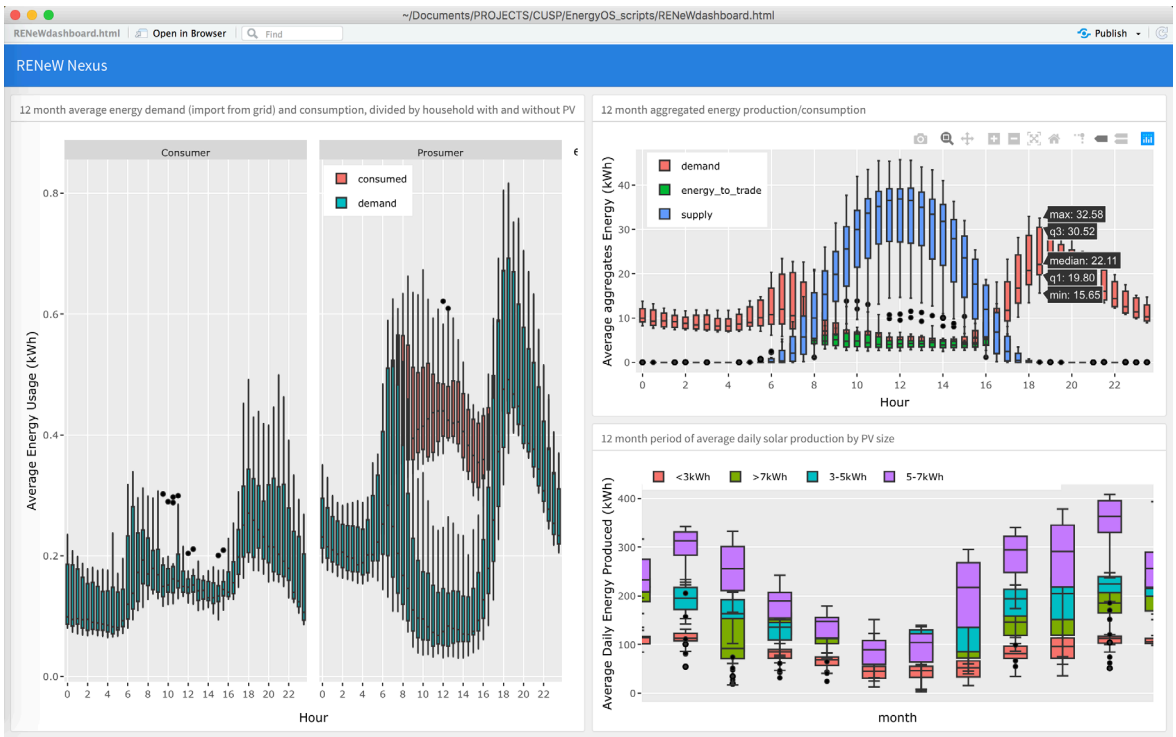

Figure E2. The plots to be shown in the Legacy visualisation facility will be interactive, displaying the statistics of the boxplot ranges when hovered over the data points

The participants can view the energy data via the EnergyOS portal either as a dashboard showing their current consumption and production (Figure EOS1) or as a historical plot showing the energy produced and consumed for different time periods, e.g. the previous day, past week, etc. (Figure EOS2).

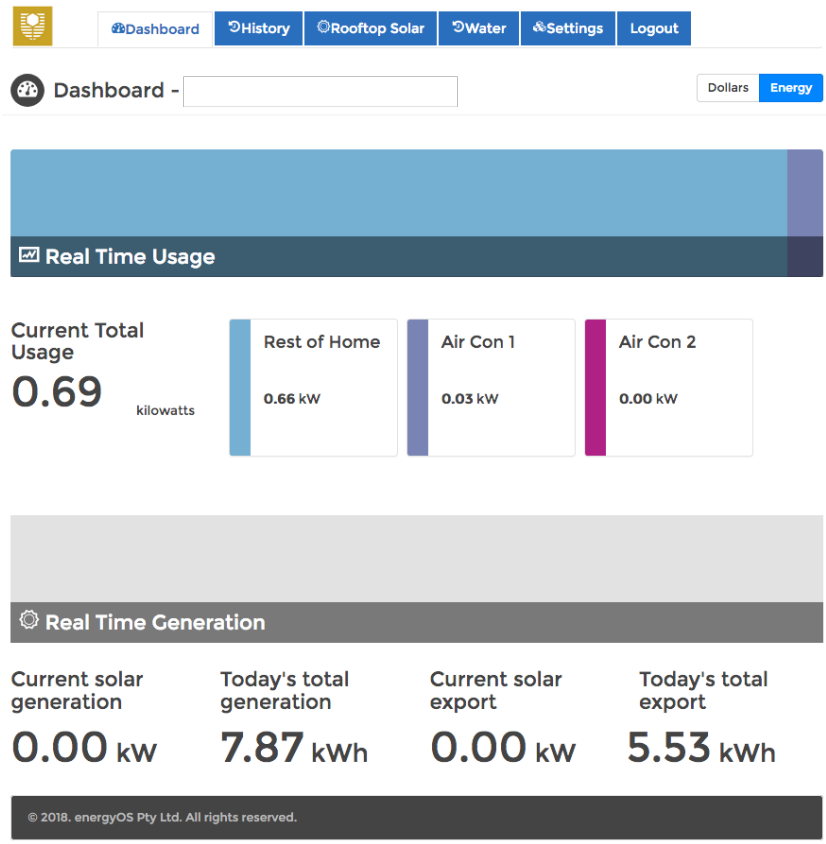

Figure EOS1. EnergyOS dashboard for dynamic data use example in homes.

Figure EOS2. The EnergyOS dashboard will be visualised through Legacy showing current consumption and production for homes.

Teaching engagement

The living lab will be an excellent location for teaching students. Having several screens capable of running breakout sessions will allow for group and project work in a flipped classroom style, encouraging the students to come up with their own hypotheses and then use the data available at L3 to explore these ideas. In addition, the Legacy Living Lab will be a hub for industry engagement where both students and researchers will benefit from collaborations with industry partners.

Stakeholder engagement

Stakeholder interviews were held to gauge the interest in utilising the visualisation equipment at L3; two main motivations became apparent: education of customers and the public, and running co-creation workshops. Below are three examples of the space and data utilisation proposed by stakeholders.

User Case 1

An energy retailer was interviewed. They are planning to use this space to bring in customers for co-creation workshops as well as for educational purposes.
Using the WGV and RENeW Nexus data they are especially interested in exploring the peak demand impact on the power network, specifically how do household with and without PV compare. Building on this research the next step is modelling how changing consumer and prosumer behaviour will impact the peak demand and power network usage. With data collected from the future East Village at Knutsford this research will then expand into modelling the impact of batteries on the utilisation of the South West Interconnected System (SWIS).
For their customer education the retailer is particularly interested in showcasing how the SWIS works, how solar energy is produced and utilised by households and how the energy cost breaks down into actual cost of energy production and grid maintenance.

User Case 2

A digital services company is planning to use this space to hold workshops for current and prospective partners and clients. In particular, they want to showcase how their digital services platform works and demonstrate how trades are made on a geographical map. Using the available data research will look at how energy is used and produced at different scales, e.g. household, precinct, and across the grid. Analysis will include the number of kWh traded and the number of trades closed, subdivided by projects and trading logic. For self-contained systems the analysis will also include emission offsets considering the number of kWh traded. For example, East Village at Knutsford will have a large community battery to store the excess energy produced by PV and with energy usage data collected from the residents a model can be built to predict the energy demand of the precinct from the battery as well as the grid for the next day. In the ideal case these predictions can then be used by the grid operator to adjust the supply of energy to the precinct, enabling the entire grid to reduce its carbon emissions.

Visualisation Facilities

The layout of the visualisation facilities has been informed by the user cases. Smart energy and water data from WGV and RENeW Nexus forms part of the displays accessible data providing a showcase for the research that has been carried out during the CRC LCL. In the Living Lab the spatial characteristics of the energy and water data will be visualised using filtered data from meters in WGV, at the Museum site and across Fremantle. The data, stored on a cloud server, will be accessed via an API (Application Programming Interface) which will supply de-identified data to the researchers and approved stakeholders.

The focus of the WA iHub node is to provide sophisticated data and spatial analysis capabilities, delivering a compelling interactive experience to researchers, stakeholders and the public as part of the Legacy facility.

Figure 1: 3D interior mock of L3

The iHub facility will extend over two floors (see Figure 1) of the Legacy Living Lab, with the main visualisation area on the ground floor and a secondary visualisation area on the upper floor.

L3 will have 2 visualisation pods, 3 table displays, a set of ipads (or other suitable tablets) and AR/VR equipment (e.g. Oculus Quest). This layout has been informed by the user cases.

Visualisation Pod 1

This pod consists of four individual 65" touch screens with a small bezel, mounted next to each other in portrait mode. Pod 1 is located downstairs in the main visualisation area attached to the back stairs (see Figure 2) and functions as a large presentation screen.

Pod 1 will have video-conferencing capabilities as well as the ability to take input from different sources and share content with the other iHUB visualisation devices in L3.

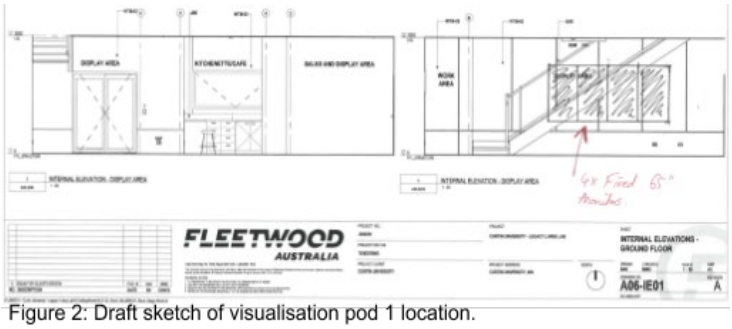

Figure 2: Draft sketch of visualisation pod 1 location.

Visualisation Pod 2

Visualisation pod 2 has the same capabilities as pod 1; video-conferencing, multi-source inputs and sharing content with other iHUB visualisation devices in L3.

However, this pod is located on the upper floor (see Figure 3) and will consist of up to six 55" screens, these screens will be on moveable mounts, which can either be used in curved & immersive configuration or flat lecture style mode to better reflect similar visualisation suites across the other iHub nodes.

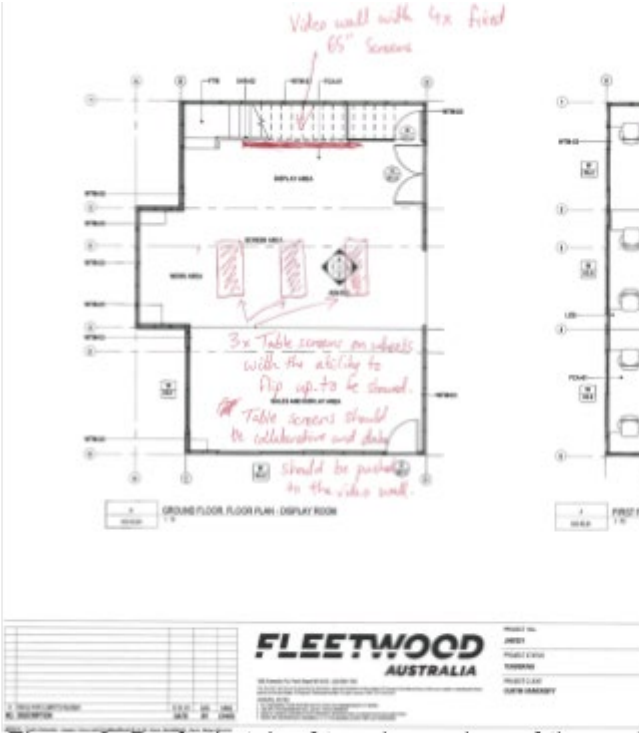

Figure 3: Draft sketch of top down view of the mai visualisation pod 2 on the upper floor (right)

Other Visualisation Equipment

The proposed table displays are 65" to 75" touch screens mounted on a moveable stands, which can be flipped to use the displays either vertically or horizontally (i.e. table format).
The table displays, like the visualisation pods, need to be able to take input from different devices and share their content with the main visualisation pod displays.

As the L3 iHub will be used for stakeholder engagement and public education, and as group sizes for these events can vary drastically we want to equip the iHUB with a set of iPads (or other suitable tablets) to allow for changing circumstances and group sizes.

Furthermore, augmented and virtual reality (AR and VR, respectively) are great tools to demonstrate the work we do. For example, we can have a virtual walkthrough planned of existing buildings or we can augment our reality by overlaying information onto surfaces, e.g. showing statistics and information on L3 itself displayed onto its walls using AR glasses.

Status of Legacy Living Lab

Legacy Living Lab (Figure 4) will arrive on site in August/September 2019. High speed internet has been arranged for a three year connection and the visualisation facility will be installed according to Figures 2 and 3. The stakeholder engagement studies have informed the visualisation of the data from previous CRC LCL projects and provided a legacy for their use.

Figure 4 Legacy Living Lab during assembly at Fleetwood, June 2019. The Lab will be in place at East Village, Fremantle, in August/September 2019

Sponsors and support for Legacy Living Lab

Stramit

Ludlow Timber Products