Creating Sustainable Energy Savings & Emission Reductions in a Smart Building

Moving from old to new

Lina Juodelyte| 22 March 2021

Australia's national science agency

Solving the greatest challenges through innovative science and technology.

In 2019-2020, CSIRO:

With over 5,000 dedicated people

Across the world including Australia, Singapore, Vietnam, US and Chile

Delivered $7.6B value a year

To the Australian economy through our science and technology

Working on 55 sites & 1100+ buildings

One of the world's largest multidisciplinary science and technology organisations

Challenges

Six challenges CSIRO is assisting the nation to overcome, and turn to Australia's unique advantage

- Food security and quality
- Resilient & valuable environments
- Sustainable energy & resources
- Future industries
- Health & wellbeing
- A secure Australia & region

Life-changing innovation

- FutureFeed for cattle that reduces methane related emissions
- COVID survival on surfaces testing – up to 28 days
- Mapping 3M galaxies in 300 hours with ASKAP telescopes

Fast wifi ›

Aerogard ›

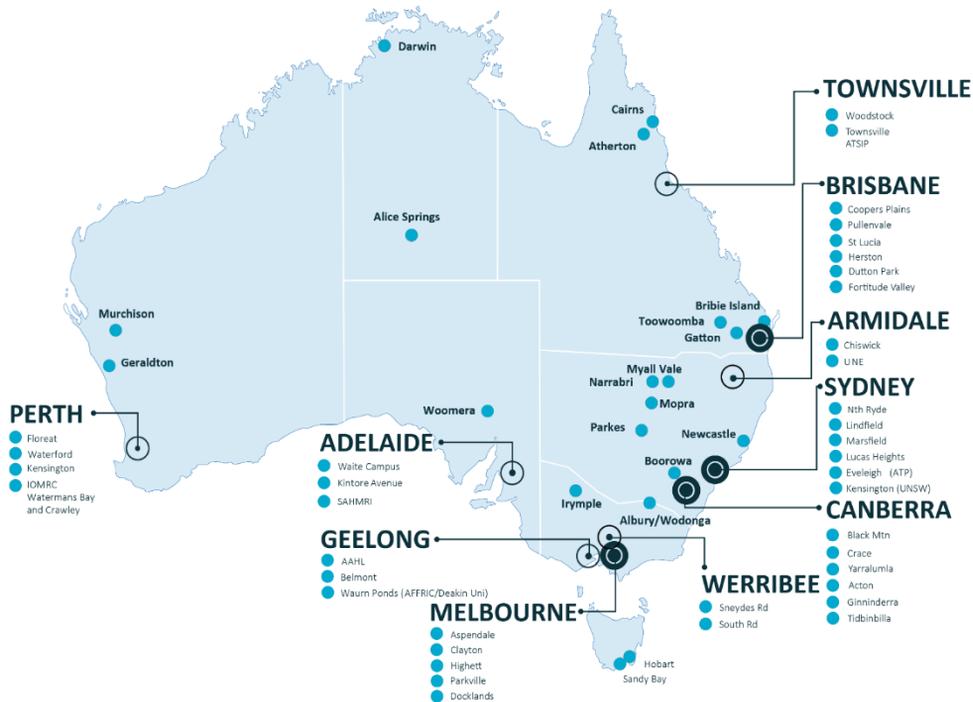Plastic banknotes ›

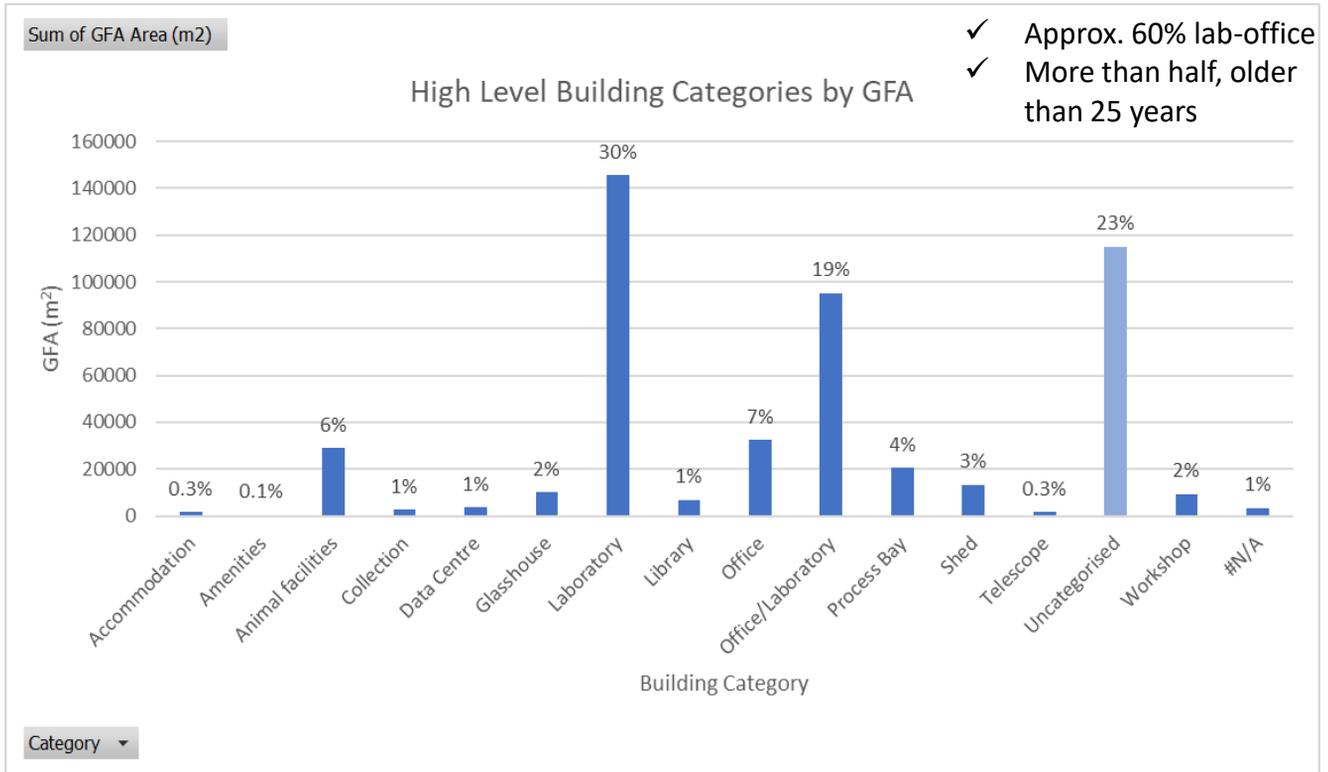Total Wellbeing Diet ›

CSIRO Infrastructure

- Office and labs
- Data centres & supercomputers
- Glasshouses
- Telescopes
- Ships
- Power hungry equipment

CSIRO'S portfolio - locations

TOWNSVILLE
- Woodstock
- Townsville ATSIP

BRISBANE
- Coopers Plains
- Pullenvale
- St Lucia
- Herston
- Dutton Park
- Fortitude Valley

ARMIDALE
- Chiswick
- UNE

SYDNEY
- Nth Ryde
- Lindfield
- Marsfield
- Lucas Heights
- Eveleigh (ATP)
- Kensington (UNSW)

CANBERRA
- Black Mtn
- Crace
- Yarralumla
- Acton
- Ginninderra
- Tidbinbilla

WERRIBEE
- Sneydes Rd
- South Rd

PERTH
- Floreat
- Waterford
- Kensington
- IOMRC Watermans Bay and Crawley

ADELAIDE
- Waite Campus
- Kintore Avenue
- SAHMRI

GEELONG
- AAHL
- Belmont
- Waurn Ponds (AFFRIC/Deakin Uni)

MELBOURNE
- Aspendale
- Clayton
- Highett
- Parkville
- Docklands

Darwin
Cairns
Atherton
Alice Springs
Murchison
Geraldton
Woomera
Bribie Island
Toowoomba
Gatton
Myall Vale
Narrabri
Mopra
Parkes
Newcastle
Boorowa
Irymple
Albury/Wodonga
Hobart
Sandy Bay

CSIRO'S portfolio - facilities

Sum of GFA Area (m2)

High Level Building Categories by GFA

- ✓ Approx. 60% lab-office
- ✓ More than half, older than 25 years

Building Category values (GFA m²):
- Accommodation: 0.3%
- Amenities: 0.1%
- Animal facilities: 6%
- Collection: 1%
- Data Centre: 1%
- Glasshouse: 2%
- Laboratory: 30%
- Library: 1%
- Office: 7%
- Office/Laboratory: 19%
- Process Bay: 4%
- Shed: 3%
- Telescope: 0.3%
- Uncategorised: 23%
- Workshop: 2%
- #N/A: 1%

Category ▾

CSIRO

What is a sustainable building?

- **Serves it's function** – enables organizational goals with occupants feeling safe & comfortable
- **Uses inherently renewable resources** – energy, water, materials (SUPPLY SIDE)
- **Uses only resources it needs**, e.g. no leaks, optimised consumption, etc. (DEMAND SIDE)

Sustainable Infrastructure in CSIRO

PROPERTY STRATEGY

SUPPLY SIDE

- **5MW+ rooftop solar** – reducing peak demand needs, increasing energy security, reducing costs
- **Power Purchase Agreement** - approx. 70% of electricity demand is generated through renewables
- **Geo-cooling -** supercomputer in WA is using groundwater cooling

DEMAND SIDE

- **New buildings & refurbishments -** building and refurbishing more efficiently
- **Equipment upgrades** – more efficient HVAC & scientific equipment, better controls, LEDs
- **Optimisation** – recommissioning, chiller staging, schedule optimisation, fault detection

BUILDING & SITE DATA

Build better

- Pushing the envelope for sustainability in new buildings, making them more sustainable, reliable, comfortable
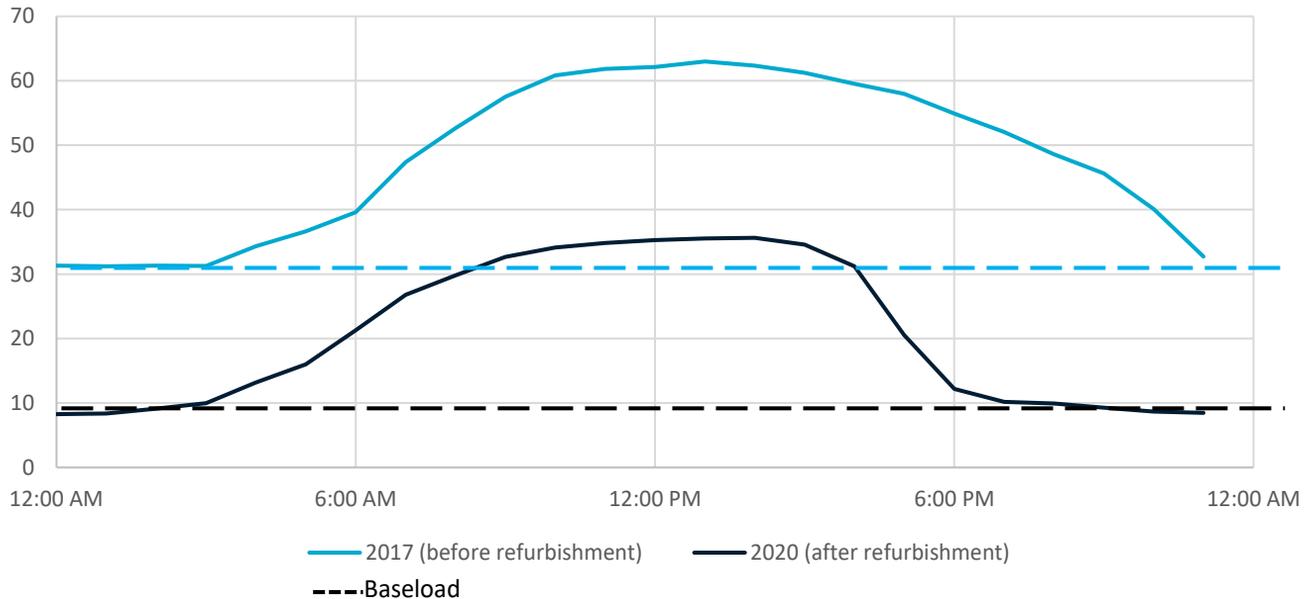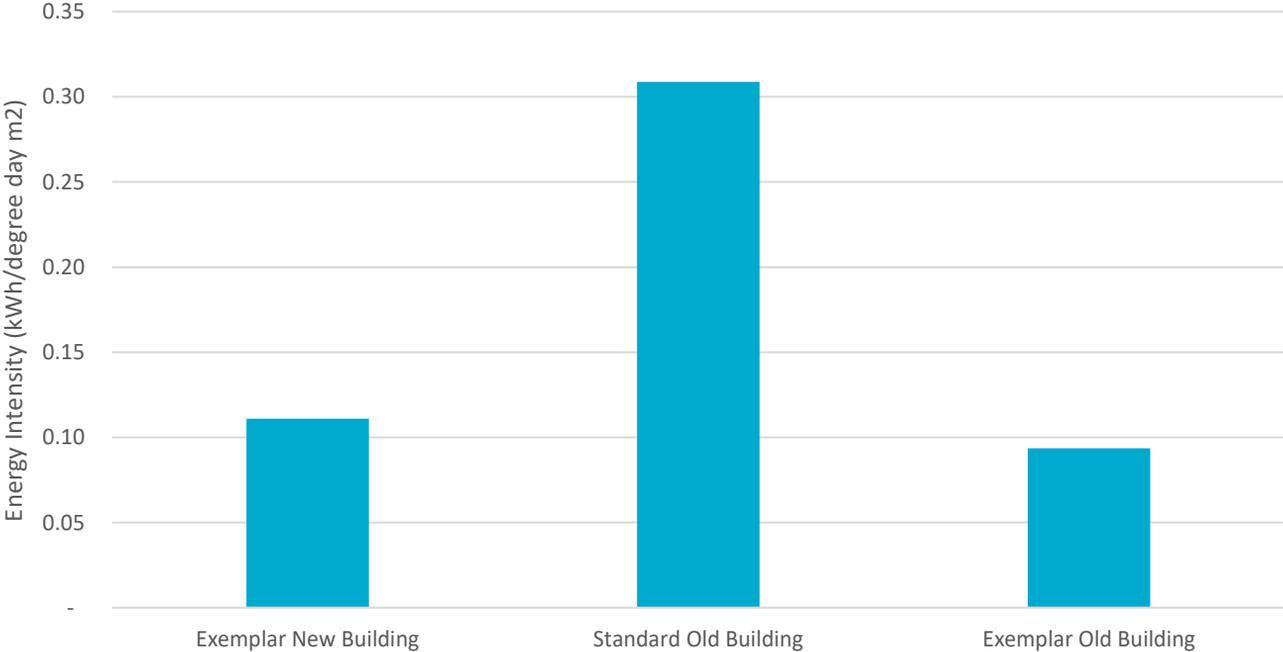- Treat CSIRO buildings as 'living labs'

Refurbish better

Refurbished or Not?

Annual Consumption (kWh/m2)

716.39

338.12

N   Y
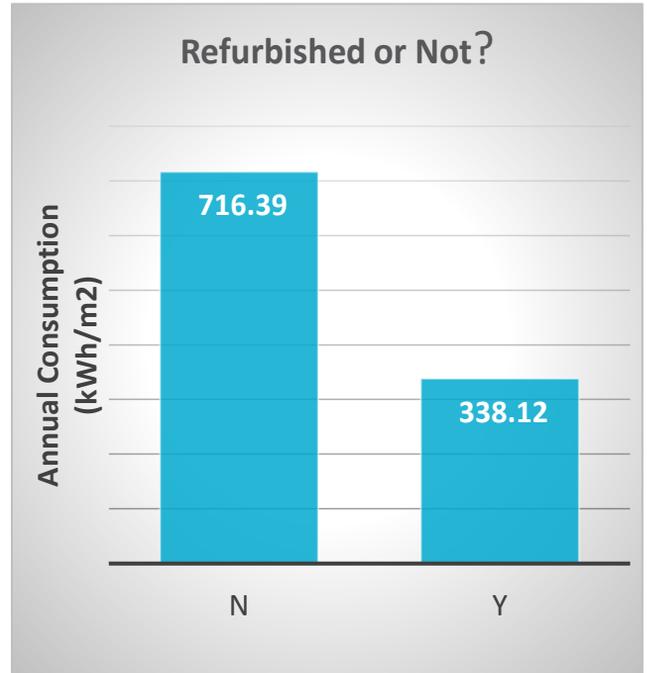
Refurbished building at Black Mountain, ACT

Average Weekday Consumption Profile

Legend:
- 2017 (before refurbishment)
- 2020 (after refurbishment)
- Baseload

New vs Old vs Old refurbished

Energy Comparison between "Model" Buildings

Lessons Learned

1. Being on the edge is fun, but challenging
2. Sustainable measures might be offset by increasing energy requirements
3. Law of diminishing returns

Equipment upgrades

- HVAC equipment – chillers, boilers, VSDs

- LED rollout at 10 sites – more than 2,000 tCO_2e

- Specialised upgrades - 6 automated sashes for Fume Cupboards

- Innovative technologies, e.g. nanotechnologies for chiller coating, adiabatic cooling

Lessons Learned

1. Boring is beautiful
2. 'Cutting edge' can become BAU very quick when right technology comes along
3. HVAC innovations seems to be hard – slow, expensive, risky – so breaking down some of the barriers is needed
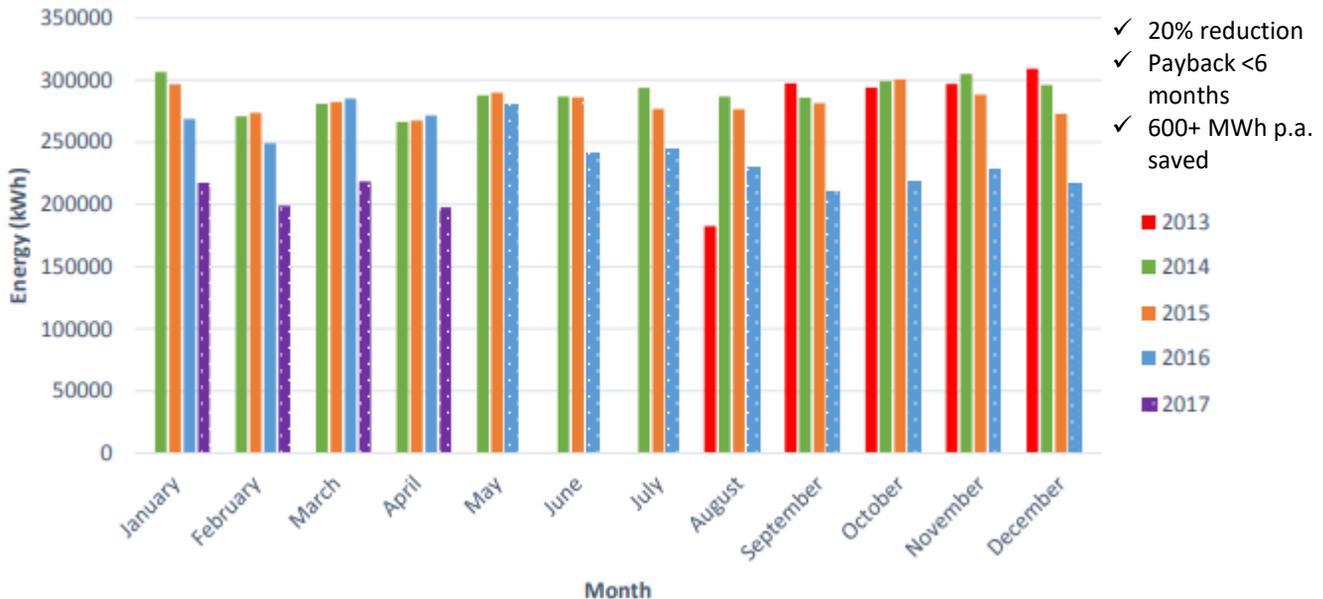
Success 3: Optimisation – Smart Buildings

- Recommissioning
- Fault Diagnostic & Detection Tools
- Staging of chillers
- Engaging occupants - Live Dashboards, engagement programs

Plant Growth Facility before and after FDDT

Year on year consumption

✓ 20% reduction
✓ Payback <6 months
✓ 600+ MWh p.a. saved

■ 2013
■ 2014
■ 2015
■ 2016
■ 2017

Fault Diagnostic & Detection Trials

- Black Mountain, ACT:
  - ✓ Good tool/software
  - ✓ Engaged & knowledgeable FM
  - ✓ Contractors knowledge of site
  - ✓ Good documentation
  - ✓ Findings integrated in R&M process

- Clayton, VIC:
  - ✓ Good tool/software
  - ✓ Engaged & knowledgeable FM
  - ✓ Findings integrated in R&M process
  - X Contractors knowledge of site
  - X Good documentation

Lessons Learned

1. The line between success and failure can be thin
2. Optimisation goes hand in hand with digitalisation
3. Process between tools-operators-occupants ensures the best outcomes

Success 4: Submetering System

- CSIRO Submetering System covers:

  - More than 50% of CSIRO's emission

  - 500+ data points on Top10 energy consuming sites

  - 137 buildings

- Nearly ½ of electricity in Top 10 sites are consumed by 15 buildings (1/4 of all CSIRO's electricity)

- Nearly 70% of energy is consumed by HVAC

- Benchmarking between facilities is not worth

Lessons Learned

1. Just because data is there, doesn't mean it's easy to use:
    - data issues
    - capability and capacity of operators, contractors, sustainability teams
    - limitation of buildings
2. Prevention is better than a cure... Theoretically.
3. Managing many data points is challenging:
    - Many moving parts make maintenance hard
    - Trust issues with data
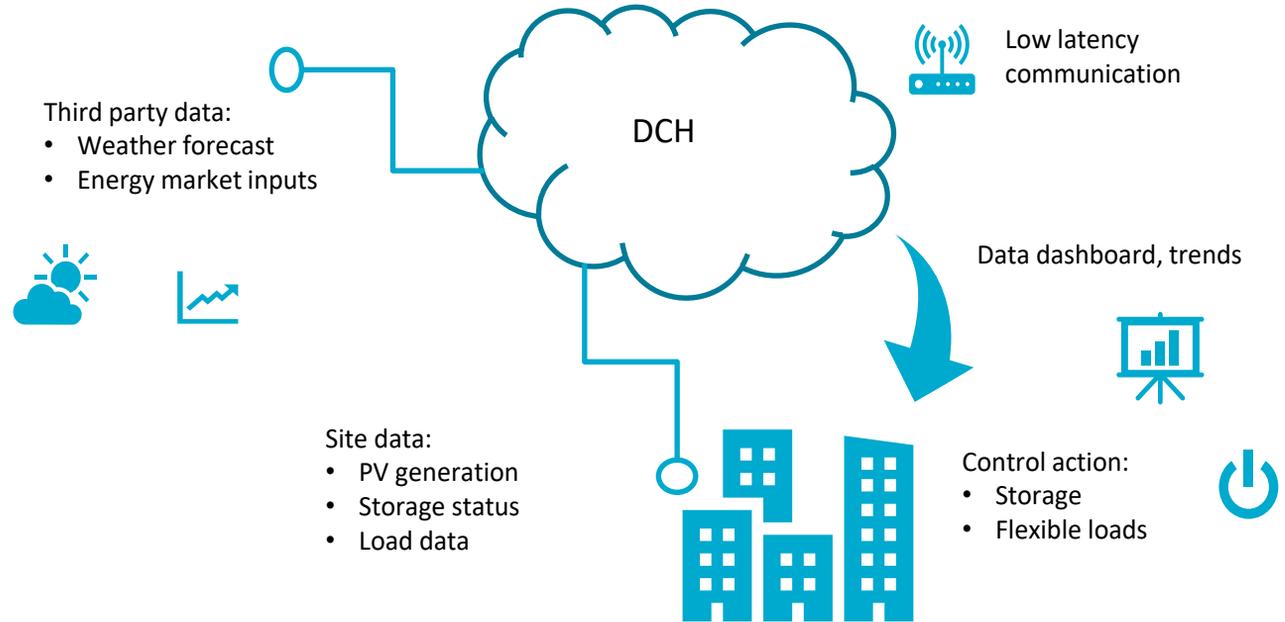   - Underutilisation of data

Next frontier

1. Smarter Buildings - digitised, agile, comfortable and optimised
2. Engaged Occupants - using building no more, no less than needed
3. Smarter Operators - smart & relevant building for meaningful improvements
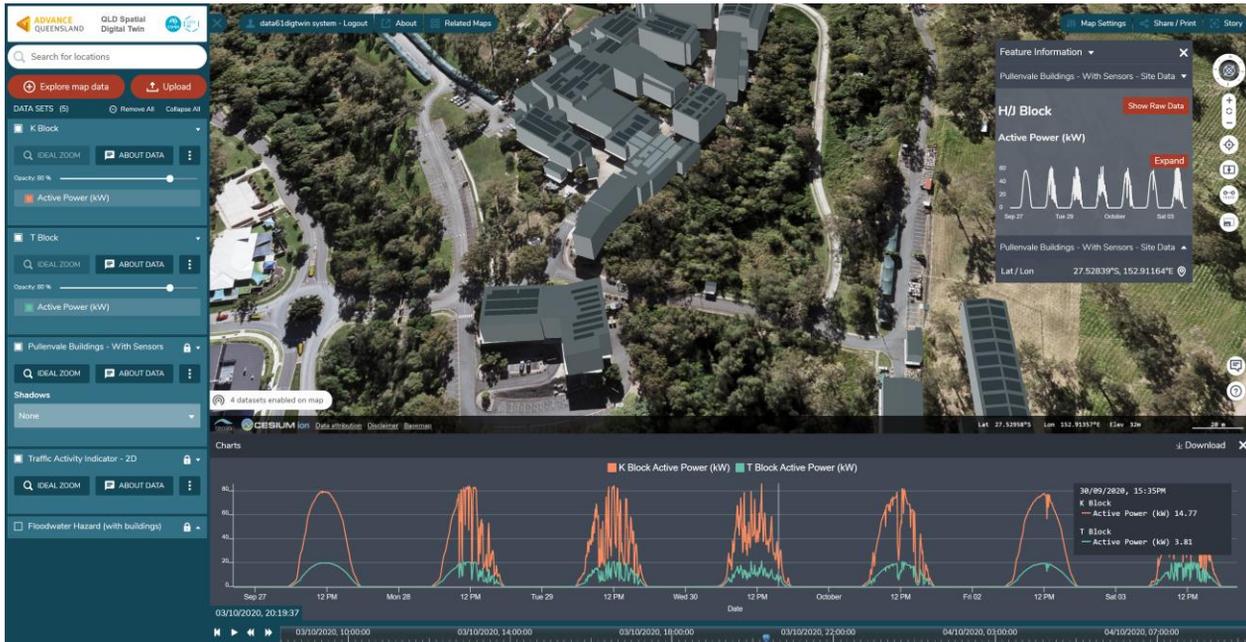4. Living Labs - demonstrating the power of new inventions in our buildings

Data Clearing House

Digital Twin Pullenvale

Balancing old & new - speed of change is accelerating & slow at the same time - how can we leave no building behind?

Thank you

CSIRO