Incorporating novel energy technologies into university buildings

The Sir Samuel Griffith Centre

Ned Pankhurst, Senior Deputy Vice Chancellor, Griffith University, 22 Feb 2016

Session I : Key Note Speeches: Green Technology and sustainable strategies for Planetary Health

"Eco-Friendly Hospitals For A Sustainable World"

Public buildings as a platform for energy innovation

- New technologies typically:

  are expensive
  carry increased construction and commissioning risk

- In consequence, private sector investment in novel technologies at scale is limited

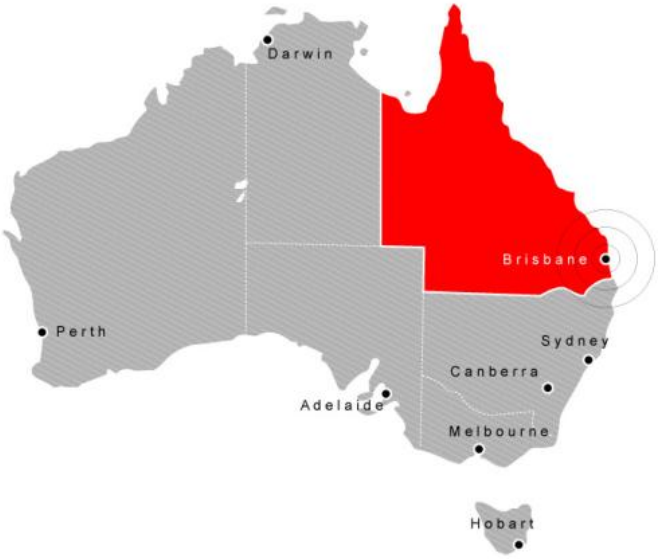
- Public sector entities may be able to assume these risks:

  where there is government or third party support
  where proof of concept aligns with institutional strategy or priority
  where risk is part of research activity

- Universities are well placed to engage in these activities as proof-of-concept at scale

Campus Renewal

- Griffith is a 45 year old university
- Rapid growth (450 students in our foundation year, now 43,000)
- 5 campuses south from Brisbane to Queensland NSW border
- Older campuses typical of Australian ‘gum tree’ campuses constructed in the 1970s
- Parklands, forests and impermeable concrete faces
- Process of campus renewal and refreshment



Campus Renewal

A Sustainability Agenda

- Coincidence of the Australian Federal Government's Education Investment Fund (EIF) Sustainability Round of funding and Master planning for our Nathan campus

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- The cornerstone of environmental science, multi-disciplinarity and sustainability as foundation components of the University teaching and research portfolio
- 6000 environmental science graduates
- Major research investments through the Nathan-headquartered Australian Rivers Institute, Environment Futures Centre, Asia Pacific Centre for Sustainable Futures, Environmental Engineering
- Desire for a capstone project uniting themes through an iconic 'arrival' building

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Education Investment Fund Sustainability Project

"**The objectives of the EIF Sustainability Round were to:**

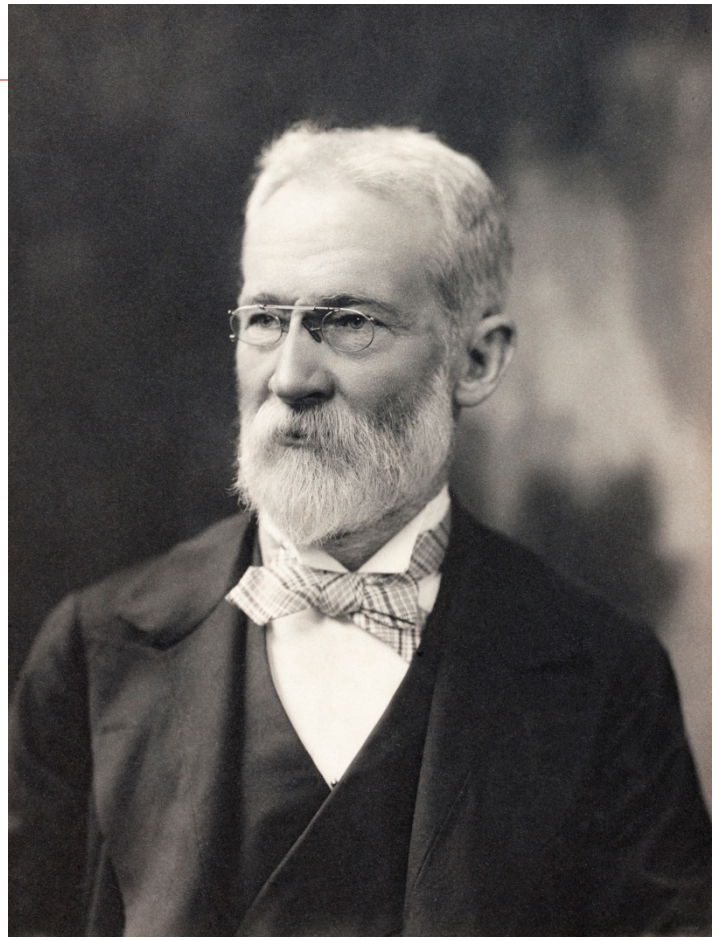
- advance teaching and/or research in areas relating to climate change and environmental sustainability,
- display leadership in the development and demonstration of environmentally sustainable infrastructure, and
- contribute towards the Australian Government's priorities concerning climate change and sustainability.

"Projects will both advance teaching and/or research related to climate change and sustainability and showcase environmentally sustainable design. Some projects may also act as demonstration sites for new and emerging technologies that can be tested at scale."

Program Guidelines EIF Round 3 & EIF Sustainability Round

Features of the project

- **A project that:**
  - Includes a solar power-hydrogen production energy management system at demonstration scale
  - Integrates business, engineering and environmental science disciplines around sustainability
  - Builds critical capacity in climate change adaptation research
  - Is key to the Nathan Campus redevelopment in the footprint of the Toohey Forest
  - Brings industry collaborations for uptake of the technology for renewable power generation at urban and remote locations



Sir Samuel Griffith

- Chief Justice and Premier of Queensland, author of Federation agreements, first Federal Chief Justice
- Reformer, legislator and innovator in law and governance, advocate of education

Partnerships and Funding

Partners

- Cisco Systems
- AGL Energy Ltd
- Queensland Government (Education Queensland)
- Brisbane City Council
- Power and Water Corporation (Northern Territory)

Funding

Australian Government (EIF)	$21M
Griffith University	$22M
Queensland Government	$1M
Cisco Systems	$1M
Total	**$45M**

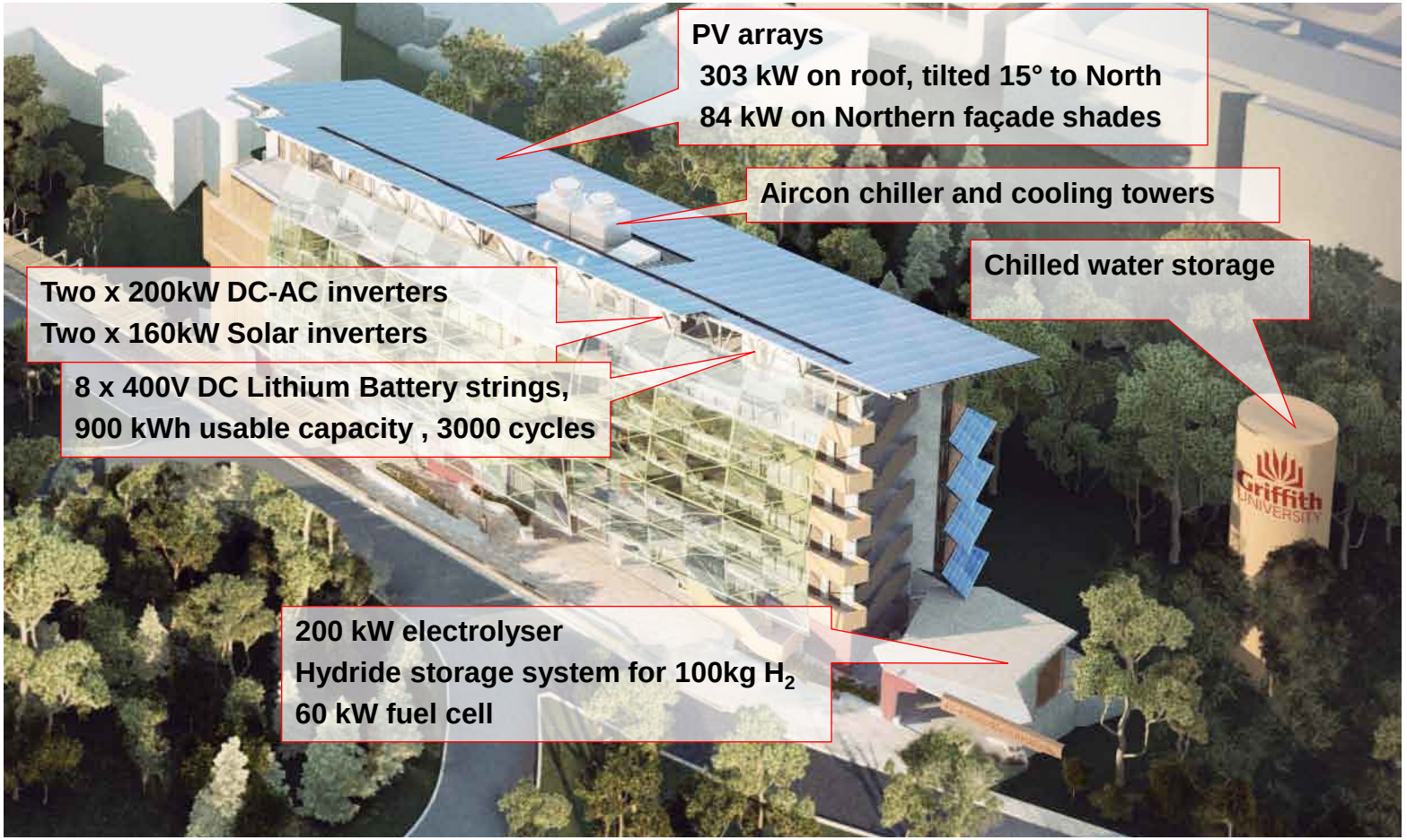
Nathan Campus EcoCentre

Sir Samuel Griffith Centre

- Statement building that presents possible energy futures
- Building that people come to visit
- Building that tells a story about us
- A project that builds collaboration across key research areas
- A concept that people can copy

What were we trying to do?

Some technical stuff…



All the energy for the building comes from the sun

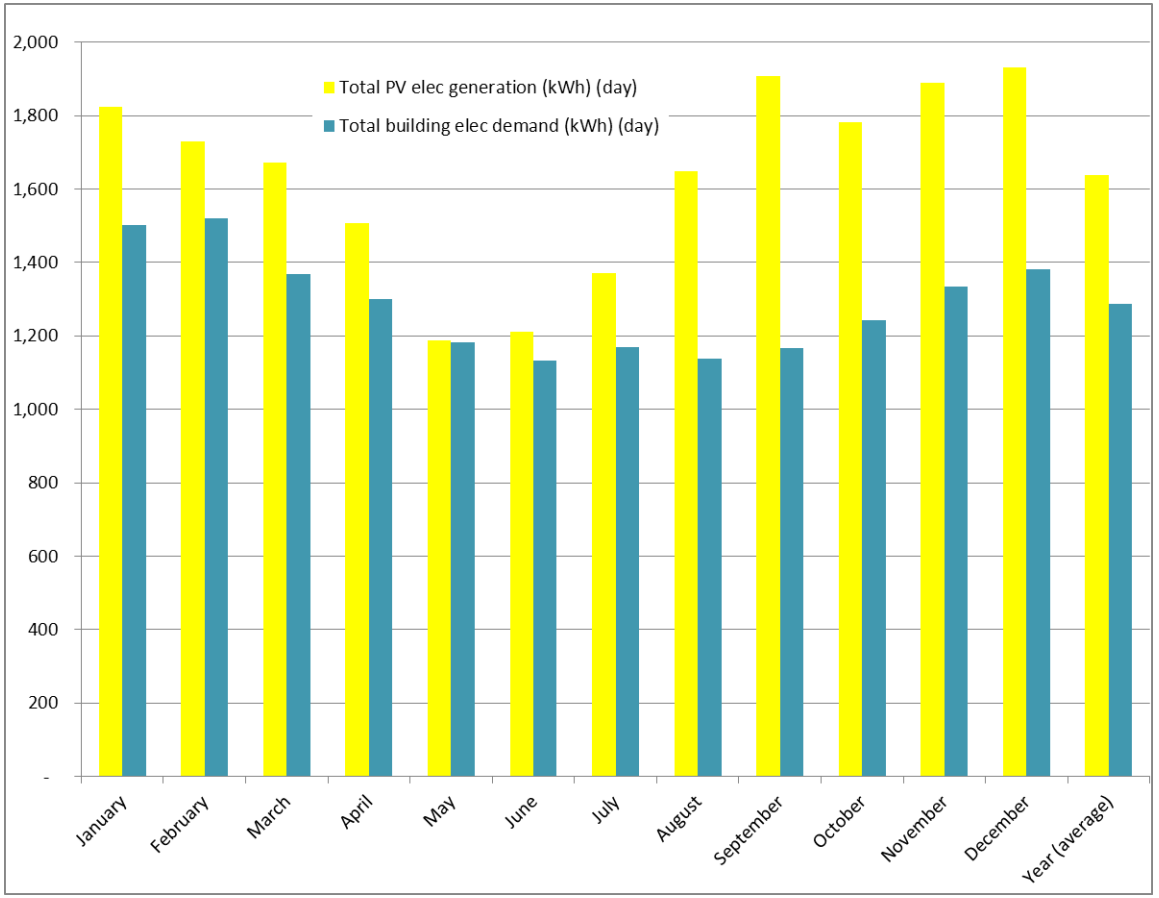
Energy generated by PV system:

- 1800-1900 kWh per day in Spring and Summer
- 1200 kWh in Winter
- average 1640 kWh per day

Energy consumed by building:

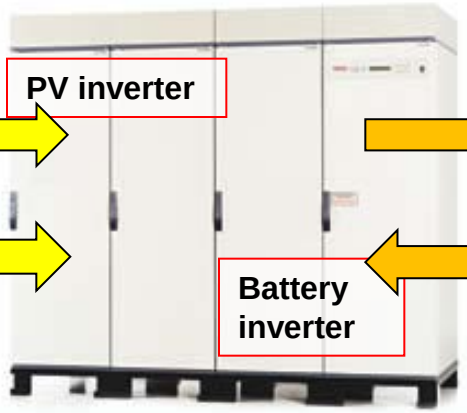
- 1500 kWh per day in January and February
- < 1200 kWh in Winter
- average 1290 kWh per day

On average, PV generates 25% more energy than building consumes



Energy flows

PV array

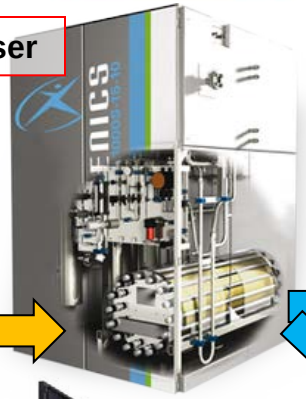


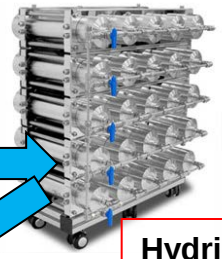
PV inverter

Batteries

Battery inverter

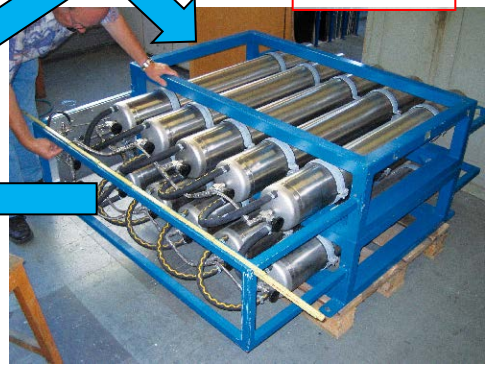
Electrolyser





Hydride storage

Fuel Cell

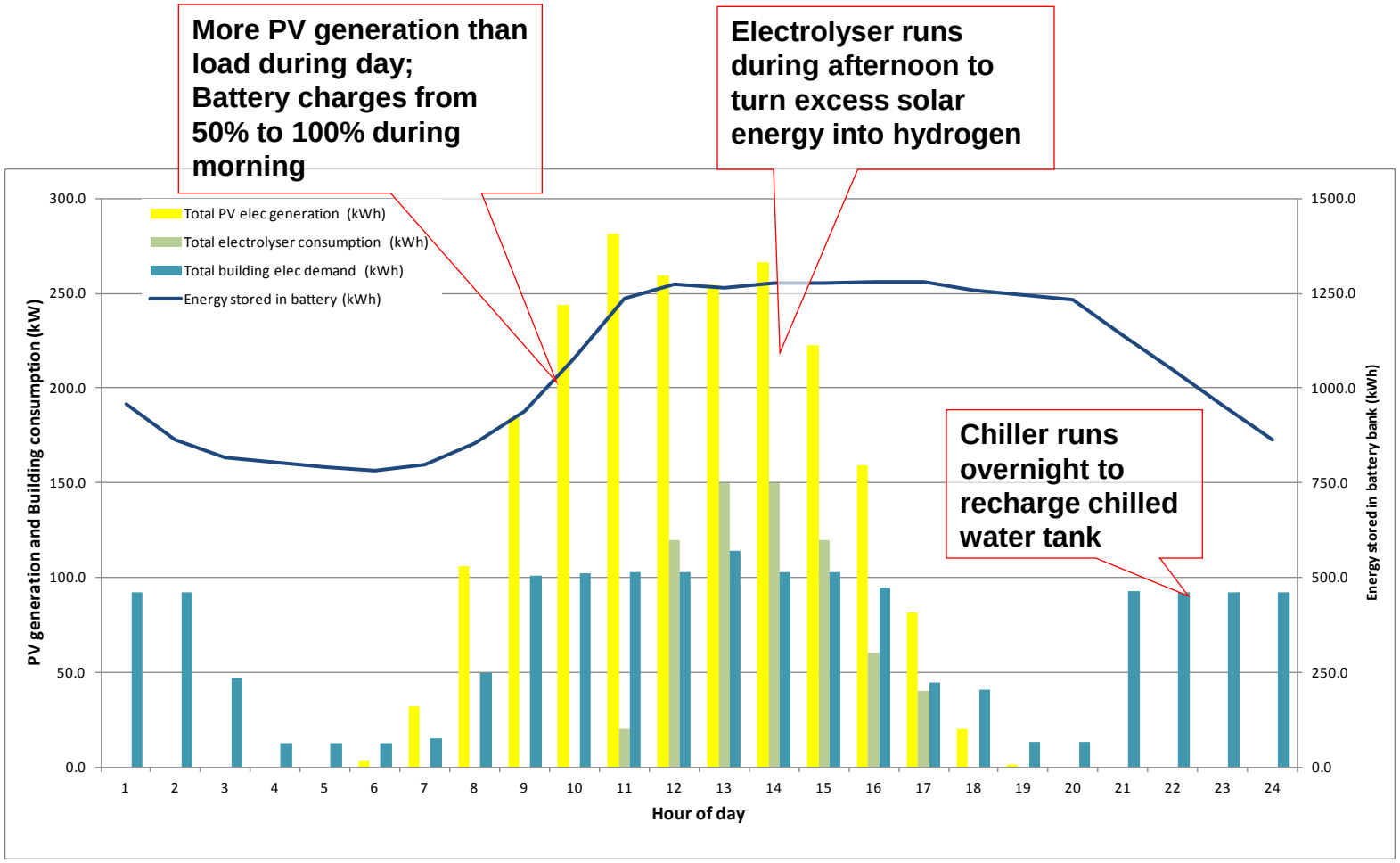


Building load

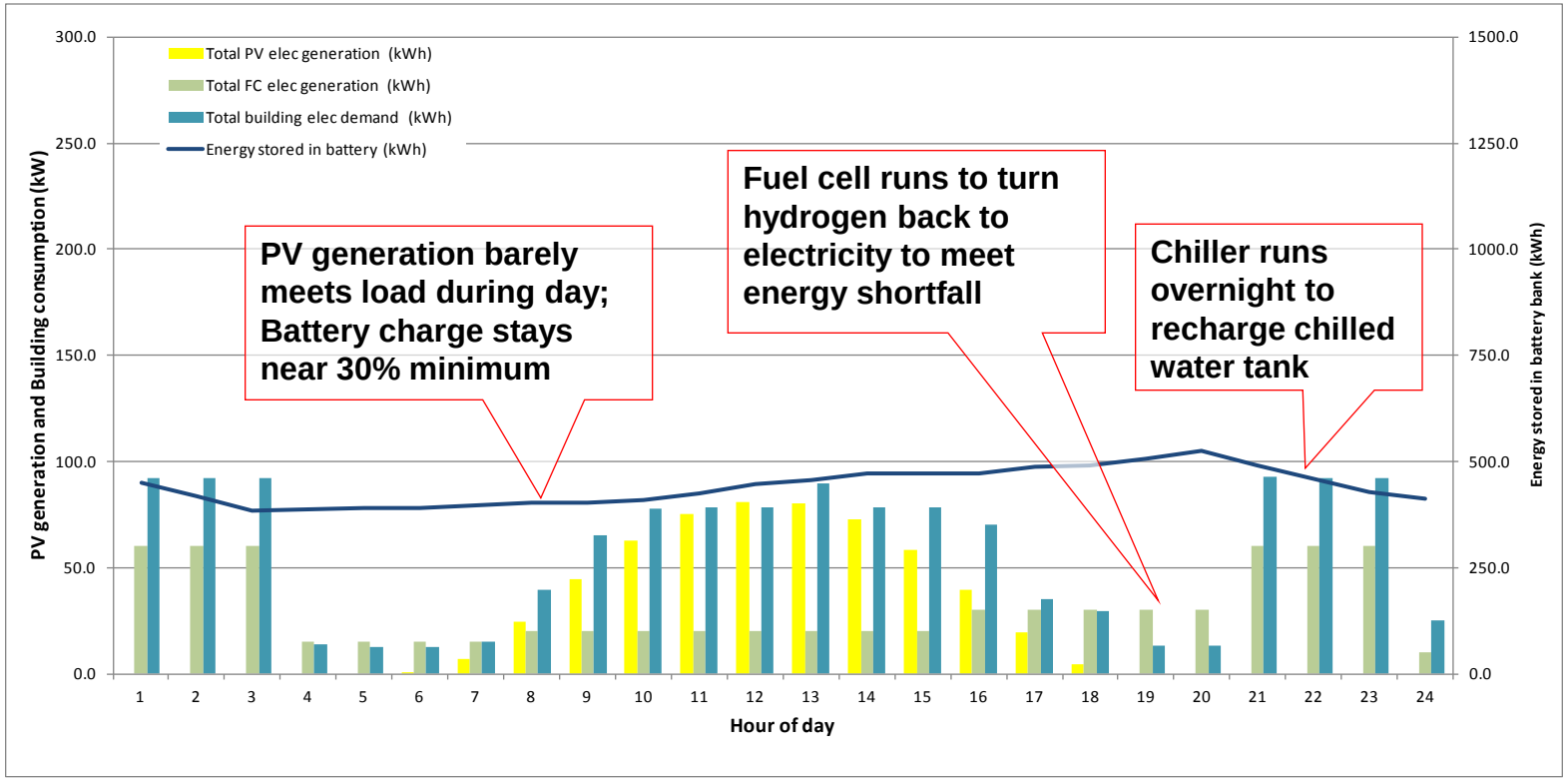
Hydrogen storage

- Bespoke design of large scale hydrogen storage (complexed as metal hydrides)
- Designed and constructed to our specifications by Japanese Steel Works
- Capable of holding 100kg of gaseous hydrogen (commercially available systems have much lower storage capacity)

A sunny day – extra energy stored as Hydrogen



A cloudy day – Hydrogen turned back to electricity



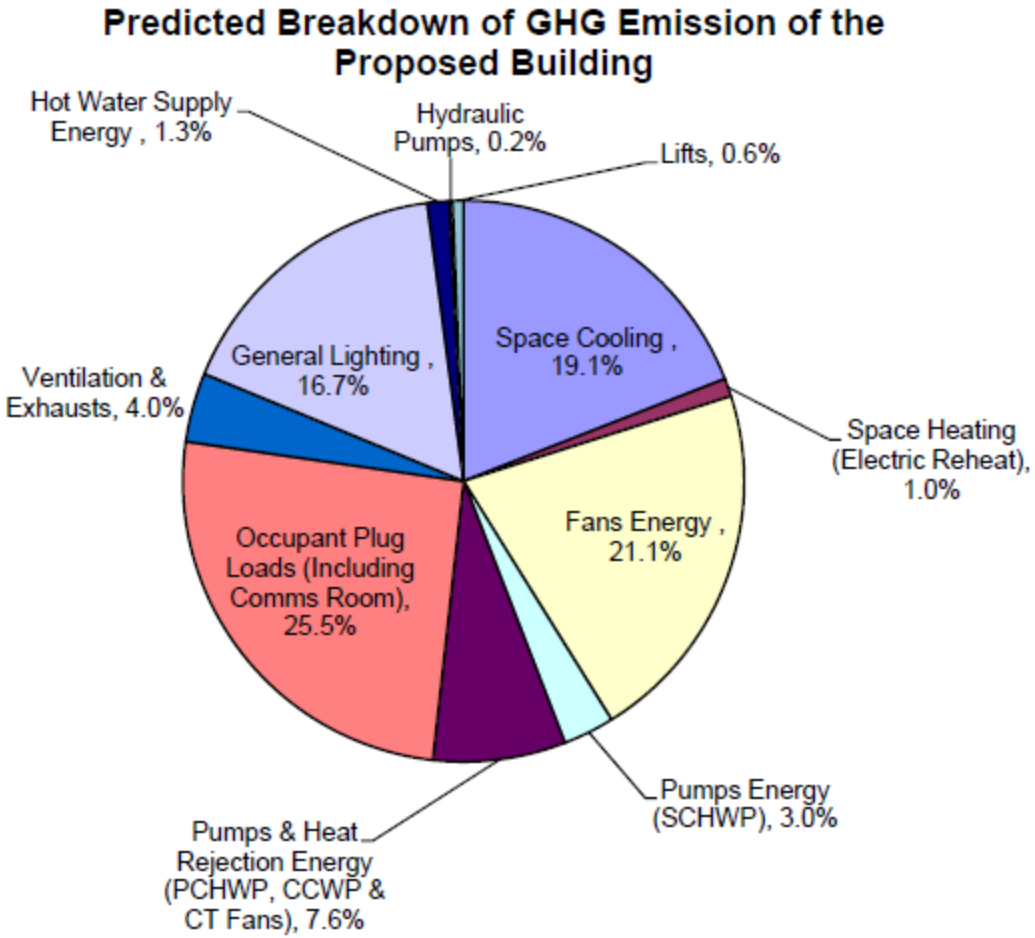
Building energy consumption is minimised

Energy consumed by building:

- 1500 kWh per day in January and February
- < 1200 kWh in Winter
- averages 1290 kWh per day

Demand is minimised, efficiency is maximised:

- Typical daytime demand is 110 kW
- Airconditioning chiller runs overnight in cool night air to recharge chilled water tank, 90 kW
- Demand at dawn is 10 kW

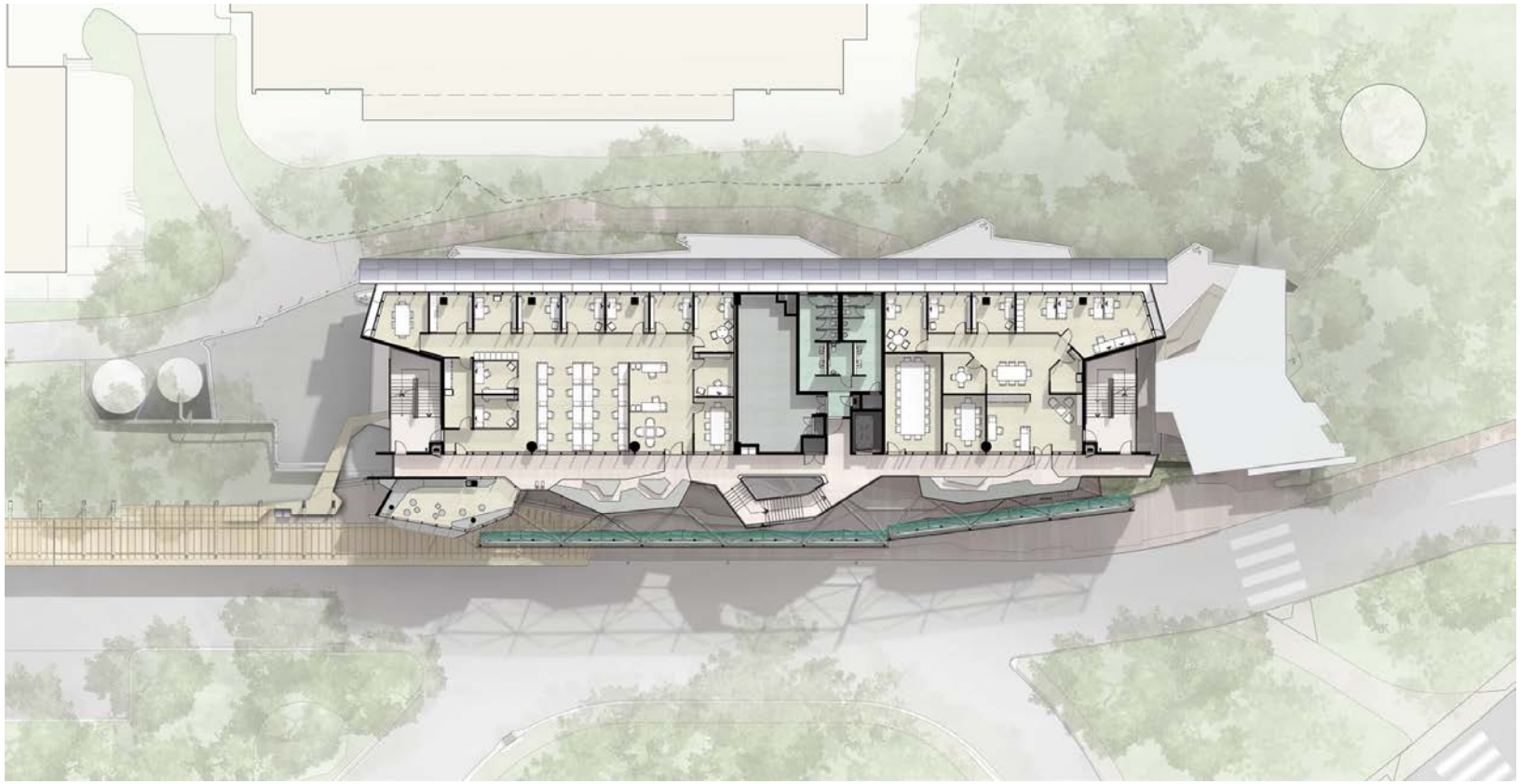


Some Design Challenges

- High level of energy efficiency
- Building design to minimise energy use
- Open plan organisation
- No energy intensive laboratory space
- Smart energy management system
- Solid state hydrogen storage design and location
- Site constraints and building footprint
- Photovoltaic collection surface area, tilt and orientation
- Design consistent with use expectations

Some cultural stuff and some ironies…

- Universities deliver research and innovation
- Universities often have very conservative staff and operational procedures and practices
- Academic staff don’t like change



Don’t mess with my computer….

Network management software (Cisco Energywise) and affiliated reporting tools remotely monitor and power down devices such as IP Phones, Ethernet Clocks, Digital Media Players, Virtual Desktop devices Wireless Access Points and Audio Visual equipment when they are not in use.

- Network & Telephony Service
  - » Provide all network ports with Power Over Ethernet management capability

- Computing Service
  - » Plan for 100% Thin Client computing for Postgrad Students (80 students)
  - » Plan for 80% Thin Client Computing for Staff (110 staff)
  - » Virtual Servers hosted in Central Data Centre

Other cool stuff…..

- The primary design component is the south-facing circulation spine
- naturally ventilated, it's curved glass 'rain-screen' opening at the ends and splitting in the middle to include air flow.
- The northern façade is protected by full-length, 2 metre wide horizontal louvres which both provide shade to glazing and support continuous blades of solar photovoltaic cells.
- Photovoltaic cells over the entire roof both also provide inherent insulation.
- At ground level, entry is via a breezeway, which cuts through the building, this space including further natural ventilation up into the south-facing 'verandah' edge.

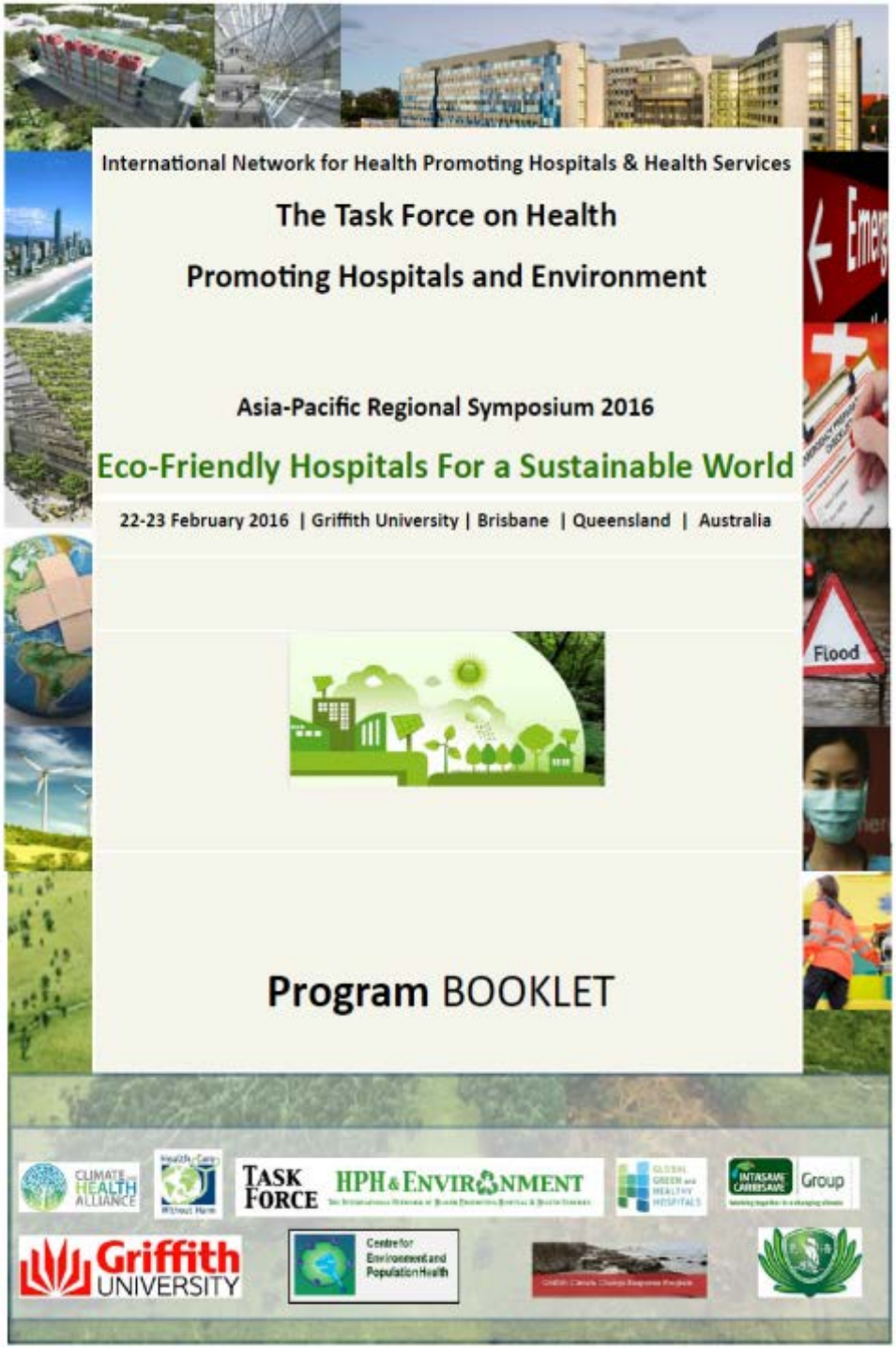
More cool stuff….

- The fuel cell facility at the eastern end is exposed to view from the street and from its pedestrian forecourt
- The chilled water for the air conditioning is stored in a 21 metre high chilled water stratification tank exposed as a design feature
- Open plan workspaces and offices are supplied with both air conditioning from the system and fresh air directly from adjustable vents on the perimeter.

What have we learned?

- In house technical capacity is paramount
- Install diagnostics and metering at all points in the system at the outset (essential for performance monitoring and fault finding)
- Buy locally
- Integration is key –employ the best software engineers
- Understand the self-protect software in componentry
- Don’t be too credulous of third party modelling
- Understand the way that (and when) building energy loads change and how this affects energy production
- Understand the real performance characteristics of photo-voltaics

- **Green Building Council of Australia**
- **6 star rating for Design and As Built**



AN INTERNATIONAL KNOWLEDGE AND PRACTICE-SHARING REGIONAL SYMPOSIUM ON

"ECO-FRIENDLY HOSPITALS FOR A SUSTAINABLE WORLD"
MONDAY, 22nd Feb 2016

Griffith University, Nathan Campus

Hosted by The Task Force on Health Promoting Hospitals and Environment
of International Health Promoting Hospitals and Health Services Network
and co-hosted by Griffith University
Venue: Griffith University Nathan Campus, Building N18 (Central Theatre), Theatre II

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