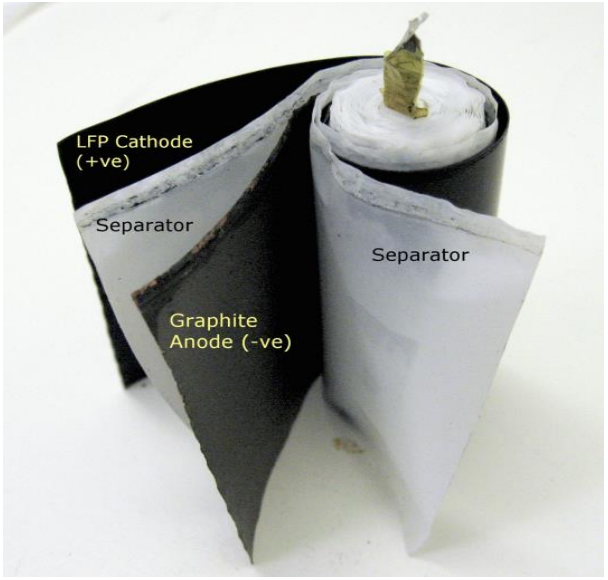
QUT Battery Interest Group (BIG)

Queensland University of Technology (QUT) has four domains of capability and engagement in analysing energy retail business models, developing battery materials, improving battery cell management and optimising network connections. QUT can assist industry to research the integration of storage in energy markets, battery material design, construction and testing (see key domain contacts below).

1. Research capability in battery materials development and testing



QUT has wide ranging expertise in materials development, characterisation and testing for energy storage technology. There are several key personnel in the School of Chemistry, Physics and Mechanical Engineering and the Institute for Future Environments that can design and synthesise electrode materials and electrolytes suitable for battery applications.

There is a suite of instrumentation available to characterise such materials pre and post operation in a working device including X-ray photoelectron spectroscopy, X-ray diffraction, Raman and FTIR spectroscopy, thermogravimetric analysis, elemental analysis, optical microscopy, atomic force microscopy, scanning electron microscopy, transmission electron microscopy and scanning helium ion microscopy. This will provide the required information to probe structure/composition-activity relationships to understand the workings of a battery.

Battery making and testing facilities include a state of the art glovebox, coin cell press, 12 channel battery testing galvanostat (Biologic) as well as sophisticated localised electrochemical imaging facilities that include scanning electrochemical microscopy (SECM), intermittent contact SECM and ac-SECM (Biologic) to probe on a micrometer level the performance of battery materials.

In addition there are experienced staff that have capabilities in modelling the fundamental processes involved in battery processes such as Li ion intercalation/de-intercalation, crystal structure changes, kinetics of Li ion diffusion, charge distribution and band structures and solid electrolyte interphase formation on electrodes.

Key personnel

- Prof. Peter Talbot – email: p.talbot@qut.edu.au
- Prof. Jose Alarco
- Prof. John Bell
- A/Prof. Geoffrey Will
- Dr Jinzhang Liu
- Prof Nunzio Motta
- Dr. Anthony O'Mullane
- Dr. Hongxia Wang
- Dr. Aijun Du

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2. Research capability in battery cells management

Charging schemes based on minimal battery degradation

Present battery charging schemes have relied on battery state of charge as the main criteria in developing such schemes. However, charging schemes based on accurate electrochemical models representing battery health and battery degradation mechanisms are hard to find. The models that address electrochemical kinetics, intercalation and diffusion can accurately estimate battery internal state variables giving indications of battery health and status of degradation. Such models can be mathematically complex, therefore model simplifications are necessary for them to be used in practical battery charging and control schemes effectively.

Key personnel

- Prof Mahinda Vilathgamuwa – Email: mahinda.vilathgamuwa@qut.edu.au
- Prof Gerard Ledwich
- Prof John Bell

3. Research capability in network connections

Role of batteries in electricity network (Transmission and Distribution grids)

Australia has seen tremendous growth of intermittent renewable generators such as PV and wind in the recent years. The traditional ways of planning and operation of both the transmission and distribution electricity networks will have to change to accommodate these intermittent sources. Energy storage will play a significant role in this new era, and will bring several benefits: peak lopping and demand response, energy market participation and support for renewable energy dispatch, frequency support and inter-area angle control and disaster resilience. This project will investigate the optimal sizing and placement of energy storage units, in particular, batteries, in transmission and distribution networks to maximise these benefits.

In addition to the modelling and simulation work, electrical testing of batteries and systems can be conducted at QUT's Heavy Current Laboratory (HCL) at the Banyo PPP. The HCL can test at the 415 V AC level, with loads up to 200 amps. All electrical quantities can be measured with a sample rate up to 1000 samples per cycle. This allows all typical transients to be captured for post processing analysis. The HCL is moving to full "Power Hardware in the Loop" testing which will add the capability of simulating real network operating conditions for battery systems, over a very wide range of network scenarios.

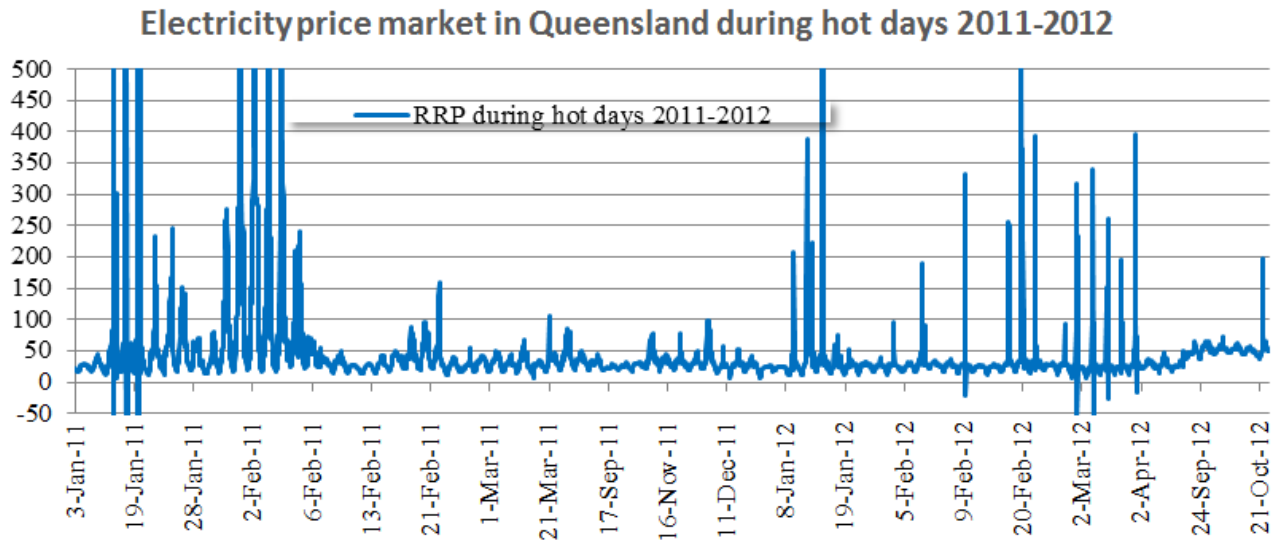
Furthermore, there is an extensive research in the area of agent based modelling (ABM) to support planning for battery size and placement. ABM software has been developed that simulates future demand together with an optimisation program that optimises placement and sizing of batteries on the network to support peak lopping of maximum demand.

Key personnel

- Dr Yateendra Mishra – Email: yateendra.mishra@qut.edu.au
- Assoc/Prof Geoff Walker
- Prof Mahinda Vilathgamuwa
- Prof Gerard Ledwich
- Adj/Prof Richard Taylor (HCL)
- Prof Robin Drogemuller (ABM)
- Mrs Fanny Boulaire (ABM)

4. Setting up business environment with the right business signals

The use of batteries has many benefits to electricity customers and networks. The specific storage solutions for different classes of customers depend on the tariffs applied. For industrial customers there is a peak half hour demand charge per month as well as an energy charge. It is the use of battery and PV systems to reduce this peak demand charge which can form the basis of a business case for investment. There are opportunities for aggregators to negotiate rewards for the impact of multiple customers with controllable storage on different sectors of the electricity supply chain. Bring together multiple rewards with enhance the business case for battery investment for a wider group of customers. Alternatively introduction of a distribution congestion charge could provide an incentive for residential and SME customers to invest in batteries.



Key personnel

- Prof Gerard Ledwich – Email: g.ledwich@qut.edu.au
- Prof Uwe Dulleck
- Dr Anula Abeygunawardana