LOW CARBON LIVING CRC

Open-Source Embedded Network and Microgrid Modelling Tools for Consumers

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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).

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Acronyms

DUOS	Distribution Use of System
PV	Photovoltaics
UI	User Interface

Executive Summary

With the increasing deployment of distributed solar PV, and more recently the increased interest in distributed batteries, optimising their deployment configurations and financial outcomes is now receiving more attention. Currently, when a customer exports PV electricity to its neighbours on the distribution network, the full distribution use of system charges are paid. Reducing these payments through the use of embedded networks in apartment buildings or through special arrangements in mini grids could significantly improve PV's financial attractiveness. However altering the DUOS component of tariffs can also have significant impacts on network service providers and electricity retailers.

Here, a User Interface has been successfully developed that enables any user to access two models developed at the University of NSW: the multi-unit dwelling model and the mini grid model. This can now be done without having to learn how to program in the original open source code.

These models will help increase the uptake of renewable energy generation and other distributed clean energy technologies in embedded networks and in mini grids. This will deliver lower greenhouse emissions from the electricity sector in Australia, while supporting community-led engagement in lower carbon living.

Introduction

High penetration of distributed PV and battery storage systems is currently an area of focus for governments, regulators, networks, technology providers and consumer groups, with many trials being undertaken throughout Australia. These trials focus very much on the technical impacts, with relatively little attention being paid to the financial impacts on the different stakeholders involved. Currently, when a customer exports PV electricity to its neighbours on the distribution network, the full distribution use of system (DUOS) charges are paid. Altered tariffs with reduced DUOS would increase the financial viability of PV but would have unknown impacts on the networks and hence on other customers. Exported PV electricity may also be able to be on-sold at a lower tariff than retail electricity, reducing costs for customers that don't have PV, thus also helping retailers with customer acquisition. The coordinated use of PV and batteries can also help to develop sections of the network with greater independence and hence reliability, but the relative sizes of PV, batteries and loads need to be optimised.

Two PV deployment options that provide opportunities for tariffs with reduced DUOS are multi-unit dwellings and mini grids connected to the main network.

Two beta-version open-source modelling tools have been developed by UNSW researchers to explore these two options. One is for embedded networks in multi-unit dwellings and the other is for local mini grids within the distribution network. These tools have been used by researchers in partnership with a number of industry stakeholders.

The multi-unit dwelling model was developed with apartment blocks in mind, and analyses electricity generation and distribution under different technical and ownership arrangements of PV and batteries. For example, possible options include individual household ownership or shared behind the meter ownership, which can then be used to meet common property loads or individual loads through an embedded network. it then calculates the resultant financial flows amongst the occupants.

The mini grid model calculates the electricity flows for customers with or without PV, including the use of exported PV electricity by neighbours or a central battery or the wider grid. It then allows the application of different tariffs to these electricity flows and the resulting financial outcomes for the customers as well as the network service provider and the electricity retailer. A key point of difference between the models is that in the mini grid model the network is owned by the network service provider; which has implications for tariffs and financial flows. Both allow optimisation of PV and batteries to maximise renewable energy generation and reduce bill costs.

Currently, these models are only accessible by people with a good working knowledge of the programming language Python. This aim of this project has been to greatly expand use of these models by a wider audience by creating a User Interface (UI) that makes it much easier to use these tools.

Approach

The approach undertaken included three stakeholder workshops: one at UNSW, one in the Sydney CBD and one in Byron Bay (the location of the mini grid that initiated the mini grid model).

The first workshop elicited stakeholder feedback on the initial design of the UI and the operation of the models. The second and third were to launch the UI and the refined versions of the models and to elicit further feedback. All workshops included options for feedback both directly and via an online survey.

The workshops were attended by a total of 92 people. This was made up of 24 from business, 13 from community groups, 43 from research organisations and 12 from government. They included:

- Business: Wattblock, LO3, Enova Community Energy, Solar-e, Westnet, Anamise, ITP Renewables, Australian Sustainability Institute, Solar Analytics, Allume Energy.
- Community groups: Solar Citizens, COREM, Energy Consumers Australia, Our Energy Future.
- Researchers: UNSW, Sydney University, RMIT, Monash University, UTS, ANU.
- Government: Ausgrid, NSW government, Local governments from Inner West, Lismore, Byron Bay, City of Sydney, Clean Energy Finance Corporation, IEEE, Australian Energy Regulator, CSIRO.

The UI's for the models were subjected to internal review before being released to a select group who had expressed early interest in the models. They were then released more widely for review, before being launched at the final two workshops.

Outcomes

The tools and UI have been publicly released and trialled by about 10 different organisations. They are on the UNSW website below and are open to anyone to use.

http://www.ceem.unsw.edu.au/solar-apartments-and-microgrid-models

These models will help answer questions such as:

- Is it appropriate to install (more) solar PV in a certain region?
- It is appropriate to install a battery / multiple batteries, and how large should the battery/batteries be?
- What are the implications of different battery operational strategies?
- How much should each customer be paid for the electricity produced/shared/traded, and what are the

implications for the network service provide and the electricity retailer?

- What are the most suitable technical implementation and business model for PV deployment on a particular apartment building?
- What internal tariff arrangements distribute the costs and benefits of PV most equitably between different stakeholders in an embedded network?

The minigrid tool has already been used for a project at the Arts and Industrial Estate at Byron Bay. It was used for the first Stage 1 of this three stage project to estimate the financial impacts on Essential Energy, Enova Energy and customers, of changes to component of the tariffs applied to export and use of PV electricity. It also provided valuable information on the impact of different sized PV systems and a centralised large battery on these outcomes. It will also be used during the second stage of this project, which has now commenced. On an ongoing basis it will use the data obtained during the trial to keep track of the financial impacts of different possible tariffs on all stakeholders, and so will inform the final tariff designs, as well as the need for a central battery.

Conclusion

A UI has been successfully developed that enables any user to access both the multi-unit dwelling and mini grid models without having to learn how to program in the original open source code.

These models will help identify optimal organisational arrangements and financial settings. This will help increase the uptake of renewable energy generation and other distributed clean energy technologies by multi-unit dwellings (embedded networks) and in local distribution networks. This will deliver lower greenhouse emissions from the electricity sector in Australia, while supporting community-led engagement in lower carbon living.

Figure1 Solar Panels

Figure 2 Adelaide Zoo

<table>
<tr><th>Project Name</th><th>Location</th><th>Aim</th><th>Engagement Activities</th><th>Challenges</th></tr>
<tr><td>TrIsCo .</td><td>Hampshire, UK; Andalusia, Spain; Viismi, Estonia; Gotland, Sweden</td><td>Transition Island Communities: Empowering Localities to Act - a two year project – July 2009 to September 2011 - aimed at overcoming the barriers to implementing low carbon communities

To engage variety of communities each at a different level of involvement in the climate change debate.</td><td>• Measuring Energy use
• Educational programs
• Training programs
• Community engagement (Climate street parties; A Solar and Biomass Heating Fair)
• Knowledge Exchange & Policy influence</td><td>• Not identified</td></tr>
<tr><td>Low Carbon Community Project</td><td>Shropshire Country Council</td><td>To achieve significant reduction of CO_2 emissions within three local communities, involving household residents and business</td><td>• Home energy checks, business and building audits, energy efficiency grants and ‘Climate Change Months’ awareness-raising activities</td><td rowspan="2">• Dissemination of information campaigns thwarted by apathy and indifference towards climate change among community members
• Difficulties associated with engaging community members
• Building trust between authorities and communities in relation to establishing and maintaining relationship</td></tr>
<tr><td>Green Living Centre</td><td>London Borough of Islington Council</td><td>A community resource to help people in the Borough reduce their carbon emissions in and around the home</td><td>• Face-to-face advice to visitors on recycling, energy, efficiency, biodiversity and green travel. One-off events to boost the Centre’s profile and engender greater interest and increase visitors numbers</td></tr>
<tr><td>Low-carbon Communities Challenge</td><td>22 communities across the UK</td><td>To fund, and learn from, community-scale approaches to the delivery of low carbon technologies and engagement activities.</td><td>• Face-to-face, personal approaches such as door knocking, using either trusted local residents or local councillors;
• Training energy or community champions to spread awareness and knowledge in the community and provide residents with ‘go to’ points;
• Involving schools in a project to raise awareness and engender support
• Having a well-known local person to champion the work. For example, Kirklees enlisted the support of a local councillor to go door knocking over a weekend;
• Getting the strongest and loudest opponents on side</td><td>• resistance within the community which have been related to lack of community consultations from the outset
• Project expectations and assumptions didn’t match those of wider community</td></tr>
</table>

Reference