



LOW CARBON LIVING
CRC

National Forum on Expanding Local Renewable Electricity for Household, Precincts and Communities

Report



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Contents

List of Figures 4

Glossary 5

Acronyms 6

Executive Summary 7

Introduction..... 8

Program..... 9

Summary of presentations..... 11

References.....14

List of Figures

Figure1 Solar roof of Sydney International Convention Centre, funded by the community-owned Sydney Renewable Power Company.....8

Figure 2: Changing orgware is difficult – it involves people!11

Figure 3: Inverter-controller (top) and 9.8 kWh battery (below) of a 5 kW household solar PV system that provides over 90% of the household's annual electricity.....12

Figure 4: Part of Hepburn community wind farm, Victoria.....13

Glossary

Blockchain	A digital ledger in which transactions are recorded chronologically and publicly
Community	A local group of households and/or organisations. Includes community micro-grids and other community projects
Distribution	Supply of grid electricity at low voltage via local poles and wires
Distribution network service provider	Organisation that controls the low voltage poles and wires of the hardware of the local electricity network: poles, wires and substations. Also known as 'distributor' or 'network service provider' or 'DNSP'.
Embedded network	A microgrid, which is not owned by the Distribution Network Service Provider, with a single point of connection to the main grid
Feed-in tariff	Tariff paid for electricity fed into the grid by a distributed generator
Local electricity trading	Small- and medium-scale generators assign their exported generation to specific local electricity customers; includes microgrids that are connected to the distribution network and direct transfer of electricity between neighbours; electricity may be valued according to time-of-use
Local network credits	A means of recognising the value of electricity generated and used locally, thus reducing future network costs while benefitting customers
Microgrid	A small electricity network, which could be either a sub-network of a main network, or an isolated network
Precinct	A local group of freestanding buildings, possibly including apartment blocks and/or a medium-scale commercial site (e.g. shopping mall, university, hospital, and light industrial area)
Prosumer	A person or organisation that is simultaneously a customer of grid electricity and a behind-the-meter generator of RE
Transmission	Supply of electricity to distributors and big industrial consumers via high-voltage powerlines (not a subject of this forum)
Virtual power network	Network of dispersed small- and medium-scale RE generators, storage and demand management that can be centrally controlled to create a single 'virtual' power plant that can feed into the grid

Acronyms

ARENA	Australian Renewable Energy Agency
CEEM	Centre for Energy & Environmental Markets
CRC	Cooperative Research Centre
CRE	Community renewable energy
DNSP	Distribution Network Service Provider
ISF	Institute for Sustainable Futures
LET	Local electricity trading
LNC	Local network credits
PPA	Power purchase agreement
PV	Photovoltaic
VPN	Virtual power network
VPP	Virtual power plant

Executive Summary

The rapid growth of distributed renewable electricity, mainly rooftop solar, at the local scale, is disrupting the previous system while providing environmental and social benefits. The old system was based on the one-way flow of electricity from very large central generators through high-voltage transmission to load centres, from which it was distributed at low voltage to millions of consumers. Now that 20 per cent of Australian households have rooftop solar PV and the commercial sector is also rapidly installing solar, these consumers are becoming generators as well as consumers and so have been renamed ‘prosumers’. The latter include households, precincts, commercial sites and community organisations.

The transition of the electricity system at local scale is an important part of the transition of the whole energy system from one based on fossil fuels to a low-carbon system based on renewable energy, energy efficiency and energy conservation. It merits facilitation. But the transition is being impeded by the old institutions – organisations, legislation, rules, tariffs and metering – that are no longer fit for purpose. They must be changed to

allow the new system to work well for consumers, prosumers and the electricity industry.

Although the situation is complex, elements of the solution have been identified. The National Forum addressed the following elements of the overall solution:

- Embedded generation, microgrids and community renewable electricity projects
- Community-owned electricity retailers
- Virtual power plants
- New market rules
- Local electricity trading
- Social equity implications
- New tariffs for retailing grid electricity
- New tariffs for feed-in to the grid
- New software for smart systems
- Contracted demand response.

These solution elements, if designed well, can streamline the transition to a low-carbon local electricity system while reducing the costs of energy services.



Introduction

The electricity industry is in crisis, both at the level of large-scale electricity supply to the wholesale electricity market and at the level of local distribution of grid electricity and the feed-in to the distribution network of locally generated electricity from small- and medium-scale renewable energy and other distributed sources. This National Forum addresses the latter, local aspect of the crisis.

The growth in air conditioning and its use during periods of high temperatures has led to substantial investment in the distribution network to meet increasing *peak* demand. At the same time the rapid growth of distributed renewable electricity (RE) generation behind the meter is reducing *average* demand on the grid and hence challenging business models of distributors and retailers. To delay a ‘death spiral’ resulting from increasing electricity prices and declining average demand, some distributors and retailers are increasing daily supply charges and attempting to impose fees and restrictions on feeding RE into the grid from prosumers (customers who are also small-scale generators). These moves undermine prosumers’ energy efficiency and rooftop solar, thus impeding the transition to a climate-friendly electricity system. Furthermore, electricity tariffs, both for purchase from the grid and feed-in to the grid, neither reflect accurately the cost of grid electricity by time of use or geographic location nor the value of locally generated RE fed into the grid. Thus existing tariffs are inappropriate from both economic and environmental perspectives.

This crisis has solutions, offering opportunities as well as threats. Provided new institutions (including tariffs

and market rules) are introduced, information technologies and blockchain software can facilitate the management of supply and demand in real time, while allowing the continuation of the transformation of the electricity system to one that is much more distributed and environmentally sound.

Aim of National Forum

To identify the barriers and possible solutions to expanding grid-connected small- and medium-scale renewable electricity for households, precincts and communities, and policy options for overcoming them.



Figure 1: Solar roof of Sydney International Convention Centre, funded by the community-owned Sydney Renewable Power Company
Photo: Sydney Renewable Power Company

Scope

The focus of this National Forum is on local distribution network, its customers and small- to medium-scale distributed generators, both household and precinct. Issues addressed include: community renewable energy projects; local electricity trading; electricity tariffs for both purchase from the grid and feed-in to the grid; virtual power plants; and other related institutional issues.

The principal focus is on the institutional structures, including pricing/tariffs, business models, legal aspects, regulations and standards, organisational structure, education and information. Engineering details of hardware are not addressed.

Time and date: 6 June 2018

Venue: UNSW Sydney, Kensington Campus

Attendance: 75

Participants: State & local government, small and medium businesses, customers (commercial scale), academics, research students, community organisations. Unfortunately the National Forum overlapped in time with the Energy Networks 2018 conference and so no representatives from electricity distributors (DNSPs) could attend.

Program

Time	Topic	Speaker
09:00	REGISTRATION	
09:30	Start	Chair: Kriston Symons – Board Member, CRC for Low Carbon Living, and End Market Director, Buildings and Places, Australia and New Zealand, AECOM
09:35	Welcome & acknowledgement of traditional custodians	The Hon. Robert Hill AC - Chair, CRC for Low Carbon Living
09:45	Overview of issues	Dr Mark Diesendorf – Education Program Leader of CRC for Low Carbon Living & Hon. A/Prof. UNSW
09:55	Demand management: an essential complement to renewable energy	Marija Petkovic – _Founder & Managing Director, Energy Synapse
10:15	NSW policies	Katherine Hole - Executive Director, Energy Strategy, Energy, Water & Portfolio Strategy, NSW Department of Planning & Environment
10:35	MORNING TEA	
11:00	Introduction to session	Chair: Dr Renate Egan – Chair of Australian Photovoltaics Institute and Cofounder and Chair of Solar Analytics Pty Ltd
11:05	Status of PV, batteries & software	Dr Renate Egan – Chair of Australian Photovoltaics Institute and Cofounder and Chair of Solar Analytics Pty Ltd
11:25	Local network credits & local electricity trading	Dr Sven Teske — Research Director, Institute for Sustainable Futures, University of Technology Sydney
11:45	Network tariff design & analysis	Dr Rob Passey — Senior Research Associate, Centre for Energy and Environmental Markets, School of Electrical Engineering & Telecommunications, UNSW
12:05	Enova Energy: a community electricity retailer	Felicity Stening – Operations Manager, Enova Energy
12:25	Financial impacts of solar PV & air conditioners on Australian households	Dr Anna Bruce — Senior Lecturer, School of Photovoltaic & Renewable Energy Engineering, UNSW
12:45	LUNCH	
13:45	Introduction to session	Chair: Meg MacDonald – Board Member, CRC for Low Carbon Living
13:50	Virtual power plants	Dean Spaccavento — Cofounder and CEO of Reposit Power
14:10	Blockchain for peer-to-peer trading	James Eggleston – Analyst, Power Ledger, and PhD Candidate, Curtin University Sustainability Program
14:30	Parallel panel 1: Community renewable energy	Chair: Fran Strachan – Communications Manager, CRC for Low Carbon Living Dr Franziska Mey — Senior Researcher, Institute for Sustainable Futures, UTS, and Research Director, Community Power Agency Elizabeth Tomc — PhD Candidate, University of Sydney Warren Yates – Director of ClearSky Solar Investments Ltd

14:30	Parallel panel 2: Organisation, rules & tariffs	Chair: Dr Archie Chapman – Research Fellow in Smart Grids Centre for Future Energy Networks, School of Electrical and Information Engineering, University of Sydney Chris Barrett – Commercial Manager, Green Infrastructure, City of Sydney Luke Marshall – PhD Candidate, UNSW Sharon Young – PhD Candidate, UNSW
15:30	AFTERNOON TEA	
16:00	Plenary panel: strategies & policy options for the future	Chair: Meg MacDonald – Board Member, CRC for Low Carbon Living Dr Sven Teske - Research Director, Institute for Sustainable Futures, University of Technology Sydney Dr Rob Passey - Senior Research Associate, Centre for Energy and Environmental Markets, School of Electrical Engineering & Telecommunications, UNSW Marija Petkovic - Founder and Managing Director, Energy Synapse Dr Anna Bruce - Senior Lecturer, School of Photovoltaic & Renewable Energy Engineering, UNSW
17:00	CLOSE	

Summary of presentations

Mark Diesendorf explained the rationale of the National Forum and offered an overview of the issues. In brief, technology can be described as having three components, hardware, software and ‘orgware’, the latter comprising organisational structure, legislation, financial mechanisms, rules and tariffs. Contrary to widespread myths, we already have most of the necessary hardware and most is affordable, although a few products must still be rolled out on a large scale. The big gaps are on software and orgware, the focus of the following presentations.

Ref.: Diesendorf & Elliston (2018).



Figure 2: Changing orgware is difficult – it involves people!

Barriers and solution elements

Archie Chapman, from University of Sydney, discussed how coordinated groups of consumers with rooftop PV and batteries and networks could work together to meet their respective needs and reduce retail costs. As a case study, he discussed the Bruny Island trial.

Dean Spaccavento, from Reposit Power, reported several case studies, including his business that is already operating a Virtual Power Plant along these lines in the ACT. Reposit Power’s VPP is delivering a wide range of services from its generation capacity, including wholesale arbitrage, frequency control, power factor correction, voltage support, network support and negative price curtailment.

A different approach was the creation in 2016 of Australia’s first community-owned electricity retailer, Enova Energy, introduced at the Forum by

its Operations Manager, *Felicity Stening*. Enova is a social enterprise that aims to assist the community to reduce carbon emissions and to benefit the community more generally. It plans to enter Power Purchase Agreements (PPAs) with new renewable electricity providers, implement solar gardens, microgrids and VPPs, and move from its initial region into Sydney, Newcastle and Wollongong.

The City of Sydney’s renewable energy initiatives were outlined by *Chris Barrett*. Projects in which the City is involved include the Town Hall solar rooftop, that may include future electricity sharing within the precinct, and Green Square town centre, which will include sharing across a private network between community buildings and the aquatic centre. Such energy precincts can provide value to networks as well as being ‘financial and environmental winners’, to quote Chris.

Maria Petkovic, from Energy Synapse, posited that demand management is an essential complement to renewable energy. The old paradigm, where supply has to follow demand, is no longer necessary nor desirable. Demand management and energy efficiency, together with renewable energy and battery storage behind the meter, can compete with on-grid generation and provide a range of services to benefit both customers and networks. Barriers to demand response include the lack of cost-reflective network tariffs and lack of price signals to the residential sector.

Rob Passey, from the CEEM, UNSW, examined network tariff design with the focus on embedded networks. An embedded network is a microgrid with a single connection point to the main grid and is not owned by the Distribution Network Service Provider (DNSP). It could be a shopping centre, apartment bloc, retirement village or eco-village. Rob described a computer model of an embedded network developed by two PhD students, *Luke Marshall* and *Naomi Stringer*, that describes electricity flows and financial flows in embedded networks and is useful for optimising the technology mix (renewable electricity generation, batteries, demand response) and for designing tariffs.

Sharon Young, from UNSW, investigated the potential for cost-reflective tariffs to influence prosumers' behaviour. There is no single perfect tariff. Various tariffs can be used e.g. to minimise exports to the grid during peaks in demand on the grid, or to increase exports during troughs, or to maximise battery use.

Ref.: Haghdadi et al. (2017)

At first glance, transitioning from a centralised electricity supply systems to a distributed electricity supply-demand system – with millions of household prosumers, thousands of embedded networks, and hundreds of VPPs – appears very complicated. How can all the exchanges of electricity and money be tracked and verified? *James Eggleston*, from Power Ledger, introduced a method involving blockchains for doing that.

Sven Teske, from ISF, UTS, argued that the evolving distributed system needs a different market framework from the old centralised system. Sven outlined a project led by ISF and involving DNSPs, gentailers, local government and community organisations, with funding from ARENA. The project aims to facilitate the introduction of Local Network Charges – implemented as Local Network Credits (LNC) paid to the generator – and Local Electricity Trading (LET), also called Virtual Net Metering. LNC recognises the value of electricity generated and used locally, thus reducing future network costs. However, a change in market rules is needed to implement it. LET involves 'netting off' generation from one site at another site on a time-of-use basis, so that the first site can 'sell' or assign generation to the nearby second site. It could be implemented now. The group is conducting five case studies. A key finding is that LET and LNC could increase access to community renewable energy (CRE).

Ref.: Rutovitz et al. (2018)

Luke Marshall, from UNSW, pointed out that commercial metering is generally performed on time scales greater than thirty seconds, with most metering systems measuring net flows on half-hourly intervals. This is a barrier to accurate accounting for the economic benefits of embedded microgrids that result from either reductions in external network use or contributions to improved reliability. Determining these benefits depends on sub-second level timing, and cannot be commercially factored (or incentivized) without

corresponding metering.

Marshall, Bruce & MacGill (2017)

Ref.: Marshall et al. (2017)

Anna Bruce from CEEM, UNSW, compared the impacts of solar PV and air conditioners on electricity bills of Australian households, with the focus on cross-subsidies. The analysis of PV impact was based on 300 households with Ausgrid as distributor, while the air conditioning impact was based on Smart Grid Smart Cities households. The results are complex and depend on tariff structures, however the main points are that air conditioners most likely significantly increase costs for other customers, while PV most likely has a neutral cost impact on other customers.

Ref.: Passey et al. (2018).



Figure 3: Inverter-controller (top) and 9.8 kWh battery (below) of a 5 kW household solar PV system that provides over 90% of the household's annual electricity. Note the small size of the battery.

Photo: Mark Diesendorf

Community renewable energy

A whole session was devoted to community renewable energy (CRE). *Franziska Mey*, from ISF, UTS, outlined the environmental, economic, social, political and technological benefits. CRE was one of the principal drivers of renewable energy in Denmark and Germany. Although it is still in the early stage of growth in Australia, over 70 projects have already been installed. Franziska identified four types of CRE: donation/community; commercial-community partnership; community investment; and multi-household.

Ref.: Mey, Diesendorf, MacGill (2016)



Figure 4: Part of Hepburn community wind farm, Victoria

Photo: Hepburn Wind

Warren Yates described ClearSky Solar Investments, a community-based not-for-profit company that provides finance for Power Purchase

Agreements (PPAs). It provides an easy way for ordinary people to invest in solar projects by others. So far it has financed 29 projects across mainland Australia, comprising more than 2 MW of capacity.

Elizabeth Tomc, from the University of Sydney, outlined her modelling research on the ways community renewable energy networks can reduce the price of electricity in urban contexts.

State government

Although government speakers from three states had been invited, only NSW accepted. *Katherine Hole* addressed regulatory frameworks in NSW – Electricity Supply Act, Electricity (Consumer Safety) Act and property and tenancy laws – together with the impact of national law and rules. Regulatory reforms are under way.

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