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# Local network credits and local electricity trading: Results of virtual trials and the policy implications

Jay Rutovitz[a,*], Sebastian Oliva H.[b], Lawrence McIntosh[a], Ed Langham[a], Sven Teske[a], Alison Atherton[a], Scott Kelly[a]

[a] University of Technology Sydney, Institute for Sustainable Futures, Sydney, NSW 2007, Australia
[b] Energy Centre, University of Chile, Santiago 8370451, Chile

ABSTRACT

Current charging methods for network infrastructure and recompense for distributed energy may not result in optimum system solutions. Once feed-in tariffs to support the development of renewable generation are phased out, the payment for grid exports is usually based on the wholesale energy value alone. Network charges are generally levied in full, with few attempts to offer a partial charge, or completely waived. Local Electricity Trading (LET) and Local Network Credits (LNCs) offer one approach to reforming charge structures. This paper examines the effects of LET and LNC on different stakeholders in four virtual trials of medium scale distributed generation projects around Australia, and the implications for policy. The trials found the large value gap between behind the meter systems and grid exports may lead to duplication of network assets, inefficient sizing and operation of distributed generators, and a lack of incentive for dispatchable generators to operate at peak times. The trials indicated that in most circumstances, the combination of LNC and LET addresses all four problems identified to some degree.

## 1. Introduction and background

A number of jurisdictions around the world have seen an extraordinary expansion of distributed generation (DG). Key DG technologies deployed have included distributed photovoltaics (PV), wind turbines and cogeneration units (cogen). The deployment of distributed PV has been particularly remarkable, driven by a dramatic fall in PV system prices combined with strong government support (Bazilian et al., 2013; Candelise et al., 2013; Sunshot, 2015). While there have been challenges associated with high penetrations of distributed PV systems (Deeba et al., 2016), there have been significant benefits in many sectors and PV uptake has made an important contribution towards mitigating the risks of climate change (Akorede et al., 2010; Oliva et al., 2014; Perez et al., 2011)

The most widely implemented commercial arrangement for this DG deployment has been net metering. By the end of 2015, more than 50 countries had implemented some form of net metering policy (REN21, 2017). Under net metering, customers with DG first self-consume the electricity they generate, and any excess generation is exported to the electricity grid. The value of self-consumed generation is the full avoided retail electricity tariff while the value of electricity exported to the grid is typically set at a flat payment per kWh known as a feed-in tariff (FiT).

Australia has the world's highest per capita index of distributed PV systems and currently 18% of households own a PV system.[1] A key driver of this deployment was the highly subsidized FiT rates in place in different Australian states, together with some other capital subsidy programs for PV. Due to the significant costs of these programs, compulsory FiTs were either reduced or stopped altogether rather suddenly, and now most Australian FiTs represent only the wholesale generation value of grid exports (Martin and Rice, 2013; Poruschi et al., 2018). This process coincided with considerable increases of the network component of the electricity bill caused by substantial network investments to manage the electricity peak demand (Productivity Commission, 2012; Simshauser and Nelson, 2013). As a result, today's FiT rates represent less than half of retail rates, so the value of DG self-consumption is far greater than the value of exports to the grid.

However, it has been argued that FiTs that pay only the energy component of the retail tariff are not a suitable reward for generation exported to the distribution grid (Cossent et al., 2009), which is being

* Corresponding author.
E-mail address: jay.rutovitz@uts.edu.au (J. Rutovitz).

[1] Calculated from Australian Bureau of Statistics 2016 census, total households in Australia 9,901,496 (http://www.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/036?opendocument) and estimated residential installs of 1,794,081 from the Australian Photovoltaic Institute (http://pv-map.apvi.org.au/), downloaded 5th May 2018.

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on-sold to nearby customers at the full retail rate. While DG exports utilise only a very small segment of the distribution grid, their price includes the charge for the entire electricity transmission and distribution network. Thus a reduction of the network charge for distributed generation sales, proportionate to the level of utilisation of the grid, has been proposed in several jurisdictions. Such a network credit was proposed in Australia as a 'Local Generation Network Credit' (LGNC)[2] (AEMC, 2016).

A key commercial arrangement that complements the implementation of Local Network Creditsis Virtual Net Metering, also known as Local Electricity Trading (LET). This type of arrangement allows a generator to assign their exported generation to specific electricity customers on a Time-of-Use basis (Asmus, 2008; Huijben and Verbong, 2013). Whilst an LNC reduces the network component of the electricity bill, LET may offer the opportunity for retailers to reduce the energy and retail components of the bill.

LET and LNC arrangements have already been implemented in a few jurisdictions in different ways. LET – or Virtual Net Metering – has been implemented in many US states for solar programs where customers purchase solar panels from a large array located off-site and receive the benefits of net metering (Asmus, 2008; Huijben and Verbong, 2013). In the UK, LNCs have been systematically applied under the 'Common Distribution Charging Methodology' (DCUSA, 2015). In Australia, a compulsory LNC payment was rejected by the Australian Energy Market Commission (AEMC) (AEMC, 2016). Still, the Australian electricity law does indicate that locational transmission charges should be credited to distributed generation sales (Langham et al., 2013) although in practice is only generally applied to larger generators over 5 MW. The state of Western Australia has regulated what is known as a "prudent discount", which could be regarded as a form of LNC that specifically seeks to avoid the construction of private wires between nearby customers that duplicate existing infrastructure (Government of Western Australia, 2004). In the US, states such as Connecticut and Minnesota have also implemented some form of LNC (Norris et al., 2014; State of Connecticut, 2013).

The financial impacts of DG with net metering and FiTs have been widely studied in the existing literature from both the DG owner perspective (Burns and Kang, 2012; Colmenar-Santos et al., 2012; Darghouth et al., 2011; Liu et al., 2014; McHenry, 2012; Mills et al., 2008; Muhammad-Sukki et al., 2011; Oliva et al., 2016; Radhi, 2011; Rüther and Zilles, 2011) and the utility perspective (Blackburn et al., 2014; Eid et al., 2014; Mayr et al., 2015; Satchwell et al., 2015a, 2015b). However, with no demonstrations or economic assessments of new commercial arrangements for DG such as LET and LNCs, it is still to be tested whether they are effective at creating a level playing field for distributed generation.

In this article we estimate the financial impacts on the DG owners and network service providers (NSPs) of LET and LNC arrangements for four virtual trials in Australia. Key policy implications from the study are discussed and policy recommendations proposed.

The organisation of the paper is as follows: the methodology used for our study is presented in Section 2, and the data inputs summarised in Section 3. Section 4 presents the results and discussion. Finally, Section 5 presents the policy implications and the conclusions of the study, with some suggestions for future research in this area.

## 2. Methodology

A business case model was constructed to compare local generation projects under current market conditions (that is, a minimal feed-in tariff paid based on the current wholesale price) with the same generator installed with the two measures under investigation, namely Local Electricity Trading (LET), and payment of a Local Network Credit (LNC). The effect of physically connecting the generation site and trading sites by a private wire, effectively combining the sites behind one meter, was also tested where such an installation was a reasonable proposition. Two alternate methodologies were used to calculate the LNC. The measures are considered together and separately.

The model uses hourly data for a full year, and requires yearly profiles for the potential generator output, and for demand at the generation site and any potential trading sites. This is a granular approach that has been previously used in several studies of the economics of distributed generation, including (Borenstein, 2008; Darghouth et al., 2011; Mayr et al., 2015; Mills et al., 2008; Oliva et al., 2016). The method aims to capture the correlations between the DG output, the customer consumption and diverse market outcomes such as the Time-of-Use electricity rates.

The model compares the business case for the new generation in current conditions, and with and without the new measures. The changes in costs for the proponent sites are calculated, including the local generation site (LG site) and whatever trading sites are included in the trial (called the LET sites). The model also calculates the financial impact on the relevant network business.

The total annual electricity cost (AEC) of the LG and LET sites together, for each virtual trial is calculated as in Eq. (1).

$$AEC = FC + \sum_{t=1}^{8760} R_{LG_t} \times imp_{LG_t} + R_{LET_t} \times Vimp_{LET_t} + (R_{LET\,t} - EC_t - RC_t - LNC_t) \times Vbm_{LET\,t} - FiT \times Vexp_{LET\,t} \quad (1)$$

Where at hour $t$ the parameters are:

$FC$: All fixed charges including generation investment repayments in $/year
$R_{LG\_t}$: Electricity retail tariff rate at the LG site in $/kWh
$imp_{LG\_t}$: Electricity imports from the grid at the LG site in kWh
$R_{LET\_t}$: Electricity retail tariff rate at the LET site in $/kWh
$Vimp_{LET\_t}$: Virtual electricity imports from the grid (after LG netting-off) at the LET site in kWh
$EC_t$: Energy cost component of retail tariffs in $/kWh
$RC_t$: Retailing cost component of retail tariffs in $/kWh
$LNC_t$: Local network credit in $/kWh
$Vbm_{LET\_t}$: Virtual electricity behind the meter (after LG netting-off) at the LET site in kWh
$FiT$: Current flat feed-in tariff offer for exports to the grid in $/kWh
$Vexp_{LET\_t}$: Virtual electricity exports to the grid (after LG netting-off) at the LET site in kWh

In order to see the effect of the two measures, eight different scenarios were defined.

1. **BAU**: Business as usual – current electricity and network charges, with the current consumption profiles (without any new generation). We applied the current tariffs to the consumption profiles to arrive at the annual cost of BAU, by summing for each hour of the year the tariff in $/kWh multiplied by the BAU consumption in kWh for that hour. This is the baseline cost for comparison with all the other scenarios, and includes the costs of both the LG site and the LET sites.
2. **Current market**: Installation of new generation, with the market as it is now (exported electricity receives a FiT). All costs associated with generation are included, such as the annual repayments on purchase, O&M, and any fuel costs (these costs are included in all subsequent scenarios).
3. **LET only**: Includes new generation, with Local Electricity Trading in place for the exported electricity, but no LNC paid. Exports from the LG site are netted off at whatever LET sites are included, and any

[2] The rule change request used the terminology Local Generation Network Credit (LGNC), so that is used whenever the rule change is referred to. It is interchangeable with Local Network Credit (LNC) in this paper.