Local Energy Trading Feasibility Study (Interim Report)

Northern Alliance for Greenhouse Action (NAGA)

FG Advisory

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Document prepared by:

FG Advisory Pty Ltd.
ABN: 69 165 911 571
Level 17, 31 Queen Street
Melbourne, VIC 3000

Key Contacts:

Luke Zha
Associate Director
+61 411 135 880
luke.zha@fgadvisory.com

Randy Gadient
Managing Director
+61 435 250 565
randy.gadient@fgadvisory.com

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Prepared by	Tom Strawhorn
	Jake Hinton
Verified by	Randy Gadient
	Luke Zha

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All financial figures presented herein are based on information provided by participating councils in conjunction with general estimation methods, and should be used for preliminary budgeting purposes only. Actual costs may vary.

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Key Terms

Term	Description
AEMO	Australian Energy Market Operator; the body responsible for operating Australia's largest electricity network – the National Electricity Market, or NEM
Business as Usual (BAU)	Current energy procurement model. The baseline case.
Cost Reflective Network Pricing	A network tariff model that charges customers of electricity on the distance that energy travels from its generating source to the point of consumption, as well as the costs of network operation. May also refer to nodal pricing, real-time pricing, critical peak pricing, etc.
DER	Distributed Energy Resource – an energy generation source that is distributed in the electricity grid. An integrated system of energy equipment co-located with consumer load (AEMC 2017). Includes both 'smart' and 'passive' devices.
DM	Demand Management - Any action taken to reduce or reshape the demand for electricity, as an alternative to increasing energy supply, with the intent of supporting system reliability and/or minimising network, generation or consumer costs. Energy supply refers to the combination of electricity generated, the capacity to generate electricity and the capacity to deliver the energy to customers through transmission and distribution networks.
DNSP	Distribution Network Service Provider, the organisation responsible for the distribution of power from generator to customer.
DR	Demand Response – a mechanism that reduces peak demand on the network based on an input signal from the Distributor in anticipation or during peak demand conditions in the network.
FiT	Feed-in-Tariff (a term used for financial incentives for feeding energy into the grid from renewable energy generation sources
kW	Kilowatt. A unit of power. 1,000W
LET	Local Energy Trading
LGC	Largescale generation certificates. One large-scale generation certificate is equal to one megawatt hour of eligible renewable electricity. Once created and validated, these certificates act as a form of currency and can be sold and transferred to other individuals and businesses at a negotiated price.
LGNC	Local Generation Network Credit. A proposed credit to a customer who uses less of the network than traditionally through consumption and provision of locally sourced energy.
MW	Megawatt. A unit of power equal to 1,000,000W, or 1,000 kW
NEM	National Electricity Market – Australia's largest electricity network, spanning the interconnected power system in Australia's eastern and south-eastern seaboard.
NNM	Non-Network Option - A means by which an identified [network service] need can be fully or partly addressed other than by a network option (chapter 10 of the NER).
NPV	Net Present Value. The value in the present of a sum of money, considering all future cash flows and discounting them to the present value using the nominated discount rate.
Off-peak	Between 11:00pm – 7:00am Mon-Fri and Weekends.
Peak	Between 7:00am and 11:00pm Mon – Fri
POC	Power of Choice – a major electricity retail market reform package established by AEMC
Representative Council	Supplier of electricity consumption interval data used in modelling scenarios
Simple Payback	The length of time required to recover the cost of an investment
VPP	Virtual Power Plant

Executive Summary

Context

FG Advisory has conducted a technical and commercial review into the feasibility for Victorian Councils to adopt Local Energy Trading (LET). The review involved consultations with the energy industry and detailed technical and financial modelling to assess the viability of LET under five nominated scenarios. All modelling results are based on real energy and facility data from participating Northern Alliance for Greenhouse Action (NAGA) Councils.

Industry Perspectives

There was a mix of perspectives from Electricity Retailers regarding the commercial potential of LET, with a high variance observed in the current levels of investment in LET product development and trial projects. However, most Retailers agreed that the benefit of additional customer acquisition and retention did not outweigh the commercial viability risks, including undercutting the traditional Retail model, high administrative costs and lack of access to customer data between Retailers.

Feedback from Electricity Network Distributors indicated that, at its current scale, LET was not viewed as a significant contributor to meeting their regulated objective of investing in projects that demonstrably improve grid stability and avoid capital expenditure in network augmentation.

FGA considers that the key barrier to adoption of LET are commercial barriers of low customer demand and high supplier cost/risk. We consider that there is a role for regulators and government to enhance the commercial viability of the LET model through the following reforms:

1. Providing greater access to customer data across retailers, currently in review under the Power of Choice (POC) reforms.
2. Introduction of Distance Based Pricing to incentive widespread LET projects that utilise only a small portion of the grid, aiding in avoidance of distributor investments in further network augmentations.
3. Introduction of Cost Reflective Pricing to incentive LET projects that achieve a demand response outcome.

To provide Councils with the ability to enhance the financial and environmental business case of solar investments, Councils could advocate for LET to be incorporated into future energy contracts.

Scenario Analysis

FGA's modelling of five real-world scenarios demonstrates that LET can be financially viable in a Council context, see Table 1 below.

Based on potential annual savings by adopting LET over a business-as-usual (BAU) grid export scenario, the results show that the One-to-Multiple LET Scenarios can be financially viable. The One-to-Multiple scenarios included a site with greater than 100kW of solar PV supplying electricity to a group of smaller sites. The disparity between the low solar export rate at the generating site, and the high electricity import rates at the smaller consuming facilities resulted in LET providing a better financial outcome compared to BAU.

We note that there is potential for the non-viable scenarios to be viable in the future given an optimised selection of sites and technical designs. Further enhancements to the financial viability of LET could be realised through the removal of existing market barriers (as above), including the existing LET requirements to be under a single Retailer and Distributor.

Scenario	Viability	Council Data	Capital Cost ($)	BAU Savings	LET Savings
1: One-to-One Medium Scale	No	Darebin City Council	$769,500	$50,463	$20,785
2: One-to-Multiple Medium Scale	Yes	Manningham City Council	$855,000	$54,371	$54,979
3: One-to-Multiple Large Scale	Yes	Nillumbik Shire Council	$3,900,000	$65,766	$73,279
4: Multiple-to-One Small Scale	No	Melbourne City Council	$21,850	$7,711	$3,594
5: Multiple-to-Multiple	No	Hume City Council	$1,333,800	$76,397	$49,906

Table 1 Financial Summary (Savings are per annum)

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1 PROJECT BACKGROUND

1.1 Background

This review was conducted in response to broad energy market challenges facing Victorian Councils, such as escalating electricity prices, impact to the electricity network from increased uptake of distributed and intermittent energy systems and the emergence of new energy-trading platforms.

FG Advisory was engaged by the Northern Alliance for Greenhouse Action (NAGA) to conduct an independent analysis of the potential technical and commercial benefits and barriers to Victorian Councils from Local Energy Trading (LET).

1.2 Project Objectives

This LET review examines the feasibility of Victorian Councils trading locally generated electricity within their respective building portfolios, and assesses the high-level costs and benefits of LET across a range of scenarios. This study was designed, in part, to complement the emission reduction targets of local government across Victoria. To date, these targets have been pursued through solar photovoltaics (PV). The concept of LET further incentivises investment in solar PV generation.

The Study assumes a local focus, and will cover, through the use of various scenarios based on real data, all member Councils of the Northern Alliance for Greenhouse Action (NAGA).

1.2.1 Modelled Scenarios

Five modelled scenarios were collaboratively developed with the NAGA Councils to be meaningful and instructive to all Victorian Councils.

Within each scenario, renewable generation is traded within the Council's respective facilities, with sites categorised as Generators (generating energy for trade) or Customers (consuming traded energy). The five scenarios are described in brief below:

1. One-to-One Medium Scale (Darebin Council): One generator to one customer facility with medium scale solar. This Scenario models a council which may need to distribute generation across facilities located within different distributor networks.
2. One-to-Multiple Medium Scale (Manningham Council): One generator to multiple customer facilities with medium scale solar. This Scenario models a council featuring one large generating facility (e.g.: community centre) to trade exported renewable energy amongst other facilities.
3. One-to-Multiple Large Scale (Nillumbik Shire Council): One generator to multiple customer facilities with large scale solar. This Scenario models a council featuring a large site suitable for large scale solar generation (e.g.: landfill site, stadium) to trade exported renewable energy amongst other facilities.
4. Multiple-to-One Small Scale (Melbourne City Council): Multiple generators to one customer facility with small scale solar. This Scenario models a council featuring a building portfolio typical of an urban environment, with high onsite energy consumption, but spatially limited rooftop solar arrays.
5. Multiple-to-Multiple (Hume City Council): Multiple generators to multiple customer facilities with medium scale solar. This Scenario models a Council featuring a building portfolio with several medium scale assets such as sports stadiums, leisure centres and libraries.

1.3 Information Sources

The findings and analysis presented in this Report are based on the following information sources:

Industry Perspectives

1. Industry review of and engagement with relevant Retailers, Distributors, Product Suppliers that may potentially facilitate the project Scenarios
2. See Section 2 below for further details.

Technical and Commercial Analysis

1. Analysis of the current energy consumption and load profile for all participating council assets
2. Modelling of solar array generation output
3. Modelling of solar array generation energy trading between nominated sites
4. Development of a user friendly financial model that provides LET analysis outputs
5. See Section 3 below for further details.

1.4 How Local Energy Trading Works

This section provides context as to how LET works with the changing nature of network power systems; from a traditionally centralised configuration to an increasingly decentralised energy network.

1.4.1 Current Power System (Centralised)

The traditional National Electricity Market (NEM) operates in a centralised model. Generators, Distributors, and Retailers work together to provide electricity from large scale energy generation plants (predominantly fossil fuel based) to many end customers. A simplified depiction of this system is shown below.

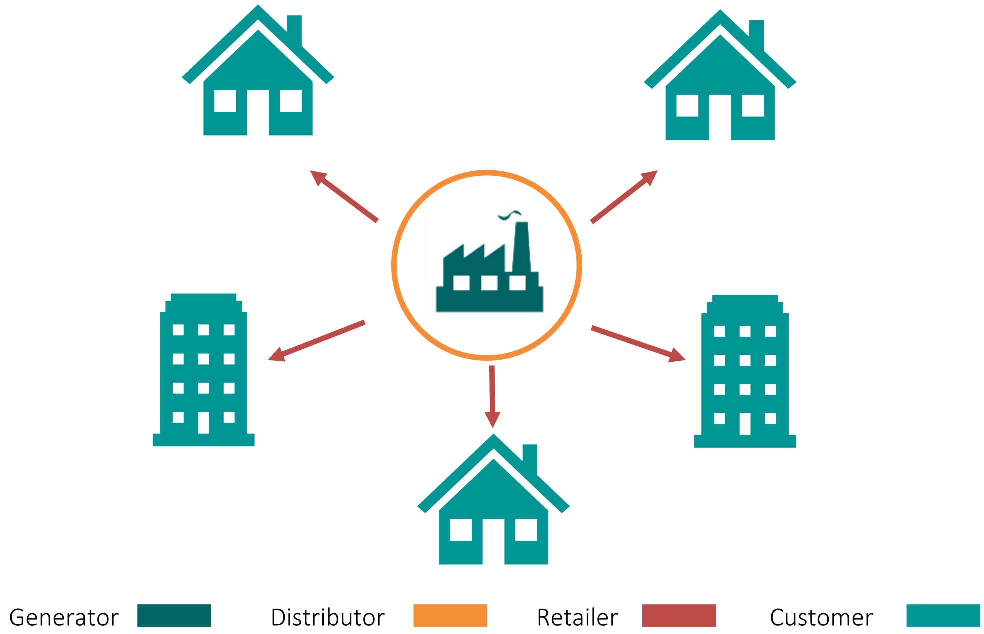


Figure 1: Traditional, centralised power system

1.4.1.1 Generator

Traditionally, large scale centralised generators bid to produce electricity to meet market demand at given time intervals to meet the needs of the electricity market, with the price of energy reflecting the market demand at any given time interval. The generators are paid the 'spot price' of electricity to generate energy to satisfy market demand. To manage price volatility, Retailers and generators often enter into hedging contracts to fix the price for future electricity sales.

1.4.1.2 Distributor

The traditional role of the distributor is to maintain the electricity network that connects generators and customers. Distributors are effectively monopolies that are regulated by the Australian Energy Regulator (AER). The AER seeks to set fair network prices so that energy customers pay no more than necessary for the safe and reliable delivery of electricity.

1.4.1.3 Retailer

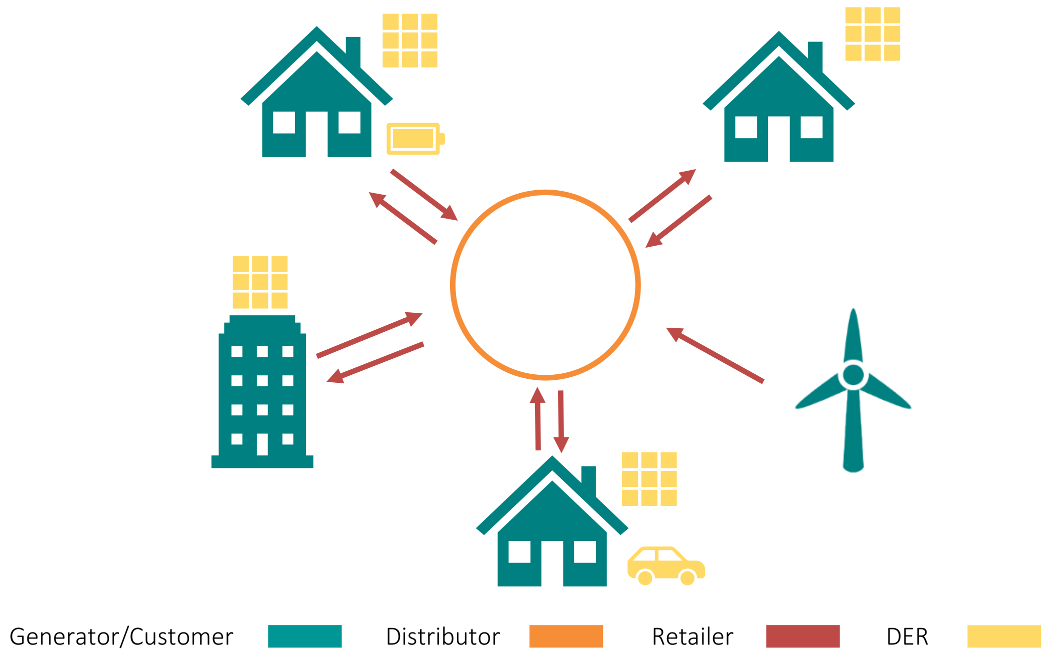
The traditional role of the Retailer is to manage the financial interaction between the generators/distributors and the end-customer. Electricity retailers generally provide fixed price contracts for commercial clients, but face fluctuating costs for obtaining the electricity sold under these contracts. Retailers manage their own retail price risk set to customers as well as NEM price risks (spot market) and energy volume risks. With the continued emergency of prosumers (customers who also generate their own electricity), Retailers are adapting to a changing energy landscape.

1.4.1.4 Customer

The customer purchases and consumes electricity and provides payments to their Retailer. A customer can also generate and sell excess solar electricity back into the grid for a feed in tariff (current minimum of 11.3c/kWh for solar arrays less than 100 kW in size). Customers may also sell into the wholesale market via the Small Generator Aggregator Framework. Customers have historically faced increases in electricity costs and have little choice in how they can buy and sell electricity in the current electricity market.

1.4.2 Power System with Local Energy Trading (Decentralised)

The concept of LET leverages the increasingly decentralised nature of modern power systems. As fossil fuel based generating plants are phased out, customers fill the generator gaps left behind by providing Distributed Energy Resources (DERs), contributing cleaner, local energy to the grid. A well-managed, decentralised power system serves to empower customers while maintaining, or even improving, network utilisation, as shown in the simplified graphic below:



1.4.2.1 Generator

While fossil-fuel and coal-based generators are phased out, large scale hydroelectric, wind and solar generators provide extra energy to customers who may not be able to buy enough energy locally. LET allows customers to act as small-scale generators, and sell energy to the spot market, or trade exported energy within its own property portfolio when excess energy is generated locally.

1.4.2.2 Distributor

Distributors play a key role in transferring energy between a vast source of customers and generators. Traditionally, customers size their solar PV systems to minimise export and maximise behind the meter generation. LET removes this export cap on solar sizing, incentivising further solar PV generation, and increasing local grid usage. Traditional network tariffs only apply to end-customers, not to small scale generators supplying the grid. Under LET, a generator may be charged an administration fee by a distributor for transfer of generation across the network.

1.4.2.3 Retailer

In the most extreme form of LET, customers buy and sell electricity between each other in a self-sufficient microcosm, without the need for a retail function. However, under LET, Retailers can provide a role in managing network costs, providing top-up electricity from large scale generators, and determining where best to trade locally generated electricity. Retailers face a rapidly changing marketplace to meet these new requirements.

1.4.2.4 Customer

In the Local Energy model, customers can act as generators, and have additional choices in how and where they source the energy they consume, and where and for what price they dispatch and sell their onsite generation. Under LET, customers can effectively capture value from acting as generators and retailers with their LET. Customers do, however, take on the risks associated with increased options available to them in the energy procurement market.

2 Industry Perspectives

2.1 Methodology

2.1.1 Purpose

FG Advisory undertook consultations with the following stakeholder in the energy market to understand the industry's perspective on potential LET services to Victorian Councils:

1. Retailers (Incl. Origin Energy, AGL, ERM Power, Momentum Power, Energy Australia, Flowpower)
2. Distributors (Incl. Powercor/Citipower, Jemena, AusNet, United Energy)
3. Product Suppliers (Such as Power Ledger)

2.1.2 Desktop Research

FG Advisory conducted desktop research into multiple LET, peer-to-peer and other energy trading models. This included research into past LET trials, current LET products in the market, industry reports and regulatory determinations. FGA used this research as the foundation for this study, building upon this knowledge with industry consultations and technical modelling. The most relevant case studies examined have been detailed in the reports Appendix.

2.1.3 Interviews

Leveraging existing professional relationships as an engineering consultancy with live collaborative projects with leading energy Retailers, distributors, and products suppliers, FGA engaged with relevant electricity Retailers and distributors in Victoria to understand the potential for LET services for NAGA Councils.

All current retailers and distributors across all sites within the five scenarios were approached for input on this study. In-person and telephone interviews were conducted with stakeholders to gather their insights on the current state of the energy trading market, their opinions on LET and feedback on the specific scenarios.

2.1.4 Industry Questionnaire

When interviewing stakeholders, a general template questionnaire was used customised to retailer's, or distributor's, current and past LET experience. Topics discussed in the questionnaire included the following:

1. Do you think, in general, the concept of LET is viable?
    a. What are its benefits?
    b. What issues do you foresee?

2. What are the main barriers to LET, in your perspective?
    a. Are there any regulatory barriers?
    b. Are there any commercial barriers?
    c. Are there any infrastructure barriers?
    d. Are there any technical barriers?

3. How do retailers and distributors manage the various transactions involved in LET?
4. In your opinion, what is the key change required to facilitate the growth of LET?
5. How do you envisage LET working between different retailers and networks (if possible)?

6. What public products do you currently offer that facilitate P2P energy trading or similar?
    a. What customer feedback have you received on these products?
    b. What have been the main benefits/limitations of these products?

7. What other emerging energy models are you interested in?
    a. For example; Microgrids, Virtual power plants, New Technologies, etc.

2.2 Retailer Perspectives

2.2.1 Overview

Based on FGA's research and industry consultations, there does not appear to be any mature and commercially available LET products currently offered by electricity retailers.

However, whilst we observed mixed perspectives on LET from the electricity retail market, most retailers indicated a willingness to explore LET or similar opportunities with Councils on a 'case-by-case basis' and/or under future LET products, which currently are in their development infancy.

In general, the sentiment amongst retailers active in the renewable energy and innovation space consider LET to be part of a broader value add strategy in the acquisition and retention of retail customers. More conservative retailers appear to be withholding further investment in trial LET programs, instead opting for a lower risk reactive approach in the absence of strong customer demand.

There is general agreement that LET offers a lower priority commercial opportunity compared to other alternatives (such as community energy and demand response initiatives), with the multiple retailers citing a strong balance of commercial barriers over potential benefits.

FGA notes that a number of retailers also indicated that other energy models, including community renewable energy plans (wherein multiple customers invest in community renewable resources) may be a less complex solution for Councils, and may appeal to a Council's community engagement focus.

The following sections provide a general summary of key benefits and barriers to LET, as identified by retailers, following industry consultations with a cross section of the electricity retail industry.

2.2.2 Key Communicated Benefits

2.2.2.1 Customer Acquisition and Retention

The key benefits of LET reduced costs associated with customer acquisition and retention. As customer acquisition and retention costs represent a significant proportion of total annual expenditure, there is a strong incentive for retailers to offer value add services such as LET.

Given the high cost of acquisition and retention; some retailers may be willing to accept a reduction in traditional revenue sources by offering LET services at minimal/no charge to retain customer loyalty and improve customer satisfaction.

2.2.2.2 Lower Electricity Cost

Several retailers noted that customers may realise lower overall electricity bills from the adoption of LET, which may indicate positive outcomes for the end-use customer from recent trials.

2.2.3 Key Communicated Barriers

FGA has collected and categorised identified LET barriers by retailers and provided them below. Each impact has been categorised as 'High', 'Medium', and 'Low,' indicating how often retailers indicated this barrier, and how critical they communicated this barrier to be.

Impact	Barrier Name	Description
High	1. Undercuts Traditional Retail Model	As noted above, LET may enable a reduction in the overall electricity costs for the customer. This reduction in costs to the customer and equivalent reduction in retail revenues represents a strong financial disincentive for retailers to further develop LET offerings (notwithstanding potential benefits in customer acquisition and retention, also noted above).
High	2. Higher Administrative Costs	Retailers note the potential for a high administrative cost burden, inclusive of additional labour, monitoring, data access and validation and other functional requirements to support a LET offering at a network scale. It is noted that the majority of the existing LET trials are conducted within a single embedded network. At this smaller scale, embedded network operators are less exposed to the additional administrative costs as compared to a LET offering at large scale.
High	3. Lack of Distance-Based Pricing	The lack of Distance Based Pricing for network charges is noted to be a major hurdle to the financial viability of LET to the customer. Customers are currently charged full network rates (which often represents up to 50% of the total electricity cost), despite that the electricity may be sourced locally with only a portion of the electricity network used. Retailers note that without Distance Based Pricing, incurring full network charges may cause potential electricity trading across multiple sites to be uneconomical.
Medium	4. Lack of Access to Customer Data	Customer information and data is not easily accessible nor exchangeable between Retailers and/or third-party energy services companies. The Power of Choice (POC) reforms aim to enable energy services companies to access customer metering data with their consent. As a result, there was a consensus between retailers that LET could not occur, within the current market, between different retailers.
Medium	5. Lack of Cost-Reflective Pricing	Currently, a common network pricing regime applies for all sites across a single network, with common network charges for each tariff and customer code. Where LET projects can facilitate a demand response outcome; with increased matching of consumption to generation or timely battery dispatches within a 'local network', customers may be able to realise additional revenues as the network provider may be able to delay or avoid more expensive augmentations and provide voltage regulation services back to the distribution network.
Medium	6. Lack of Trading Platform	Retailers cite a lack of appropriate technology-based LET platforms that removes some of the perceived complexity, and provides a user friendly, intuitive, safe, and secure interface/experience, with necessary integrations to systems such as billing and metering.
Medium	7. 'Zero Sum Game'	The decrease in costs of a particular customer participating in P2P trading will be compensated by an increase in costs of a separate customer, who may not have the resources to participate in energy trading (solar PV, batteries, etc.).
Medium	8. Scale of Trading	Retailers identified an economy of scale with LET. Trading small magnitudes of traded energy will incur similar administrative costs to large magnitudes of traded energy, but the compensation the retailer receives will vary significantly. Retailers have indicated that large scale trading is preferred, or a fixed fee structure should be considered.
Low	9. Variance in Feed-in-Tariffs	The value of feed-in tariffs (i.e. the rate paid for electricity fed back into the electricity grid) is determined by government policy, and is considered to represent a policy risk for both the retailer and the customer when contemplating the economics of LET. The unpredictability of future feed-in tariff values is therefore a significant barrier to LET, where the higher the feed-in tariff, the lower the relative financial return from LET.
Low	10. Low Customer Engagement	Retailers note that technology enabled customer engagement (e.g. using Apps) within the energy industry has historically been low, especially when compared to other industries such as healthcare, banking, and finance. This low level of user engagement may also be indicative of the inherent complexity of the energy market, with active participation under an LET scheme (i.e. requiring customers to bid, buy, sell, trade,) representing a prohibitively high degree of perceived complexity.
Low	11. Low Customer Demand	Traditional "set-and-forget" fixed electricity retail contracts currently represent the industry standard methodology to retail electricity to customers, which reflects the current mandated and/or preferred procurement model by customers across small to large market sectors.

Table 2 Summary of Commercial Barriers, as identified by retailers.

2.3 Distributor Perspectives

2.3.1 Overview

Consultations with Victorian based electricity distributors indicated that LET is technically and commercially feasible, but does not significantly impact the regulated objectives of the distributors.

Feedback from distributors commonly called for a tariff structure whereby network charges as applied in a 'Business-as-Usual' context is maintained, effectively protecting the distributor's traditional revenue streams, while avoiding higher network charges for customers.

We note that under the current regulations, distributors are mandated to identify opportunities with network benefits; such as those that increase network stability and utilisation, and reduce/avoid capital expenditure associated with network augmentations. To this key objective, distributors consider LET at its current scale of demand, to offer only a marginal benefit, with some distributors indicating that Councils should investigate Demand Response (DR) as an alternative cost-saving measure to LET.

We note also that several distributors have undertaken LET trials, resulting in no clear and demonstrable network benefits. Feedback from some distributors indicated that no further resource support for LET trials would occur unless

- The trial's proposed methodology was significantly different from that which resulted in the Rule Change request 'Local Generation Network Credits'
- A rule change request is likely to be submitted as a result of the new trial
- It can be demonstrated that there are clear network benefits
- Multiple proponents are engaged and support the trial

The following sections provide a general summary of key benefits and barriers of LET, as identified by retailers, following consultations with multiple Victorian distributors.

2.3.2 Key Communicated Benefits

2.3.2.1 Network Utilisation

Distributors have noted the potential benefits LET may have to network utilisation, increasing the efficiency of network infrastructure use. This improved utilisation may reduce the costs associated with network upgrades and upkeep for distributors.

2.3.3 Key Communicated Barriers

FGA has collected and categorised identified LET barriers by distributors and provided them below. Each impact has been categorised as 'High', 'Medium', and 'Low,' indicating how often distributors indicated this barrier, and how critical they communicated this barrier to be.

Impact	Barrier Name	Description
Medium	1. Regulated Objectives	Distributors are mandated to pursue objectives as set through regulation. The benefits of LET, whilst being positive for the network, don't align with distributors objectives as well as other emerging technology and models, such as Demand Response.
Medium	2. Inflexibility of Tariff Structures	Distributors have indicated that creating custom tariffs for customers to facilitate LET is not an easy process, due to the regulated nature of their business.
Low	3. Potential Future Cost to Facilitate LET	Whilst distributors did not identify any technical barriers to LET currently, they do foresee some issues arising if LET is to become more common in the energy market. *Variability of Network Usage* It was predicted that peer-to-peer trading will cause more variability in grid usage, as it will no longer operate in the traditional 'one-way' power transmission. The network will have less predictable demand profiles for customers, and this variability in demand may require network infrastructure upgrades if this model of trading is more regularly adopted. *Cost of Import Infrastructure* Current tariffs only charge customers network fees for grid export, not import. If peer-to-peer trading became more common, and the amount of generating assets greatly increased, the accompanying import would require network upgrades. Within the current tariff systems, the cost of these import-related network improvements is overlooked.

Table 3: Summary of Barriers as identified by Distributors.

2.4 Potential Impacts of LET on Stakeholders

Based on the outcomes of research and industry consultations, FG Advisory provides the following summary of potential benefits/risks to various energy market participants from the adoption of LET.

	Generator	Distributor	Retailer	Customer	Regulation & Policy
Intended Benefits	• Allows generators of all sizes to participate competitively in the market • Incentivises uptake in renewable energy generation • Fills market gap created by closure of coal fired plants	• More efficient grid utilisation, as energy travels shorter distances • Potential demand management capabilities • Simple to facilitate as transaction settlement is currently a retailer responsibility	• Increased customer satisfaction, retention, and loyalty (through offering LET products) • Potential for new revenue streams resulting from settling LET transactions and derivatives	• Initial investigations indicate a favourable decrease in overall energy prices in some Scenarios • Increased choice in selecting energy sources • Further incentivises solar PV and battery installations, and energy independence	• Supports Net Zero and carbon abatement initiatives • Helps 'democratise' energy generation • Can support AEMO's vision of Energy Security for all Australians
Known Risks	• Large, centralised generators become obsolete, stranding assets with economic value • Distributed generation may prove less reliable than traditional generation during peak demand periods when the network is constrained	• Potential loss of revenue via cost-based network charges • Negotiation of fair tariff structure • At current market sizes, may not assist in reducing peak demand requirements	• Retailers role in trading energy becomes less relevant as LET grows • Currently limited by communications between customers of different Retailers • Must develop an in-house, or purchase/license an existing trading platform	• Increased energy management required • LET requires management; many customers prefer a "set-and- forget" energy system • Increased maintenance from new technologies (Solar PV, Batteries, etc.)	• Initial investigations indicate regulatory changes are required • Greater regulatory management complexity • May incentivise trading of non-renewable generation

2.5 LET Impacts on Victorian Councils

2.5.1 Baseline Energy Charges

To investigate the changes LET would have on Victorian Councils, FGA has constructed a baseline electricity bill for NAGA Councils. The following graph represents a typical Council bill, portioned into the varying charges incurred. This graph is based on the average of all NAGA energy rates provided in this study over 2017 (where available). The figures provided display the cost of a 1 MWh (1,000 kWh) purchase of energy during a peak period.

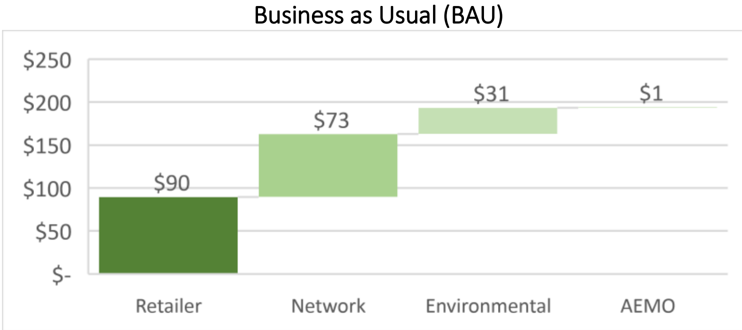


Figure 2 'Business as Usual' electricity charges

2.5.2 Potential LET Tariff Structure

In general, LET facilitates customer choice in the energy market, targeting financially efficient use of renewable energy infrastructure to realise end-customer energy cost savings. FGA's consultations with Victorian Distributors and Retailers revealed viable mechanisms in which each stakeholder can receive fair fees in an LET market. From these consultations, FGA developed a financial model for the cost of LET, aimed to preserve the current margins and financial benefit of each market participant. This structure is outlined briefly below:

FGA Modelled LET Tariff Structure

- Distributors receive full network charges for all local energy traded.
- Retailers receive a 5c/kWh fee (approximating traditional retailer margin) for all local energy traded.
- Environmental Charges are paid in full.
- AEMO and market charges are paid in full.

The additional value being claimed by the customer, is extracted from the retailer charges. The reduction in retailer charges is the result of the retailer no longer needing to purchase energy from centralised generators. Further detail on this structure, including justification, is provided in the Appendix (Section 4.3.3).

2.5.3 LET Impact on Electricity Charges

The following graph outlines a typical NAGA Council electricity bill, under the FGA proposed LET structure.

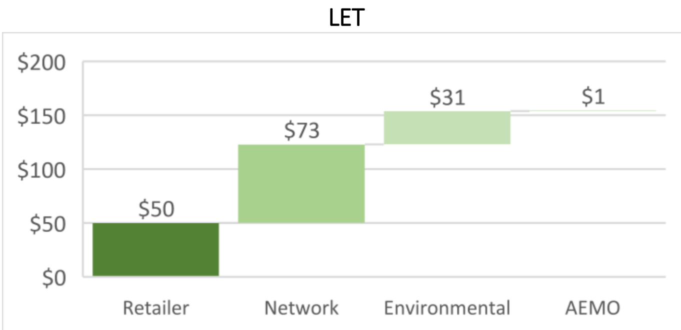
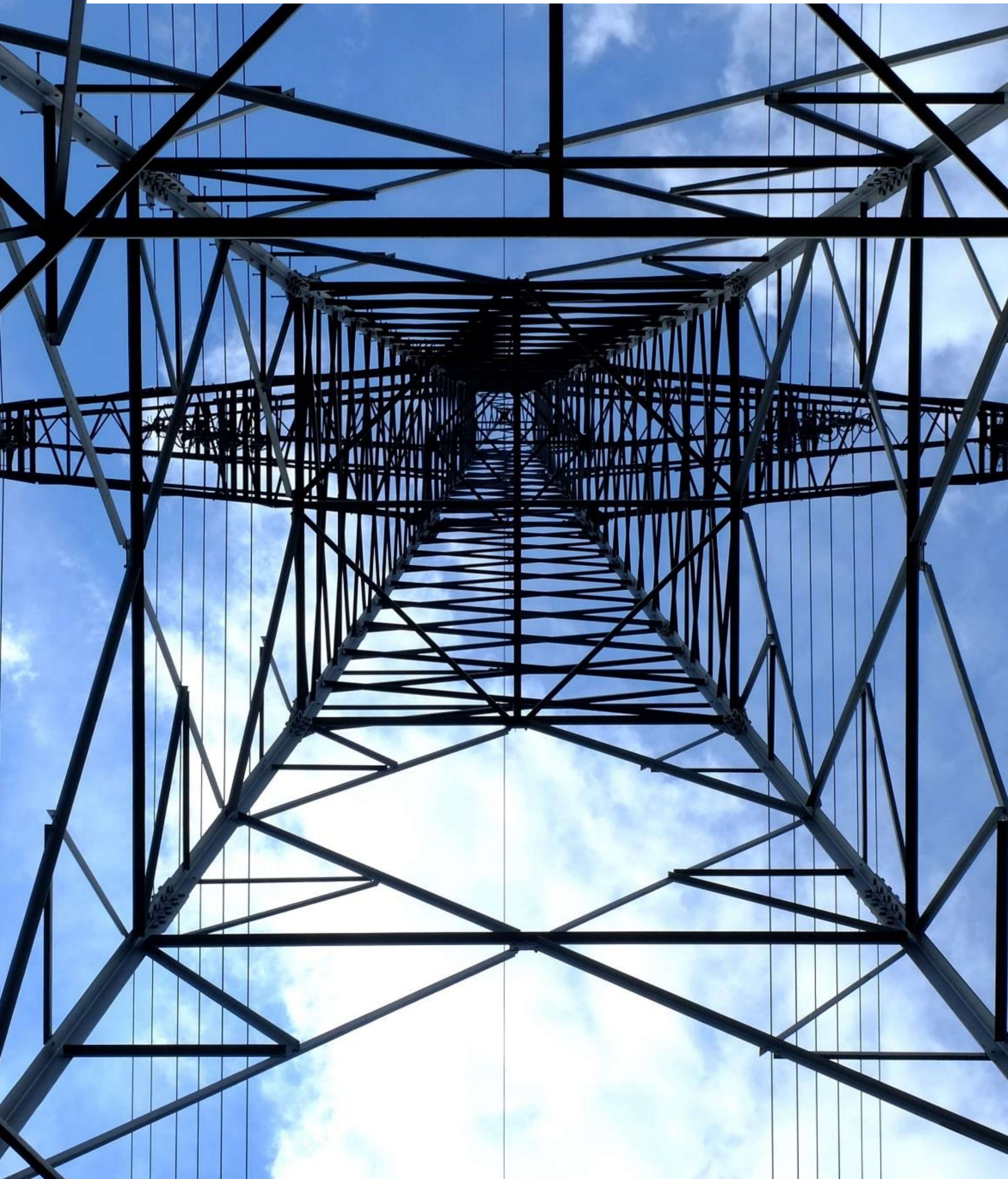


Figure 3: LET electricity charges

The graphs above demonstrate that fundamentally, LET should reduce third party energy costs for the customer in each scenario. However, the cost and value of the renewable energy generated and exported by the customer is not considered. More advanced modelling is provided in Part II of this report for each Council and scenario to consider the value of renewable energy at its current export rate.

3 Technical and Commercial Analysis



3.1 Methodology

3.1.1 Modelled Scenarios

FGA developed five LET scenarios (as shown below), based on real energy consumption and billing data, which analyse the financial impacts of LET compared to standard solar export incentives. A summary of all existing and proposed Distributed Energy Resources is provided in Section 4.5.

Scenario	Generation Capacity	Council Data	Trading Model Description	Generating Sites	Consuming Sites	DNSP(s)	No. of Retailers
1: One-to-One	Medium (100kW-1MW)	Darebin City Council	A sole energy-generating facility is proposed to trade its generation with a single customer facility.	Darebin International Sports Centre	Reservoir Leisure Centre	CitiPower, Jemena	1
2: One-to-Many	Medium (100kW-1MW)	Manningham City Council	A sole energy-generating facility is proposed to trade its generation with multiple other customer facilities.	Mullum Mullum Sports Stadium	• Doncaster Senior Citizens Centre • Pines Learning Activity Centre (Split over 3 NMI's) • The Ajani Centre • Warrandyte Reserve Pavilion	United Energy	2
3: One-to-Many	Large (>1MW)	Nillumbik Shire Council	A sole energy generating facility is proposed to trade its generation with multiple other customer facilities.	Nillumbik Shire Council Depot Tip Site	• Council Office • Eltham Leisure Centre • Diamond Valley Sports and Fitness Centre • Eltham Library	AusNET	4
4: Many-to-One	Small (<100kW)	Melbourne City Council	Multiple energy-generating facilities trade their generation to a single consuming facility.	• Community Hub at the Dock • Signal Box • Council House 2 • Library at the Dock		Citipower	2
5: Many-to-Many	Medium (100kW-1MW)	Hume City Council	Multiple energy-generating facilities trade their generation between each other (hence generators are also customers).	• Splash Aqua Park • Broadmeadows Netball Stadium • Broadmeadows Basketball Stadium • Boardman Basketball Stadium		Jemena	1

Table 4: Modelled Scenario Descriptions, outlining the scenario type, scale, Council, generating/consuming sites, and DNSPs (Scenarios 1-5)

3.1.2 Key Modelling Considerations

FGA's technical analysis and modelling incorporated feedback from industry engagement (see Section 2 above), which is outlined below:

Industry Stakeholder	Key Industry Comments	FGA Methodology
Retailer	• Undercuts Traditional Retail Model • High Administrative Costs • 'Zero Sum Game'	FGA has ensured that retailers are provided a margin similar to current market conditions (5c/kWh) on all energy traded under LET modelling.
Distributor	• Inflexible Tariff Structures • Trading Across Different Networks	Modelling assumes that full network costs are incurred for any distribution through a network. Additionally, Distance Based Pricing and Cost Reflective Pricing were not included, as they are not supported by current regulation.
Regulator/Distributor	• Regulated Objectives and Potential Future Costs of LET • The AEMO charges on customer bills cannot be omitted	Modelling ensures that distributors receive their current compensation through LET, so that LET does not interfere with mandated objectives.
Regulator/Retailer	• Cannot facilitate trading between different retailers	FG Advisory has modelled each facility as if it could trade with any other facility. This assumption is based on the premise that Victorian Councils, if interested, could engage a single retailer to manage the LET between facilities.

Table 5: Key Modelling Considerations

For the financial modelling of each scenario, FGA has assumed that the Council will sell the LGCs derived from the proposed Solar Array. For Councils with emissions targets and policies, the financial metrics and results of this study, and all the scenarios, will be affected if LGCs are retired rather than sold.

3.2 Scenario Modelling Summary

3.2.1 Financial viability

The overall financial viability of each modelled scenario is determined to be 'Viable' if annual savings from LET is greater than business-as-usual (BAU) where any excess generated electricity to the grid. Where BAU savings are greater than LET savings, the scenario is determined to be 'Not Viable'.

3.2.2 Key Modelling Findings

The table below provides a summary of all assessed scenario modelling outcomes in terms of their commercial viability:

Scenario	Outcome	Key Factors influencing Scenario Outcome	Potential Improvements	Comments
1: One-to-One	Not Viable	• Trading over two distributor networks. • Oversized Solar for customer site. • Customer site had low-cost energy, and relatively constant demand.	• Select Facilities within the same distributor network. • Size proposed Solar to minimise grid export.	• This scenario showed that for LET to be beneficial, the pooled generating and consuming sites should reside within a single distributor network.
2: One-to-Many	Viable	• High grid import costs at customer sites • Low Grid Export Rates at Generator site • Generator Site had ample space for Solar Photovoltaics.	• Size proposed Solar to minimise grid export.	• This scenario exemplified the importance of high utility rates at the generating and consuming sites, as well as the reliance on lack of mandated minimum Feed-in-Tariffs for solar arrays larger than 100kW.
3: One-to-Many	Viable	• High grid import costs at Customer sites. • Low Grid Export rates at Generator site. • Generator Site able to size Solar PV to meet Customer sites' demand.	• Size proposed Solar to minimise grid export.	• This scenario highlighted the increased emissions reduction available through LET. To maximise emissions reductions, Councils should consider emissions reduction potential in the site selection process for LET.

4: Many-to-One	Not Viable	• Insufficient total solar generation capacity:
		  ○ Insufficient roof space
		  ○ Note total consumption at consuming site significantly exceeds total generation capacity from all generating sites.
			• Councils should select different sites that can provide sufficient solar capacity (without clear roof space constraints) and/or include a greater number of sites.
			• Consider introducing more generating sites, to increase scale of LET.
				• This scenario displayed the benefit of pooling excess generation from multiple Generator sites to export to one larger site to maximise the demand savings.
				• More effective generator sites typically comprise large scale solar, wherein LET is more favourable than export rates.

5: Many-to-Many	Not Viable	• Insufficient total solar generation capacity:
		  ○ High consumption at Generator sites
		  ○ Insufficient roof space
		• Low grid import rates at Customer site
			• Identify more effective Generator sites for LET.	• This scenario showed that scale is a contributing factor to LET. In order to achieve the savings required to offset the cost of new Solar PV, there must be a significant amount of energy traded, which was not achieved in this scenario.

Table 6: Summary of Scenario Outcomes, factors, and scenario improvements.

3.2.3 Summary of LET Commercial and Energy Results

The impacts of LET compared to Business as Usual is summarised below, showing the energy, environmental, and financial impacts of each modelled scenario:

	Energy Savings			Reductions		Financial Costs/Savings							Metrics	
	Total Energy Savings (MWh)	Total Demand Reduction (kVA)	Total Grid Export (MWh)	Electricity Offset (%)	Potential CO_2 Abatement (Tonnes CO_2)	Capital Cost ($)	Total Energy Savings ($)	Total Demand Savings ($)	Total Grid Export ($)	LGC Revenue (First Year) ($)	LET Cost ($)	Total Net Savings ($)	Simple Payback Period (Year)	Net Present Value ($)
Scenario 1: One-to-One Medium Scale [405 kW] (City of Darebin)														
Business as Usual	223	44	316	15%	265.14	$769,500	$32,179	$4,470	$13,814	$33,214	$0	$50,463	16.78	$115,887
LET	453	44	86	35%	540.52	$769,500	$57,013	$4,470	$3,649	$33,214	$44,346	$20,785	56.04	-$445,464
Scenario 2: One-to-Many Medium Scale [450 kW] (Manningham City Council)														
Business as Usual	305	9.4	281	36%	363.39	$855,000	$38,983	$1,323	$14,065	$36,177	$0	$54,371	17.44	$95,463
LET	430	9.4	157	51%	511.32	$855,000	$63,944	$1,323	$7,850	$36,177	$18,134	$54,979	17.21	$106,952
Scenario 3: One-to-Many Large Scale [1,000 kW] (Nillumbik Shire Council)														
Business as Usual	4	0	1,306	0.2%	5.12	$3,900,000	$454	$0	$65,312	$80,874	$0	$65,766	82.10	-$2,746,959
LET	967	0	339	40%	1,155.95	$3,900,000	$185,750	$0	$16,958	$80,874	$129,429	$73,279	70.52	-$2,604,857
Scenario 4: Many-to-One Small Scale [163 kW Total] (City of Melbourne)														
Business as Usual	6	4.5	50	0.8%	10.93	$21,850	$1,671	$313	$5,727	$0	$0	$7,711	2.49	$99,874
LET	54	4.5	0.2	5%	71.04	$21,850	$10,683	$313	$23	$0	$7,402	$3,594	5.55	$35,065
Scenario 5: Many-to-Many Medium Scale [702 kW Total] (Hume City Council)														
Business as Usual	278	18.5	596	8.6%	330.79	$1,333,800	$96,323	$1,830	$29,799	$53,896	$0	$75,397	20.19	-$227,882
LET	870	18.5	4	27%	1,035.33	$1,333,800	$112,552	$1,830	$0	$53,896	$62,645	$49,906	34.53	-$629,188

Table 7: Summary results of LET across each scenario and financial model.

All assumptions utilised in modelling are summarised in the Appendix, Section 4.3.

3.2.4 Potential Improvement Actions

Across all scenarios, Councils should consider the following initiatives to enhance the financial viability of LET:

1. Select Generator and Consumer Sites with Largest Rate Disparity
   Electing sites with low electricity import rates as Generator Sites, and selecting sites with high electricity rates to be Consumer Sites will maximise the financial benefits of LET.
2. Size Solar on Generating Sites to meet LET Consumption, and Minimise Excess Export
   Solar that is sized on Generator sites excessively larger than the potential consumption of the Customer sites does not aid in the financial viability of LET. All excess generation that cannot be locally traded is exported to the grid at Feed-in-Tariff rates, and does not realise the financial and emissions savings that LET offers.
   This benefit can be ensured by:
   a. Sizing Solar to meet consumption of Consuming Sites
   b. Adding additional Consumer Sites to meet solar generation.
3. Consider Longer Contract Engagements with Retailers
   Consultations with retailers found that one of the benefits of LET they identified was customer retention. Some retailers indicated a willingness to provide LET services to customers for a smaller fee if Councils were willing to use a single retailer across many of their facilities, and entertain a longer-term contract. Council's should be aware of the risks involved in locking in longer-term energy-procurement contracts, which reduce a Council's ability to adapt to the changing energy market over time.
4. Advocate for a Distance Based or Cost Reflective Pricing Mechanism
   The introduction of a new tariff structure where customers pay distributors for the costs they impose on the grid would unlock more value to be exchanged between other market participants. This would allow customers and/or retailers to receive a greater financial benefit from LET.

3.3 Scenario 1: One-to-One (Medium Scale Solar)

3.3.1 Scenario Description

Scenario 1 models LET from a single generating site to a single consuming site at the **Darebin City Council**. The sites modelled, including the solar generator size and location are described below.

Site	Code	Facility Type	Site Type	Capacity
Darebin International Sports Centre	DISC	Sports Stadium	Generator	405 kW
Darebin Reservoir Leisure Centre	RLC	Leisure Centre	Customer	0 kW

Table 8: Sites included in Scenario 1, identifying generating sites, generating assets, and consuming sites.

3.3.2 Scenario Results

3.3.2.1 Overview

Scenario 1 was modelled in a 'Business as Usual' context, and compared to a LET model. The savings associated with each scenario (based on avoided energy costs, demand savings, and export revenues) are shown below.

Financial Model	Total LET Potential Value ($)	LET Export Cost	Total Net Savings ($)	Simple Payback Period (Years)	Net Present Value ($)
Business as Usual	-	-	$50,463	16.78	$115,887
LET	$65,131	$44,346	$20,785	56.04	-$445,464

Table 9: Financial comparison of Business as Usual to LET.

The total monthly energy costs for all sites considered in Scenario 1 is provided below for each financial model.

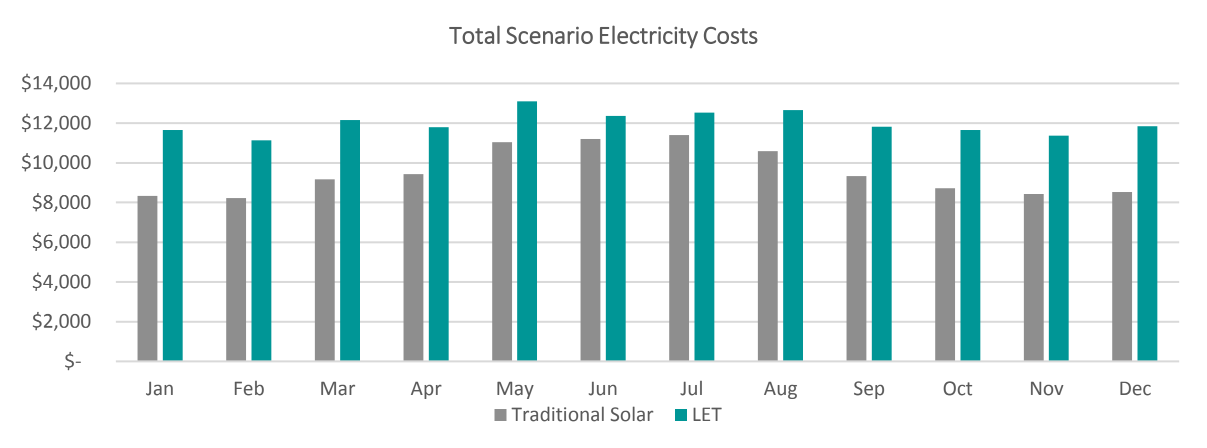


Figure 4: Total Cost Of Electricity Across All Facilities in Scenario 1 with Proposed Solar, Under Traditional and LET Models.

3.3.2.2 Scenario Comments

FGA's analysis showed that LET is not financially viable for this Scenario, as the electricity costs for the scenario rose substantially under LET, when compared to the Business As Usual model.
FGA's technical analysis of this scenario identified key factors that hinder LET, described in brief below:

1. High network fees as energy traverses two Distributors, effectively doubling network costs
2. Solar is oversized for LET export.
3. Low cost of energy at the Customer site (Darebin Reservoir Leisure Centre)
4. Low demand savings at the Customer site due to relatively constant demand profile

To improve financial viability of this scenario, Councils should consider:

1. Select generating and consuming sites within the same distributor network for LET
2. Size proposed solar PV minimise grid export.
3. Advocate for a Distance Based Pricing and/or Cost Reflective Pricing Mechanism

3.3.3 Energy Modelling

Following installation of the Solar array and the introduction of LET, each site is expected to absorb a proportion of excess solar energy generated. FGA modelled solar energy absorption of each site considered in the scenario based on hourly smart meter data profiles. If a consuming site(s) requires energy at the same time that the generator site is exporting energy, the consuming site will absorb the solar energy through LET. If no consuming site(s) require energy at the same time that the generator site is exporting energy, the energy will remain as export to the grid. The graph below shows the monthly solar generation and energy absorption of each site considered in this scenario.

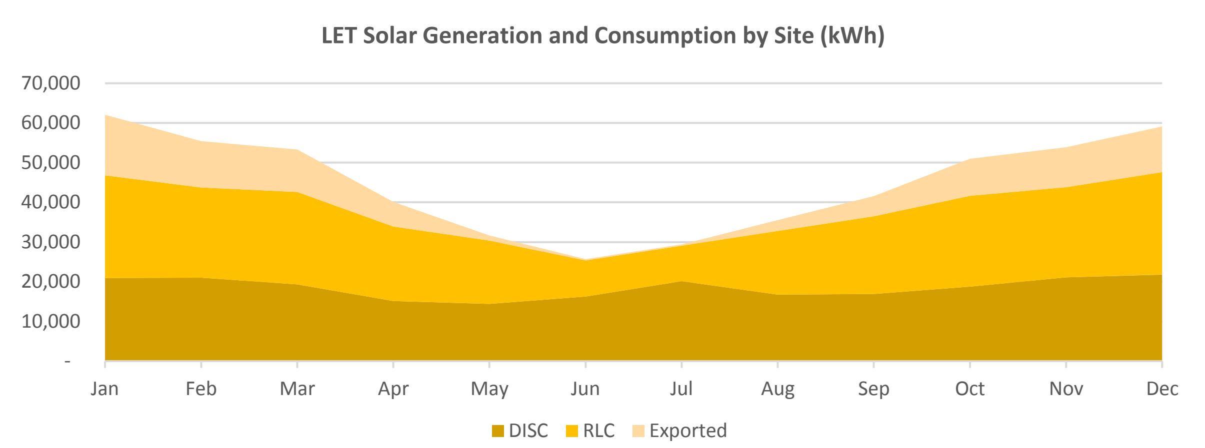


Figure 5: Breakdown Displaying Where DISC Solar Generation is Exported.

In this scenario, generated energy is first absorbed by the generating site, with export absorbed by the consuming site. In the summer months, the generating site produces solar energy in excess of the consuming site, resulting in exported energy to the grid.

The impact of LET on each site is demonstrated below, showing the total annual energy import from the electricity grid in the baseline condition (before Solar), and after LET. Substantial savings in grid electricity result from LET at each site.

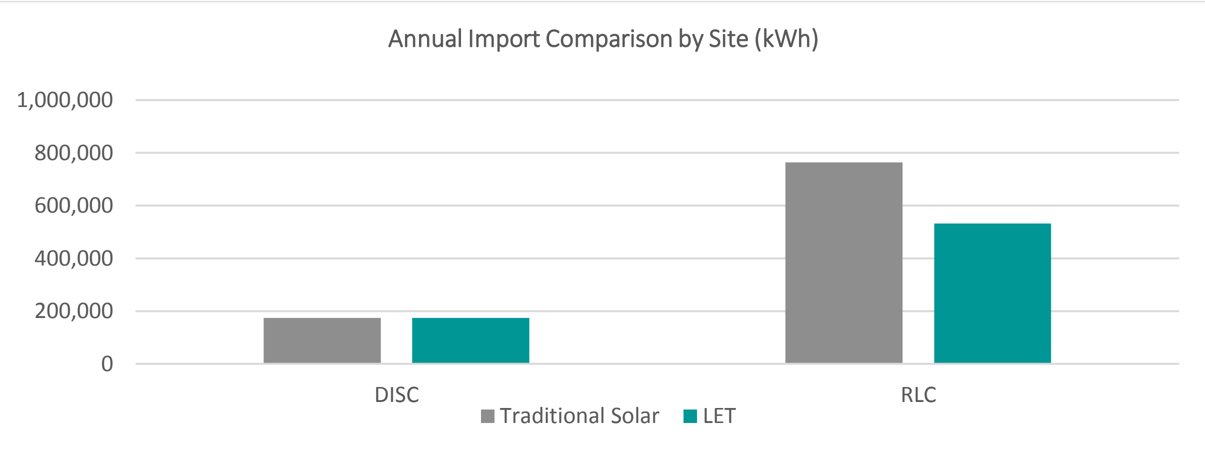


Figure 6: Comparison of Total Grid Import Required (kWh) Before and After LET

3.4 Scenario 2: One-to-Many (Medium Scale Solar)

3.4.1 Scenario Description

Scenario 2 models LET from a single generating site to multiple consuming sites at Manningham City Council. The sites modelled are described below.

Site	Code	Facility Type	Site Type	Capacity
Mullum Mullum Sports Stadium	MMSS	Sports Stadium	Generator	450 kW
Doncaster Senior Citizens Centre	DSC	Senior Citizen Centre	Customer	0 kW
Pines Learning Activity Centre (Split over 3 NMI's)	PLAC1,2,3	Community Centre	Customer	0 kW
The Ajani Centre	TAC	Community Centre	Customer	0 kW
Warrandyte Reserve Pavilion	WRP	Community Centre	Customer	0 kW

Table 10: Sites included in Scenario 2, identifying generating sites, generating assets, and consuming sites.

3.4.2 Scenario Results

3.4.2.1 Overview

Scenario 1 was modelled in a 'Business as Usual' context, and compared to a LET model. The savings associated with each scenario (based on avoided energy costs, demand savings, and export revenues) are shown below. Note that savings are inclusive of the 40% agreed bill discount offered on the following sites: DSC, TAC and WRP. Also, FGA determined that maximum savings resulted from prioritising LET export to the sites with the highest energy consumption. The optimal order of LET used was: TAC, WRP, DSC, PLAC2, PLAC1, PLAC3.

Financial Model	Total LET Potential Value ($)	LET Export Cost	Total Net Savings ($)	Simple Payback Period (Years)	Net Present Value ($)
Traditional Solar	-	-	$54,371	17.44	$95,463
LET	$73,117	$18,134	$54,979	17.21	$106,952

Table 11: Financial comparison of Business as Usual to LET.

The total monthly energy costs for all sites considered in Scenario 2 is provided below for each financial model.

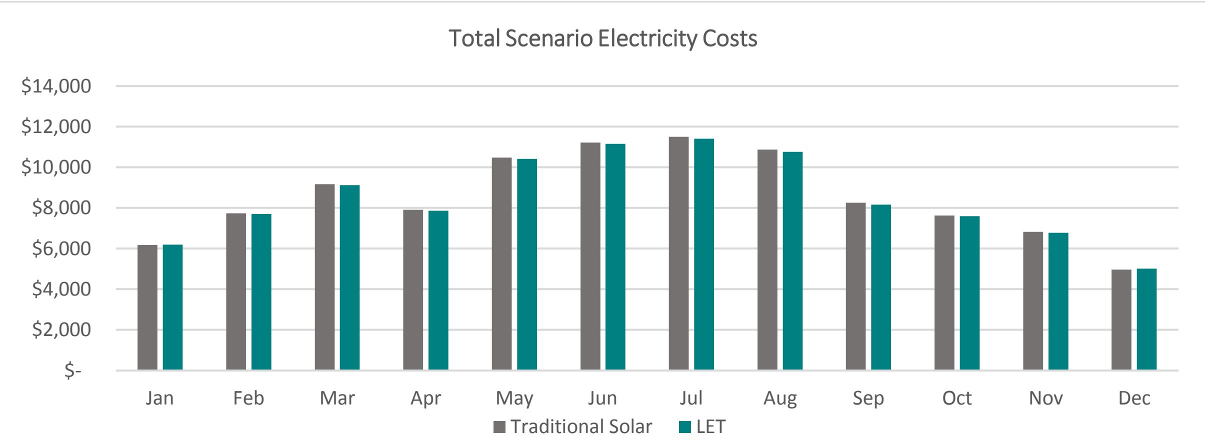


Figure 7: Total Cost Of Electricity Across All Facilities in Scenario 2 with Proposed Solar, Under Traditional and LET Models.

3.4.2.2 Scenario Comments

FGA's analysis showed that LET may be financially viable for this Scenario, and should be pursued further. FGA's analysis identified key factors that support LET in this scenario, including:

1. High energy charges for the customer sites.
2. Low export rates for the large-scale generator.
3. Single Distributor for all sites.

To improve the financial viability of this scenario, Councils should consider:

1. Size proposed solar PV minimise grid export after LET
2. Advocate for a Distance Based Pricing and/or Cost Reflective Pricing Mechanism

3.4.3 Energy Modelling

Following installation of the Distributed Energy Resource (in this case, the solar array), and the introduction of LET, each site is expected to absorb a proportion of excess solar energy generated. FGA modelled solar energy absorption of each site considered in the scenario based on hourly smart meter data profiles. If a consuming site(s) requires energy at the same time that the generator site is exporting energy, the consuming site will absorb the solar energy through LET. If no consuming site(s) require energy at the same time that the generator site is exporting energy, the energy will remain as export to the grid. The graph below shows the monthly solar generation and energy absorption of each site considered in this scenario.

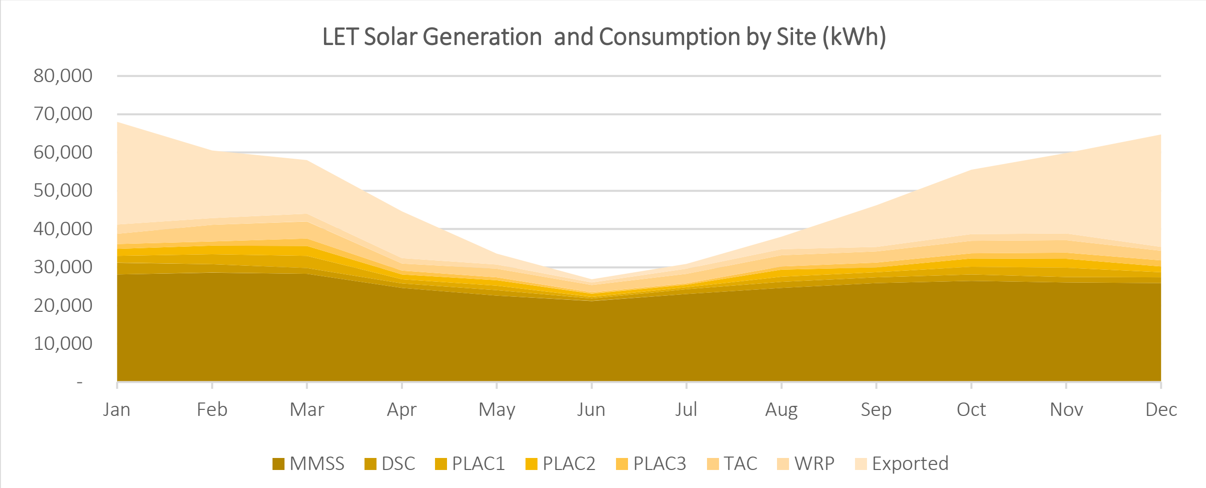


Figure 8: Breakdown Displaying Where MMSS Solar Generation is Exported.

The impact of LET on each site is shown below, showing the total annual energy import from the electricity grid in the baseline condition (before Solar), and after LET. Substantial savings in grid electricity result from LET at each site.

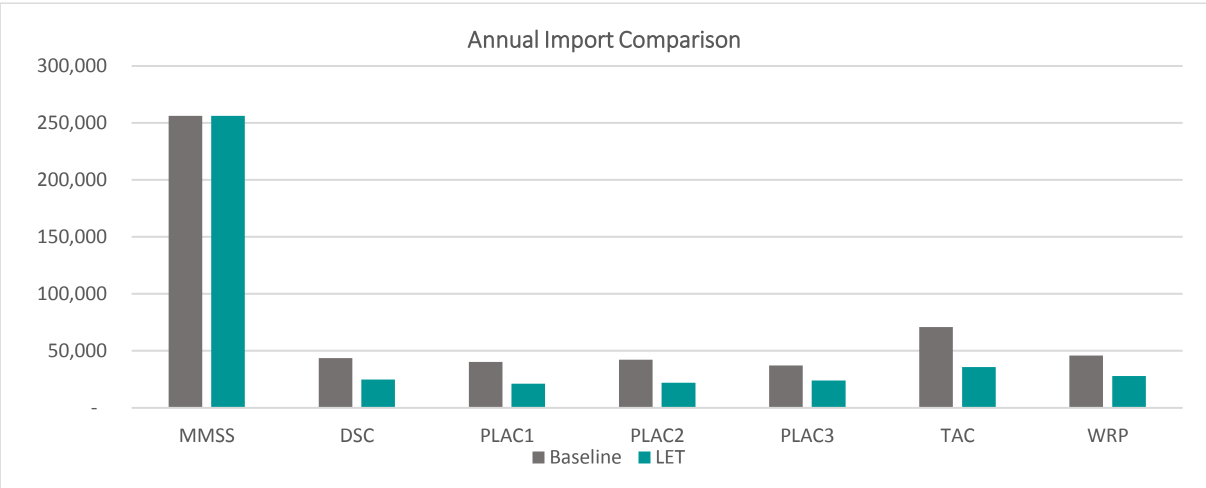


Figure 9: Comparison of Total Grid Import Required (kWh) Before and After LET

3.5 Scenario 3: One-to-Many (Large Scale Solar)

3.5.1 Scenario Description

Scenario 3 models LET from a single generating site to multiple consuming sites at Nillumbik Shire Council. The sites modelled, including the solar generator size and location are described below.

Site	Code	Facility Type	Site Type	Capacity
Nillumbik Shire Council Depot Tip Site	LFILL	Landfill	Generator	1000kW
Eltham Leisure Centre	ELC	Leisure Centre	Customer	-
Council Office	CO	Office	Customer	Not Modelled
Diamond Valley Sports and Fitness Centre	DVSFC	Sports Stadium	Customer	-
Eltham Library	EL	Community Centre	Customer	-
Community Bank Stadium	CBS	Sports Stadium	Customer	Not Modelled

Table 12: Sites included in Scenario 3, identifying generating sites, generating assets, and consuming sites.

3.5.2 Scenario Results

3.5.2.1 Overview

Scenario 3 was modelled in a 'Business as Usual' context, and compared to a LET model. The savings associated with each scenario (based on avoided energy costs, demand savings, and export revenues) are shown below. Note that FGA determined that maximum savings resulted from prioritising LET export to the sites with the highest energy consumption. The optimal order of LET used was: ELC, CO, DVSFC, EL, CBS.

Financial Model	Total LET Potential Value ($)	LET Export Cost	Total Net Savings ($)	Simple Payback Period (Years)	Net Present Value ($)
Traditional Solar	-	-	$65,766	82.10	-$2,746,959
LET	$185,750	$129,429	$73,279	70.52	-$2,604,857

Table 13: Financial comparison of Business as Usual to LET.

The total monthly energy costs for all sites considered in Scenario 3 is provided below for both financial models.

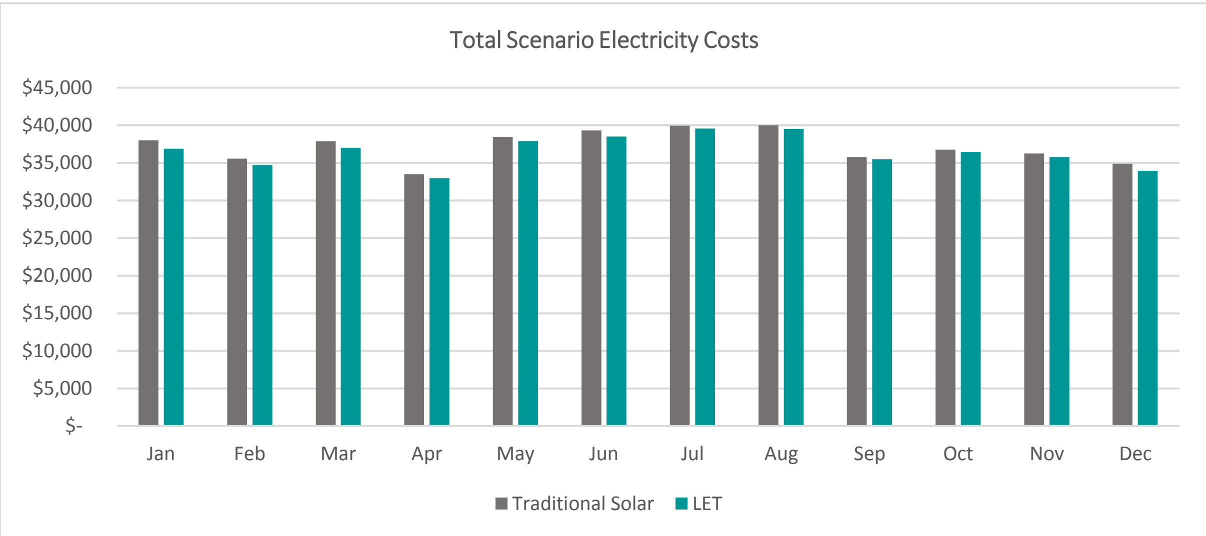


Figure 10: Total Cost Of Electricity Across All Facilities in Scenario 2 with Proposed Solar, Under Traditional and LET Models.

3.5.2.2 Scenario Comments

LET may be financially viable for this Scenario, and should be pursued further. The poor payback and negative NPV results from high cost of a large ground-mounted solar array located on a landfill site. However, FGA notes that LET almost halves the Simple Payback Period for this solar design. FGA's analysis identified key factors that support LET in this scenario, including:

1. Low export rate for large-scale generators, improving the case for alternative export models (i.e.: LET)
2. Generator Site offered ample land for Solar installation
3. High consumption of other facilities during peak solar generation periods
4. High peak rates of customer facilities (in comparison to solar export rate)
5. Single Distributor for all sites

To improve the financial viability of this scenario, Councils should consider:

1. Size proposed solar PV to minimise grid export after LET
2. Advocate for a Distance Based Pricing and/or Cost Reflective Pricing Mechanism

Another key finding from this scenario was the increased emissions reduction available through LET. In this scenario, LET increases the amount of CO_2 saved from 5 Tonnes to 1,155 Tonnes for the same 1MW system.

3.5.3 Energy Modelling

Following installation of the Distributed Energy Resource (in this case, a 1 MW solar array), and the introduction of LET, each site is expected to absorb a proportion of excess solar energy generated. FGA modelled solar energy absorption of each site considered in the scenario based on hourly smart meter data profiles. If a consuming site(s) requires energy at the same time that the generator site is exporting energy, the consuming site will absorb the solar energy through LET. If no consuming site(s) require energy at the same time that the generator site is exporting energy, the energy will remain as export to the grid. The graph below shows the monthly solar generation and energy absorption of each site considered in this scenario.

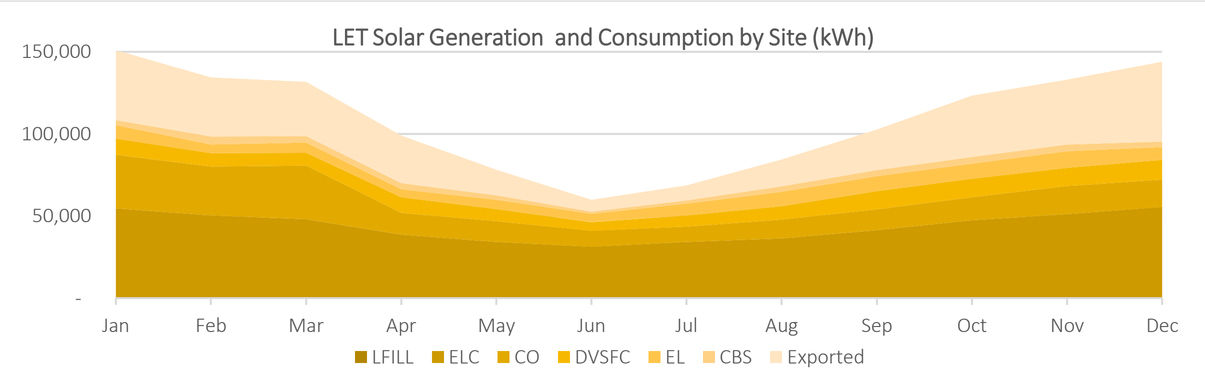


Figure 11: Breakdown Displaying Where LFILL Solar Generation is Exported.

The impact of LET on each site is shown below, showing the total annual energy import from the electricity grid in the baseline condition (before solar), and after LET. Substantial savings in grid electricity result from LET at each site.

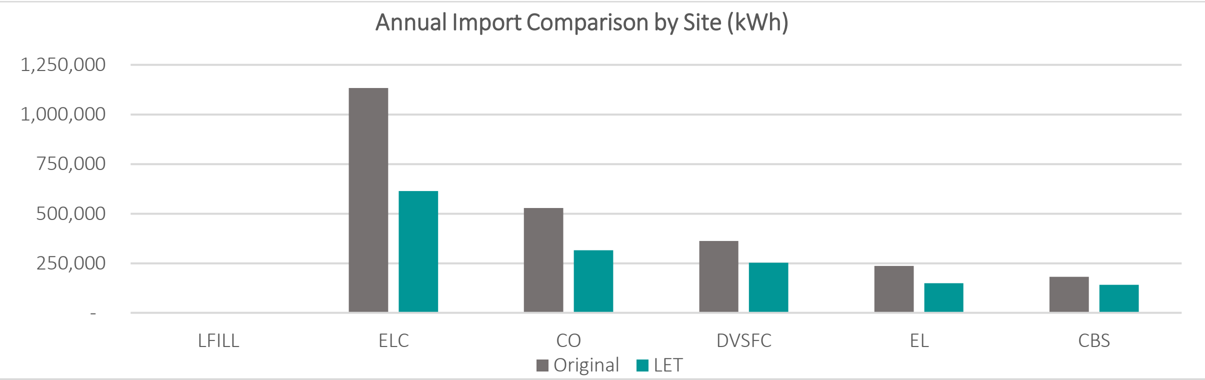


Figure 12: Comparison of Total Grid Import Required (kWh) Before and After LET.

3.6 Scenario 4: Many-to-One (Small Scale Solar)

3.6.1 Scenario Description

Scenario 4 models LET from multiple generating site to a single consuming site at City of Melbourne. The sites modelled are described below.

Site	Code	Facility Type	Site Type	Capacity
Community Hub at the Dock	CHATD	Community Centre	Generator	65kW
Signal Box	SIGB	Community Centre	Generator	10kW
Council House 2	CH2	Office	Customer	3kW
Library at the Dock	LATD	Community Centre	Generator	85kW

Table 14 Sites included in Scenario 4, identifying generating sites, generating assets, and consuming sites.

3.6.2 Scenario Results

3.6.2.1 Overview

Scenario 4 was modelled in a 'Business as Usual' context, and compared to a LET model. The savings associated with each scenario (based on avoided energy costs, demand savings, and export revenues) are shown below. Note that FGA determined that maximum savings resulted from prioritising all LET export to CH2. This was the case as the energy import rates were the same across all sites, and exporting all to CH2 resulted in the maximum demand savings.

Financial Model	Total LET Potential Value ($)	LET Export Cost	Total Net Savings ($)	Simple Payback Period (Years)	Net Present Value ($)
Traditional Solar	-	-	$7,711	2.49	$99,874
LET	$10,996	$7,402	$3,594	5.55	$35,065

Table 15: Financial comparison of Business as Usual to LET.

The total monthly energy costs for all sites considered in Scenario 4 is provided below for each financial model.

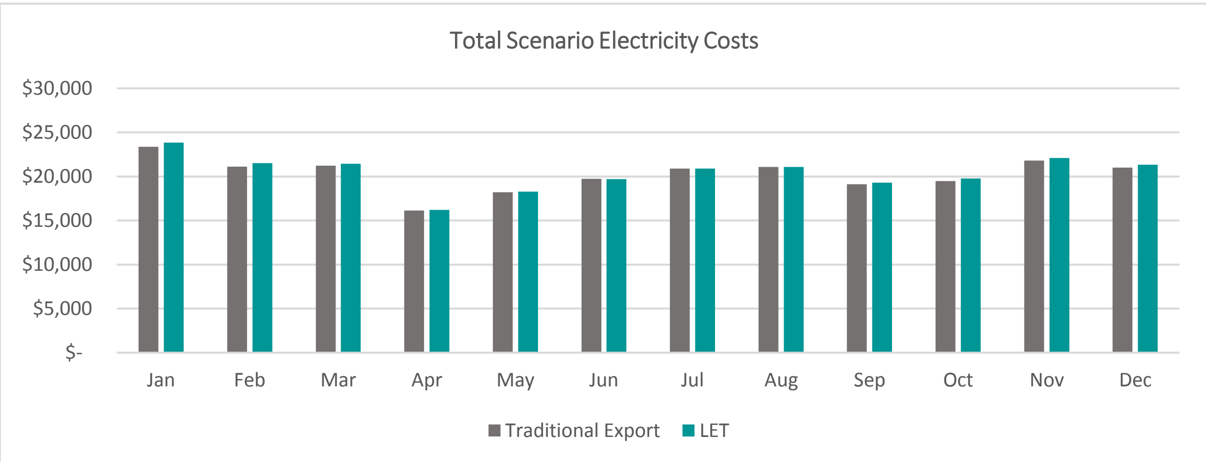


Figure 13: Total Cost Of Electricity Across All Facilities in Scenario 4 with Proposed Solar, Under Traditional and LET Models.

3.6.2.2 Scenario Comments

FGA's analysis showed that LET is not financially viable in this Scenario. FGA's analysis identified key factors that hinder LET in this scenario, including:

1. Inability to size solar greater than the consumption at each site due to:
    a. High Consumption at generating sites
    b. Insufficient roof space

To improve the financial viability of this scenario, Councils should consider:

1. Identify other potential facilities with available roof space and low consumption as Generator sites.
2. Consider introducing more generating sites, to increase scale of trading.
3. Advocate for a Distance Based Pricing and/or Cost Reflective Pricing Mechanism

3.6.3 Energy Modelling

Following installation of the Distributed Energy Resource (in this case, the solar array), and the introduction of LET, each site is expected to absorb a proportion of excess solar energy generated. FGA modelled solar energy absorption of each site considered in the scenario based on hourly smart meter data profiles. If the consuming site requires energy at the same time that the generator site is exporting energy, the consuming site will absorb the solar energy through LET. If the consuming site does not require energy at the same time that the generator site is exporting energy, the energy will remain as export to the grid. The graph below shows the monthly energy absorption of CH2.

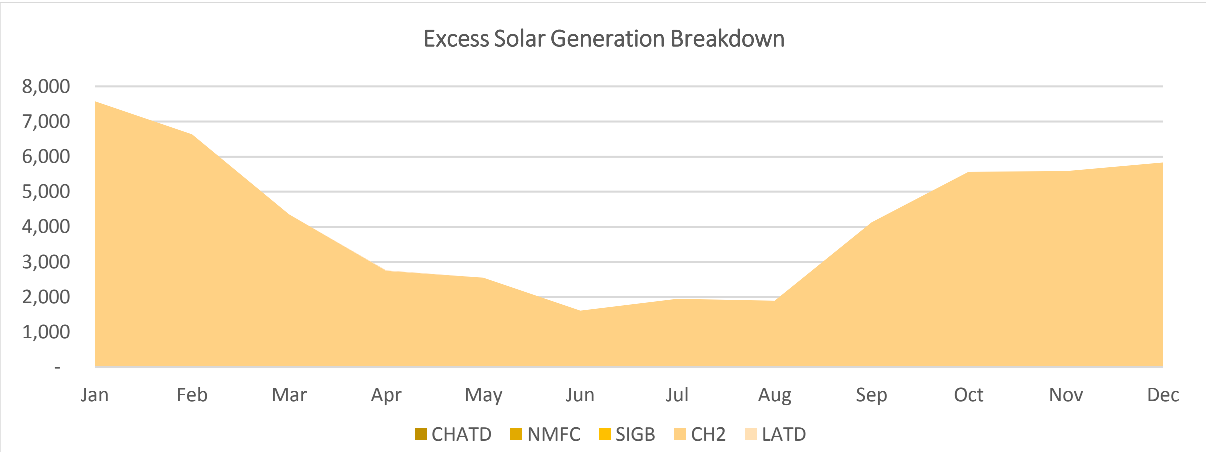


Figure 14 Breakdown Displaying Where LFILL Solar Generation is Exported.

The impact of LET on each site is shown below, showing the total annual energy import from the electricity grid in the baseline condition (before LET), and after LET. Substantial savings in grid electricity result from LET at each site.

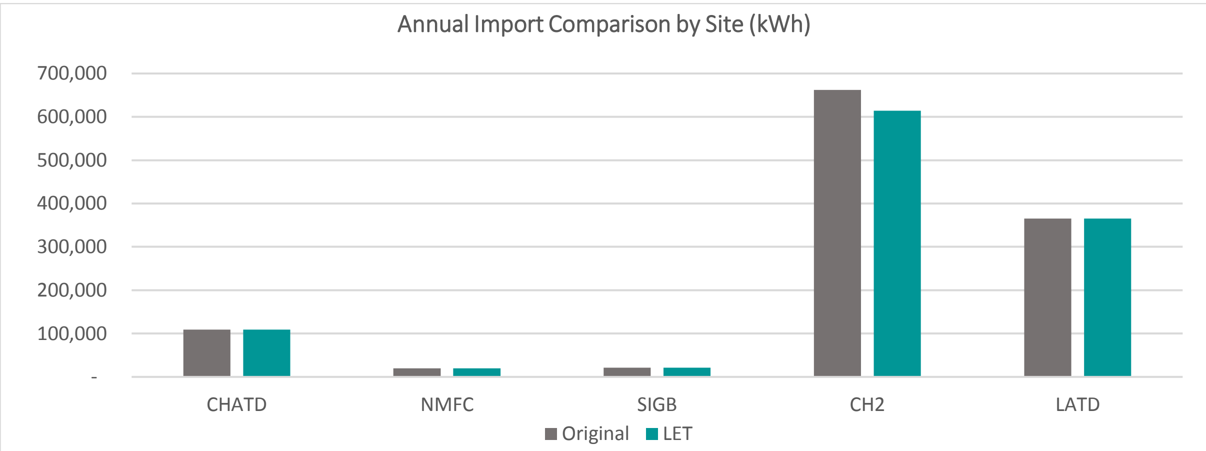


Figure 15 Comparison of Total Grid Import Required (kWh) Before and After LET

3.7 Scenario 5: Many-to-Many (Medium Scale Solar)

3.7.1 Scenario Description

Scenario 5 models LET from multiple generating site to multiple consuming sites at Hume City Council.

Site	Code	Facility Type	Site Type	Capacity
Splash Aqua Park	SPLASH	Aquatic Centre	Generator	59 kW
Broadmeadows Netball Stadium	NETB	Sports Stadium	Generator	148 kW
Broadmeadows Basketball Stadium	BB-BMED	Sports Stadium	Generator	145 kW
Boardman Basketball Stadium	BB-SUNB	Sports Stadium	Generator	350 kW
Hume Region Tennis Centre	TENNIS	Sports Stadium	Customer	0 kW

Table 16: Sites included in Scenario 5, identifying generating sites, generating assets, and consuming sites.

3.7.2 Scenario Results

3.7.2.1 Overview

Scenario 5 was modelled in a 'Business as Usual' context, and compared to a LET model.
For this scenario, FGA has modelled each generating site with the maximum amount of solar PV the facility roof permitted. The Hume Region Tennis Centre was not elected as a generator due to poor roof conditions for solar (southward sloping, and multiple HVAC units and exhausts).

Through analysis, FGA determined the maximum solar sizing was able to fulfil the consumption for BB-SUNB, BB-BMED and NETB; as a result, only two consuming assets remained: NETB and SPLASH. FGA determined that maximum savings resulted from prioritising LET export to the sites with the highest energy rates. The optimal order of LET used was: NETB then SPLASH.

The savings associated with each scenario (based on avoided energy costs, demand savings, and export revenues) are shown below.

Financial Model	Total LET Potential Value ($)	LET Export Cost	Total Net Savings ($)	Simple Payback Period (Years)	Net Present Value ($)
Traditional Solar	-	-	$75,397	20.19	-$227,882
LET	$112,552	$62,645	$49,906	34.53	-$629,188

Table 17: Financial comparison of Business as Usual to LET.

The total monthly energy costs for all sites considered in Scenario 1 is provided below for each financial model.

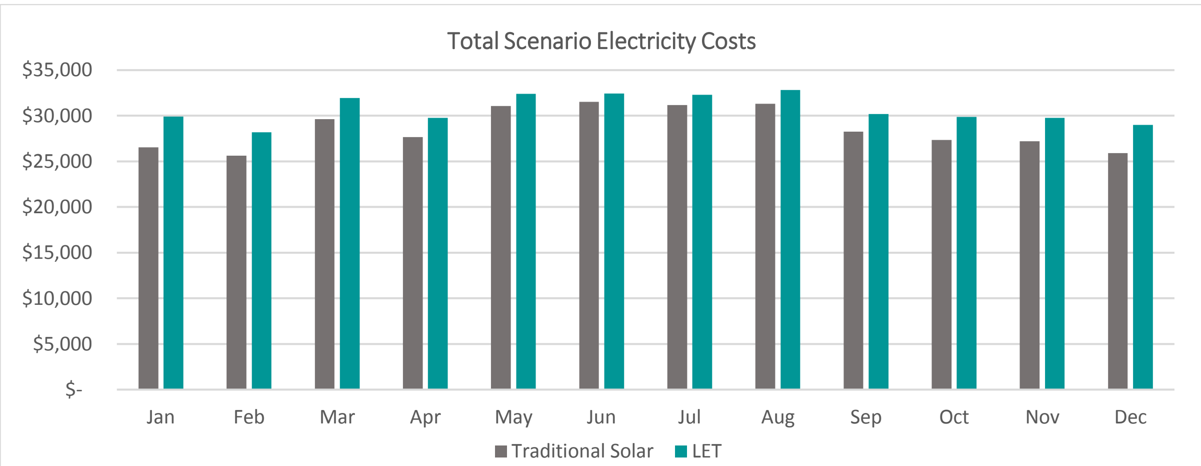


Figure 16: Total Cost Of Electricity Across All Facilities in Scenario 1 with Proposed Solar, Under Traditional and LET Models.

3.7.2.2 Scenario Comments

FGA's analysis showed that LET is not financially viable for this Scenario. FGA's analysis identified key factors that hinder LET in this scenario, including:

1. Inability to size solar to export for LET, due to:
    a. High Consumption at generating sites
    b. Insufficient roof space for solar photovoltaics
2. Low grid import rates at the major consuming site (Splash Aqua Park)

To improve the financial viability of this scenario, Council should consider:

1. Identify other potential facilities with significant roof space available and low consumption to provide a more effective Generator site.
2. Advocate for a Distance Based Pricing and/or Cost Reflective Pricing Mechanism

3.7.3 Energy Modelling

Following installation of the Distributed Energy Resource (in this case, the solar array), and the introduction of LET, each site is expected to absorb a proportion of excess solar energy generated. FGA modelled solar energy absorption of each site considered in the scenario based on hourly smart meter data profiles. If a consuming site(s) requires energy at the same time that the generator site is exporting energy, the consuming site will absorb the solar energy through LET. If no consuming site(s) require energy at the same time that the generator site is exporting energy, the energy will remain as export to the grid. The graph below shows the monthly solar generation and energy absorption of each site considered in this scenario.

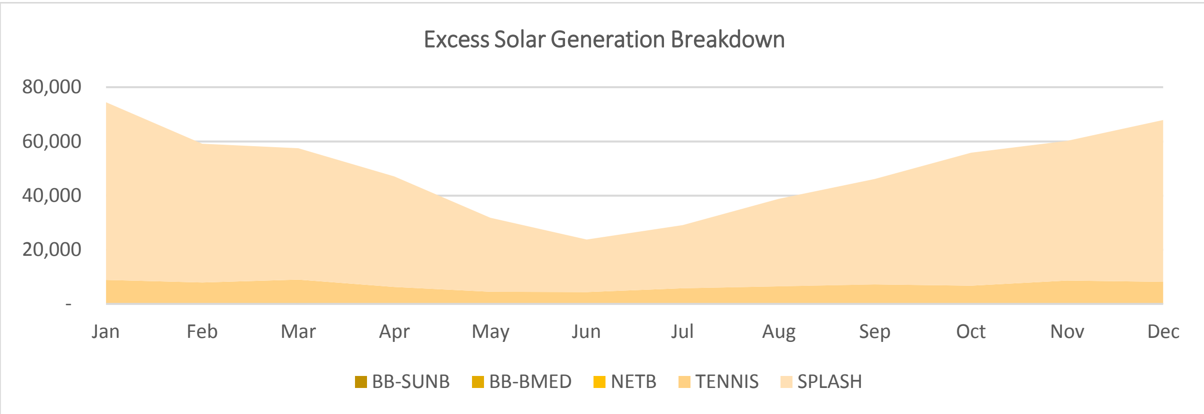
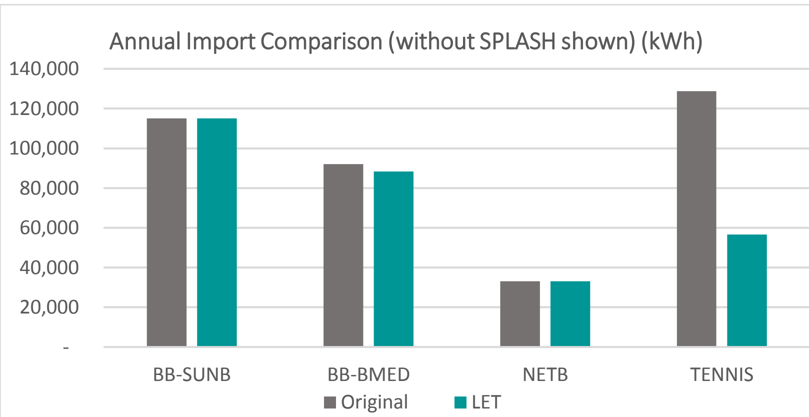


Figure 17: Breakdown Displaying Where the Excess Solar Generation is Exported.

Note that only TENNIS and SPLASH received energy from locally energy trading, as the other sites were Generator sites and were able to fulfil their own consumption before LET was possible. FGA notes that there is no export in this scenario, as all solar was absorbed at SPLASH, with no export.

The impact of LET on each site is shown below, showing the total annual energy import from the electricity grid in the baseline condition (before LET), and after LET. The SPLASH site has been provided in a separate figure, as the consumption is magnitudes larger than the other sites in this scenario, note the kWh scale.



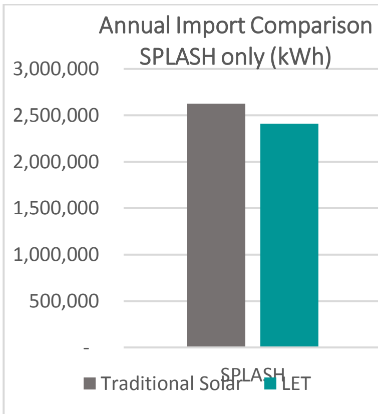


Figure 18 Comparison of Total Grid Import Required (kWh) Before and After LET, showing all sites.

4 APPENDIX

4.1 Attachment: NAGA Local Energy Trading Tool

Please find attached to this report, the NAGA Local Energy Trading Tool spreadsheet.

4.2 Case Studies

As an emerging concept in the energy industry, LET has been trialled in various small-scale projects across Australia, particularly within the last year. FG Advisory has investigated both past and present trials in the LET sector. The most relevant trials and reports (based on locale, technology, and project partners) are summarised below.

4.2.1 Case Study 1

Trial/Report: Local Energy Trading & Local Network Charges
Project Partners: Institute of Sustainable Futures UTS in partnership with ARENA

UTS
UNIVERSITY OF TECHNOLOGY SYDNEY

Description
Desktop analysis of benefits of LET and LGNC's (Local Generation Network Credits) within a Council's building portfolio, resulting in the report titled *Facilitating Local Network Credits and Local Electricity Trading*

Summary of Findings

- Under current market conditions, installation of local generation is unlikely to be financially viable (Incentive to install renewable assets with excessive export are low)
- Regulatory changes in tariff structure are required for the introduction of LGNCs in the market
- The introduction of LGNCs sends clear financial signals to invest in excess renewable generation
- LGNC rule change was proposed to the AEMC which was later rejected (details below)

Detailed Project Description

Figure 19: Five scenarios modelled

This project provides case study evidence from five 'virtual trials' of local network charges and local electricity trading, in NSW, VIC, and QLD. The scenarios examined different forms of renewable energy sources including solar PV, geothermal, cogeneration and wind.

UTS reported that the results of the economic modelling over the long term indicated approximately $1.2 billion in economic benefits from the introduction of LGNCs alone. UTS also stated that the economic benefit of LET and LGNCs was approximately 59% less than the cost of planned network expansion under a Business-as-Usual growth model.

UTS recognises that the economic benefit to customers is not realised in the short term, but after approximately 2030, whereupon network augmentation savings are realised by all customers in the market from implementation of an LGNC program.

UTS worked with electricity sector stakeholders to formulate a tariff structure regulation change fit for the future which included the introduction of LGNCs. AEMC released draft determination to reject the LGNC Rule Change in late 2016, citing the incentivisation of non-renewable generation, Retailer expense issues and the little impact on demand reduction as the key shortfalls of the proposal.

Further information on this trial is available at:
https://www.uts.edu.au/research-and-teaching/our-research/institute-sustainable-futures/

4.2.2 Case Study 2: Fremantle Distributed Energy and Water System

Project Partners: Power Ledger, City of Fremantle, Curtin University, Western Power, AEMO

Description

The project, which involves academic, infrastructure and technology partners, assesses how cities can use blockchain technology and data analytics to integrate distributed energy and water systems. Power Ledger aims to demonstrate the interconnected infrastructure of future smart cities by trading energy between a precinct wide battery, electric vehicles, and extensive rooftop solar as part of a "smart city" concept in Fremantle.

Key Findings

Through the trial, Power Ledger aims to identify:

- How cities can use blockchain technology and data analytics to integrate DERs
- The use of DERs in circumventing the need for costly distribution network overhauls
- Of particular interest to Councils, the trial will examine how customers, Retailers and distributors can interact in a mutually beneficial environment that supports LET

Detailed Project Description

Through $8 million in funding from both the Australian Government and project partners, including Curtin University, Murdoch University, CSIRO, and others, the Power Ledger trial in Fremantle will involve highly resilient, low-carbon and low-cost systems installed and connected using blockchain technology. A large scale solar PV installation, rooftop solar PV, a precinct sized battery, an electric vehicle charge station and precinct water treatment and capture systems will be orchestrated using blockchain technology and data analytics.

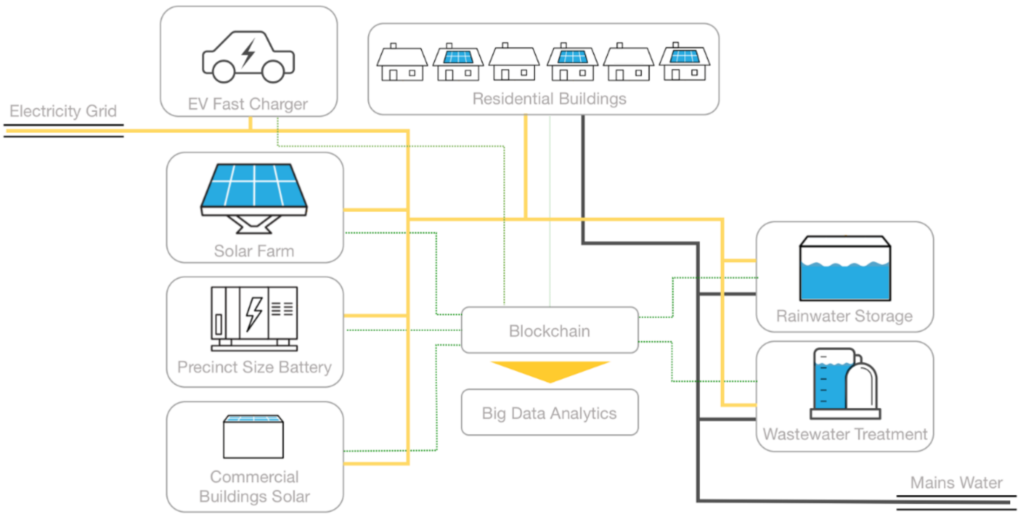


Figure 20: Sample schematic of the proposed trial in Fremantle

The project will provide the community with financial and service sustainability while still engaging the private sector. Power Ledger will provide the transactional layer for the renewable assets as well as the ownership model for the community owned battery. Of particular interest to Councils will be the arrangement terms developed between Customers and Distributor (Western Power) within the community, such that all industry stakeholders mutually benefit from the case study. The trial will span two years and was scheduled to commence early 2018.

4.2.3 Case Study 3: Peer-to-Peer Distributed Ledger Technology Assessment

Project Partners: AGL, IBM, MHC

Description

Investigation into the market value of LET and the viability of ledger technologies in a LET application.

Key Findings

- Commercially speaking, as a “zero-sum game” the LET market will only emerge if an existing market participant (Retailer or Distributor) can reduce their costs to serve LET Customers
- The assessment found that the viability of certain new products and markets, like LET, are highly dependent on the underpinning network pricing framework (tariff structure)

Detailed Project Description

AGL and IBM collaborated to understand the feasibility of Peer-to-peer (P2P) networks and ledger technology.

Three hypothetical scenarios were modelled to examine the impacts of modifications to network prices, changes to customer load profile and the potential for a disruptive force in the highly regulated market on the potential for a LET market to develop.

1. Varying Network Tariffs: No current distinction exists based on the centralised or decentralised source of energy consumed, regardless of the Customer’s proximity to the generator.
2. Load Shifting: Use of storage and intelligent energy management systems which when controlled correctly, may introduce significant LET market value.
3. Disruptive Force: A new, low-cost provider which provides administrative services to the LET market

Network tariffs were adjusted for LET through the removal of Transmission Use of Service (TUOS) charges based on the United Energy Network rates, which amount to approximately 17% of total network charges levied against Customers. An additional 1c/kWh was charged to customers as an administration fee for providing LET services.

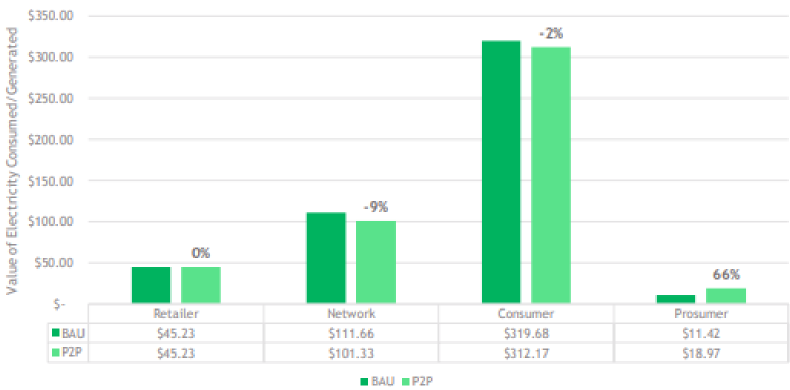


Figure 21: Modelled LET results between AGL customers led to an increase in customer and prosumer (generator) electricity savings, but a loss in network provider revenue (Peer-to-Peer Distributed Ledger Technology Assessment, 2017)

The study found that the economic feasibility of LET depends most importantly on network tariff structure. While a new low-cost service provider, or increased load shifting opportunities (through batteries) also offered significant savings potential, Councils will benefit most from direct engagement and negotiation with their incumbent Distributors if they wish to establish LET between Council assets.

4.3 Modelling Assumptions

4.3.1 Interval Data Assumptions

When scaling one facility based on another, FGA has considered the following:

- The function/type of facility.
- The facilities operating hours.
- The off-peak and peak usage differences.
- Scaling facility consumption as accurately as the data provided allows
  - For example, if monthly totals were provided, the template was scaled on a monthly interval to construct the desired facility profile.

A table outlining the major Interval Data assumptions is provided below.

Site	Modelling Assumption(s)
City of Darebin	
Reservoir Leisure Centre	As the facility decommissioned the Cogen, consumption data needed to be mirrored about June, to construct a full consumption profile.
Manningham City Council	
Doncaster Senior Citizens Centre	No interval data was available, so this facility was scaled based on the *Manningham Ajani Centre* consumption profile.
Warrandyte Reserve Pavilion	No interval data was available, so this facility was scaled around *Darebin International Sports Centre* consumption profile.
Nillumbik Shire Council	
Eltham Leisure Centre	No interval data was available, so this facility was scaled based on the *Hume Boardman Basketball Stadium* consumption profile.
Diamond Valley Sports and Fitness Centre	No interval data was available, so this facility was scaled based on the *Hume Boardman Basketball Stadium* consumption profile.
Eltham Library	No interval Data was available, so this facility was scaled based on the *Melbourne Library at the Dock* consumption profile.
Community Bank Stadium	No interval data was available, so this facility was scaled based on the *Hume Boardman Basketball Stadium* consumption profile.
City of Melbourne	
Community Hub at the Dock	No interval data was available, so this facility was scaled based on the *Manningham Ajani Centre* consumption profile. No export interval data was provided, however 90-day export totals were. This data was standardised using a typical export curve, and scaled into hourly interval data.
North Melbourne Football Club	No interval data, solar generation, export or behind the grid consumption data was available, so this site has been omitted from this scenario.
Signal Box	No interval data was available, so this facility was scaled based on the *Manningham Ajani Centre* consumption profile.
Hume City Council	
Splash Aqua Park	A full year of interval data was not available as this facility opened recently. The unknown portions of the consumption have been scaled based on the *Darebin Reservoir Leisure Centre*. The consumption scale factor was a fixed percentage greater than RLC for the unknown months. This factor was aligned with the implied scale factor over the known data period.
Broadmeadows Netball Stadium	No interval data was available, so this facility was scaled based on the *Hume Boardman Basketball Stadium* consumption profile.
Broadmeadows Basketball Stadium	No interval data was available, so this facility was scaled based on the *Hume Boardman Basketball Stadium* consumption profile.
Boardman Basketball Stadium	Approximately three weeks of data missing throughout the year. Data was substituted from other typical days/weeks that fit the period and the trend.

Table 18 Interval Data Assumptions

4.3.2 Electricity Bill Rate Assumptions

Multiple sites, generally small consumption sites, had blended rates for their imported electricity, i.e.: One Peak and one Off-Peak rate.

> To create the required network peak and off-peak rates, it was assumed that the network portion of the charge is 37.3% of the blended rate.

The "37.3%" is derived from Distributor margins referencing the "*Independent Review into the Electricity & Gas Markets in Australia*" (August 2017) published by the Victorian Government. This study implied that on average, Distributors receive a margin of 37.3% of the total electricity bill. This proportion includes demand costs, and is hence is a conservative estimate of the $/kWh network rate, ensuring that in this assumption LET is not cheaper than the FGA modelled tariff implies.

A table outlining billing import and export rate assumptions is provided below.

Site	Modelling Assumption(s)
City of Darebin	
Reservoir Leisure Centre	As the facility decommissioned the Cogen, consumption data needed to be mirrored about June, to construct a full consumption profile.
Manningham City Council	
Mullum Mullum Sport Stadium	No rates existed for this facility. This facility was modelled using MCC approved rates.
Doncaster Senior Citizens Centre	Only blended Peak and off-Peak rates were available, network charges were assumed in accordance with above method.
The Ajani Centre	Only blended Peak and off-Peak rates were available, network charges were assumed in accordance with above method.
Warrandyte Reserve Pavilion	Only blended Peak and off-Peak rates were available, network charges were assumed in accordance with above method.
Nillumbik Shire Council	
Nillumbik Shire Council Depot Tip Site	Only blended Peak and off-Peak rates were available, network charges were assumed in accordance with above method.
City of Melbourne	
All Sites	At the request of CoM, all sites were modelled using the same CoM approved rates.
Hume City Council	
Broadmeadows Basketball Stadium	No billing information was available, for the purpose of analysis the facility has adopted the same rates as *Hume Boardman Basketball Stadium*.
Broadmeadows Netball Stadium	Only blended Peak and off-Peak rates were available, network charges were assumed in accordance with above method.

Table 19 Rate Assumptions

4.3.3 LET Tariff Structure Assumptions

4.3.3.1 Electricity Bill Overview

The financial viability of LET for NAGA is directly related to the electricity charges for each site, and the structure and proportion of each type of charge. Consequently, an understanding of the general structure of Customer electricity bills is required to assess the impact of LET.

A typical Customer electricity bill in Victoria consists of the following charges:

- Retailer Charges
  - Peak and Off-peak Energy Charges
  - Metering Charges
- Distributor Charges
  - Off-peak and Peak Network Charges
  - Demand Charges
  - Network Access Charges
- Environmental Charges
  - LRET – Certificates Retailers are required to purchase from large scale renewable generators.
  - SRES – Certificates Retailers are required to purchase from small scale embedded generation
  - VEET – A Victorian scheme to increase affordability of energy efficient improvements
- AEMO Charges
  - Pool and Ancillary Charge – AEMO's charges for operating the electricity market.

4.3.3.2 *FGA Modelled LET Tariff Structure*

Based on consultation with Distributors and Retailers detailed in Part I, FGA developed a financial model to assess each scenario for LET. For LET to be commercially viable, and sustainable, each party must receive a fee for their role in trading energy under LET. This is displayed below.

Cost per kWh = (Retailer Fee) + (Distributor Fees) + (AEMO Fees) + (Environmental Fees)

The magnitude of the each of the Fees were assumed and calculated with reference to the fee table below. Note that the icons are used as a reference to indicate the fee from each party.

Retailer	Retailer fees are modelled as a fixed $0.05/kWh for all LET. The $0.05/kWh is derived from Retailer margins referencing the "*Independent Review into the Electricity & Gas Markets in Australia*" (August 2017) published by the Victorian Government. This study implied that on average, Retailers receive a margin of 22% of the total electricity bill. In consideration of the Council rates provided, this margin would account for 4.5¢ to 5.5¢ per kWh. For the purpose of this study, a 5¢ fee per kWh was been modelled for all LET energy.
Distributor	The Distributor fee is equal to the network rate ($/kWh) of the LET consuming facility bills. This rate includes variable energy charges ($/kWh) and does not include fixed network fees (such as metering charges, access charges and other per day and per month network charges). Fixed charges are omitted as they do not vary with consumption and are not impacted by LET.
AEMO	This fee is equal to the sum of the existing AEMO fees for the receiving site on a $/kWh basis.
Environmental	This fee is equal to the sum of the existing environmental certificate fees for the receiving site on a $/kWh basis.

Table 20: Fee table used in all financial calculations for LET

4.3.4 Financial Metric Assumptions

FGA requested preferred NPV rates, terms, and utility escalation rates from all participating councils to provide representative financial metrics that represent the risk profiles of all participating councils. The rates and terms used are shown below.

- NPV terms
  - Rate: 4.25%
  - Term: 25 years
- Utility Escalation Rate: 2.5%
- STC Rate
  - FGA has adopted a value of $36 per certificate (Current as of Mar 2018).
  - FGA has used an STC eligibility rate of 15.404 STCs/kW (Current as of Mar 2018).
- LGC Rates
  - FGA has used LGC values according to expectations from an industry expert.

Year	LGC value ($/MWh)
2019	$77.17
2020	$51.35
2021	$28.17
2022	$0.00
2023	$0.00
2024	$0.00
2025 onwards	$0.00

- Solar Array Export Rates
  - For systems under 100 kW: 11.3 c/kWh (Current minimum FIT FY17/18)
  - For systems over 100 kW: 5 c/kWh (Current minimum FIT FY17/18)
- Solar Array Costs
  - Roof mounted, general: $1,900 / kW
  - Ground mounted (with HV): $3,900 / kW

4.4 Baseline Consumption

FGA developed an annual baseline profile for each site, based on smart meter data and billing data provided by the representative Council. Where electricity profile data was not available for a site, FGA developed an approximated profile from a similar site, and scaled the data to match the total annual consumption (refer to Section 4.3.1 for further detail on each Scenario). The monthly baseline consumption (prior to installation of the nominated generator) of the sites considered in each scenario are shown below.

4.4.1 Scenario 1: City of Darebin

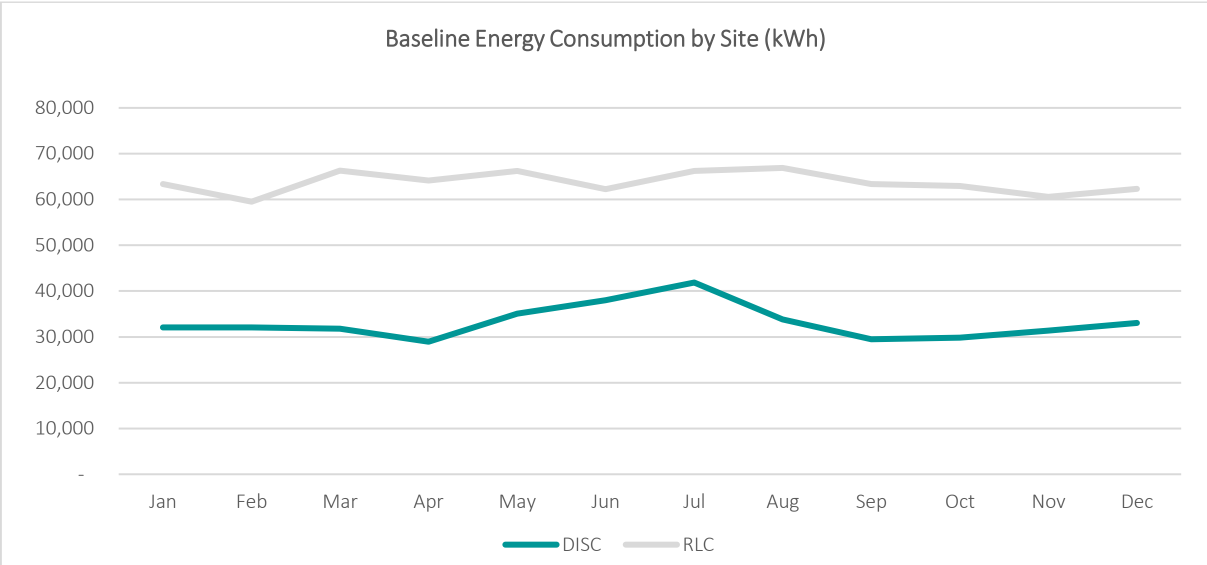


Figure 22: Baseline Monthly Electricity Consumption (kWh) for all sites for all sites in Scenario 1: DISC, RLC

4.4.2 Scenario 2: Manningham City Council

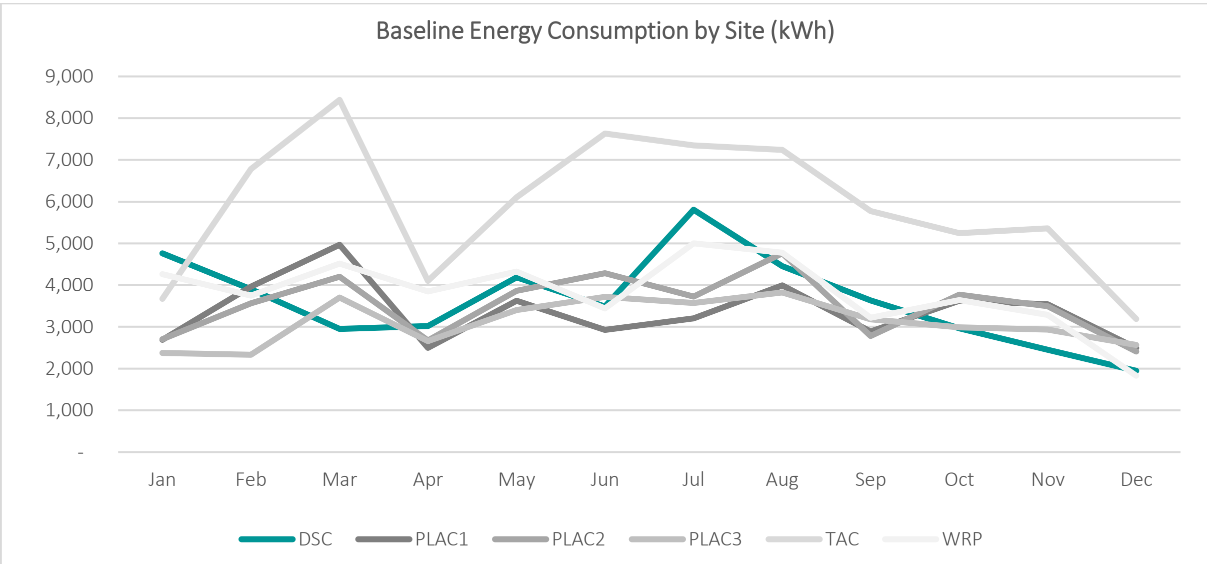


Figure 23: Baseline Monthly Electricity Consumption (kWh) for all sites for all sites in Scenario 2: DSC, PLAC, TAC, WRP

4.4.3 Scenario 3: Nillumbik Shire Council

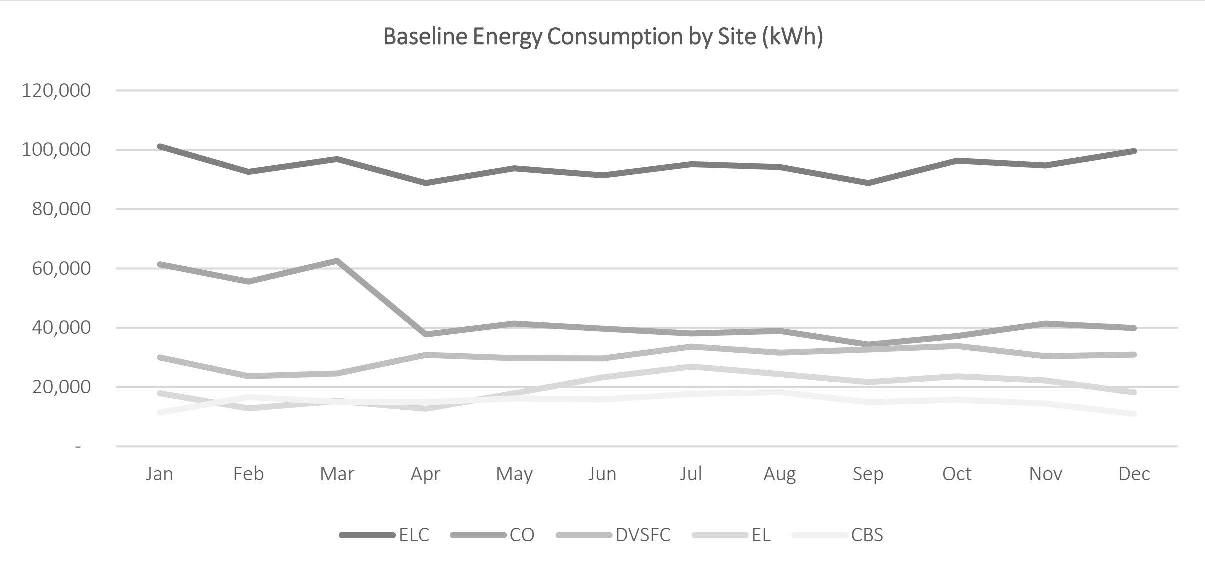


Figure 24: Baseline Monthly Electricity Consumption (kWh) for all sites in Scenario 3: ELC, CO, DVSFC, EL, CBS

4.4.4 Scenario 4: City of Melbourne

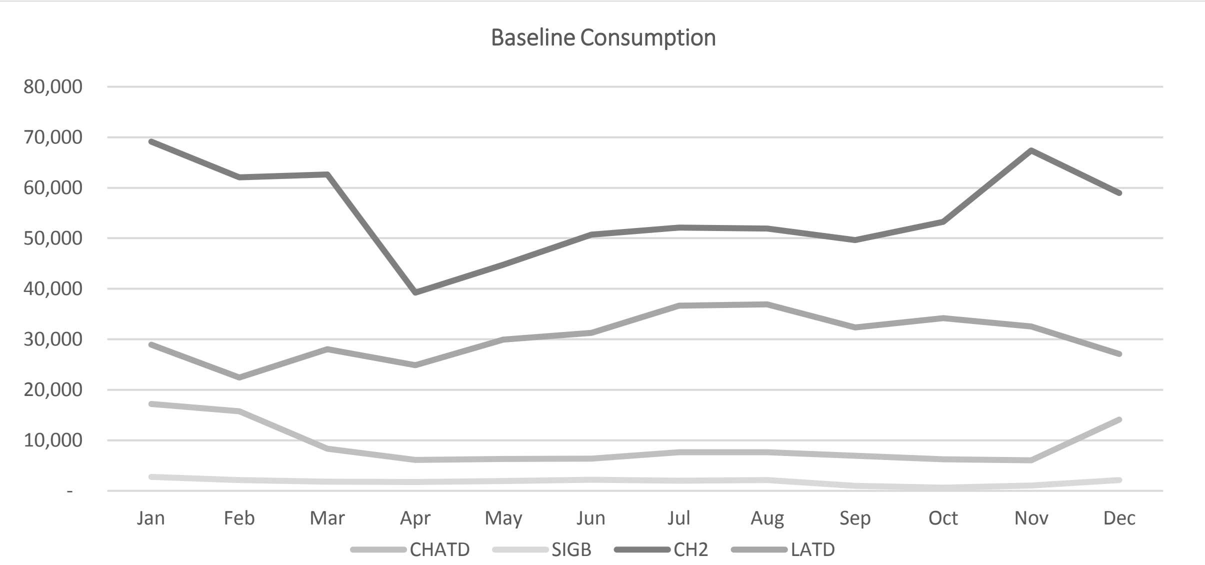


Figure 25: Baseline Monthly Electricity Consumption (kWh) for all sites in Scenario 4: CHATD, SIGB, CH2, LATD

4.4.5 Scenario 5: Hume City Council

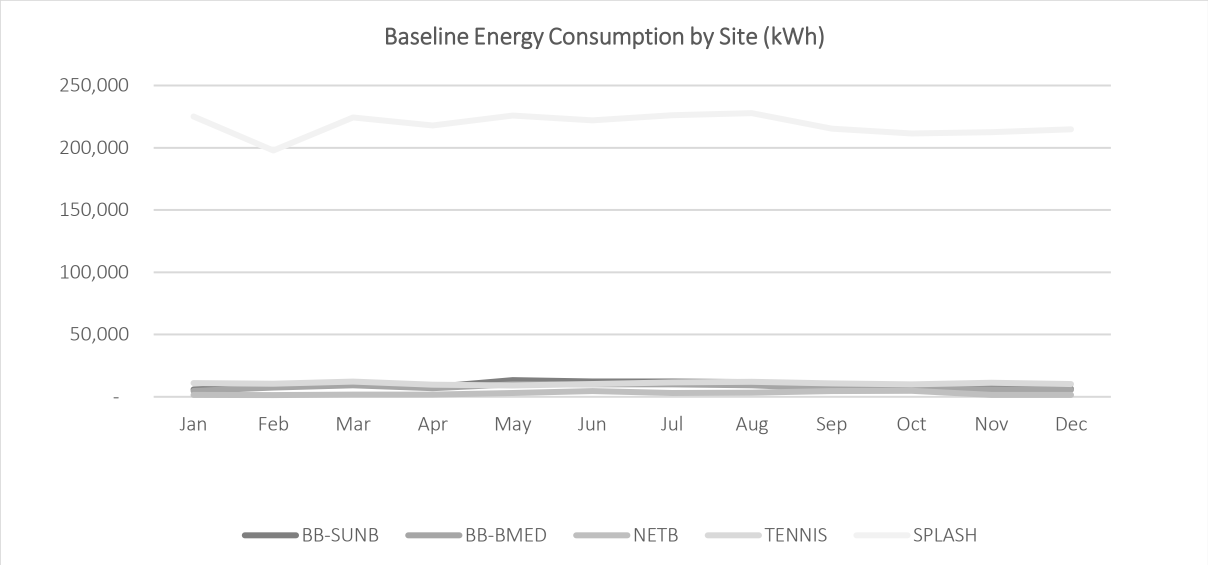


Figure 26 Baseline Monthly Electricity Consumption (kWh) for all sites in Scenario 5.

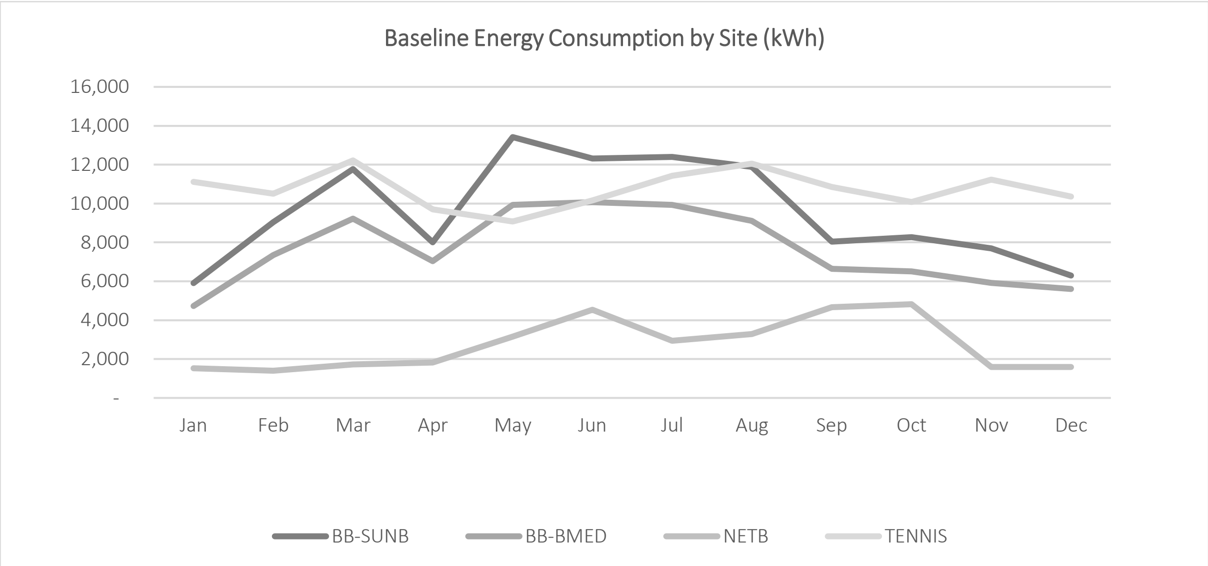


Figure 27 Baseline Monthly Electricity Consumption (kWh) for all sites in Scenario 5, excluding SPLASH.

4.5 Modelled Distributed Energy Resources

Across all participating councils, FGA completed a desktop review to confirm any existing Distributed Energy Resources (DERs), noting the location, capacity, resource type and whether or not it was considered in the LET modelling. FGA has also provided details on any solar systems that do not exist, but were modelled as part of this study to fulfil the requirements of each Scenario. The details of all DERs and the impact to modelling is described below.

Scenario	Council	Site	DER Type	Existing?	Capacity (kW)	Considered in LET Model?	Asset Description
1	City of DAREBIN	Reservoir Leisure Centre	Cogeneration	Y	N/A	N	This site had a cogeneration system that was decommissioned mid-2017. Interval data was altered to suit.
		Darebin International Sports Centre	Solar	N	405	Y	405kW rooftop solar system modelled as requested by Darebin City Council
2	MANNINGHAM BALANCE OF CITY AND COUNTRY	Mullum Mullum Sports Stadium	Solar	Y	450	Y	New 450kW solar PV being installed as of early 2018.
3	NILLUMBIK THE GREEN WEDGE SHIRE	Nillumbik Shire Council Depot Tip Site	Solar	N	1000	Y	1000kW ground mounted solar system modelled as requested by Nillumbik Shire Council.
		Council Office	Solar	Y	Uncertain	N	Existing solar PV spanning its rooftop, exporting approximately 9,000 kWh/year. This export has not been considered in modelling, as this objective of this scenario is investigating One-Many.
		Community Bank Stadium	Solar & Battery	N	100	N	Scheduled to install 100kW Solar PV and 100 kWh battery storage. This export has not been considered in modelling, as this objective of this scenario is investigating One-Many.
4	CITY OF MELBOURNE	Community Hub at the Dock	Solar	Y	65	Y	Existing 65kW solar array that exports roughly half of its generation.
		North Melbourne Football Club	Solar	Y	100	N	100kW of existing solar across 3 tenancies, this Solar was not modelled as no Solar data was available.
		Signal Box	Solar	N	10	Y	The signal box has a small/old solar PV system that is scheduled for upgrade to a 10kW system, with potential for a battery.
		Council House 2	Solar	Y	3	Y	Council house 2 is a large consumption site with minimal installed solar capacity of 3kW.
		Library at the Dock	Solar	Y	85	Y	Existing 85kW solar array.
5	HUME City Council	Splash Aqua Park	Solar	Y	59	Y	Proposed 59kW system, as specified in supplied drawings
		Broadmeadows Netball Stadium	Solar	N	148	Y	New Solar PV system, sized by FGA for this site.
		Broadmeadows Basketball Stadium	Solar	N	145	Y	New Solar PV system, sized by FGA for this site.
		Boardman Basketball Stadium	Solar	N	350	Y	New Solar PV system, sized by FGA for this site.

Table 21: List of existing and modelled DER's for the five representative Councils included in scenario modelling

4.6 Solar PV System Assumptions

FGA developed Concept Designs for most scenarios to validate the potential for Solar photovoltaics at a desktop level. Concept designs for each scenario are detailed below.

4.6.1 Solar Design Considerations

Each of the scenarios is based on existing, planned, or new solar photovoltaic installations at key sites. To evaluate the feasibility of solar PV systems at the nominated sites for each scenario, FGA conducted desktop audits, analysed available site utility data, developed preliminary designs, and performed solar energy and financial modelling for each proposed location.

The table below outlines the key design considerations for Solar photovoltaics at each site. These considerations ensure an accurate model that considers local factors for each installation.

Design Criteria	Relevance
Available Area	The availability and suitability of roof and land area was surveyed via mapping software for potential placement of ground and roof mounted solar installations. Roof mounted installations considered plant and building roofs only.
Electricity Smart Meter Data	Electricity Smart Meter Data was analysed to develop site energy use profiles and assess approximate energy savings and export figures.
Electricity Tariffs	Tariffs for each Scenario were determined based on actual billing data provided and in consultation with the relevant council.
Heritage Requirements	Any heritage listed buildings with the building portfolio considered were excluded from Scope.
Structural Requirements	Where information was provided, structural limitations were considered for roof mounted solar PV arrays.
Shading Profiles	The shading profiles of each array and surroundings were considered at desktop level in assessing solar PV feasibility.
Small Scale Technology Certificates (STCs)	STCs were applied to improve the financial performance of solar PV systems at sites with arrays less than 100 kW. STCs are calculated on the total volume of kW's installed.
Large scale generation certificates (LGCs)	LGCs were applied for each MWh of renewable energy generated at sites with arrays greater than 100 kW.

Table 22: Design Considerations assessed for each Solar array included in the study.

4.6.2 Scenario 1: City of Darebin

4.6.2.1 Darebin International Sports Centre

Site Type	Generator
Distributor	Citipower
Retailer	AGL
Site NMI	61020238100
System Size	405 kW
Tilt & Azimuth Angles	10^0 tilt, 7^0 azimuth
System Mounting	Main North Section – Flush Mounted to roofing. Side and Main South Sections – Fixed Tilt Mounting.
Renewable Energy Production (Annual)	539 MWh
Shading Analysis	Preliminary desktop analysis has not indicated that shading will be an issue.
Maintenance	Maintenance costs have been based on previous project experience, and past $/kW/yr quotes.
Key Design Criteria	The DISC has a considerable amount of roof space eligible for solar PV (pending structural feasibility). The north facing section of the roof is prioritized as it has an advantageous fall, allowing for surface mounted panels. The south facing section is only utilized near the ridge line, as the fall is undesirable.

Table 23: Proposed Design Summary for Darebin International Sports Centre

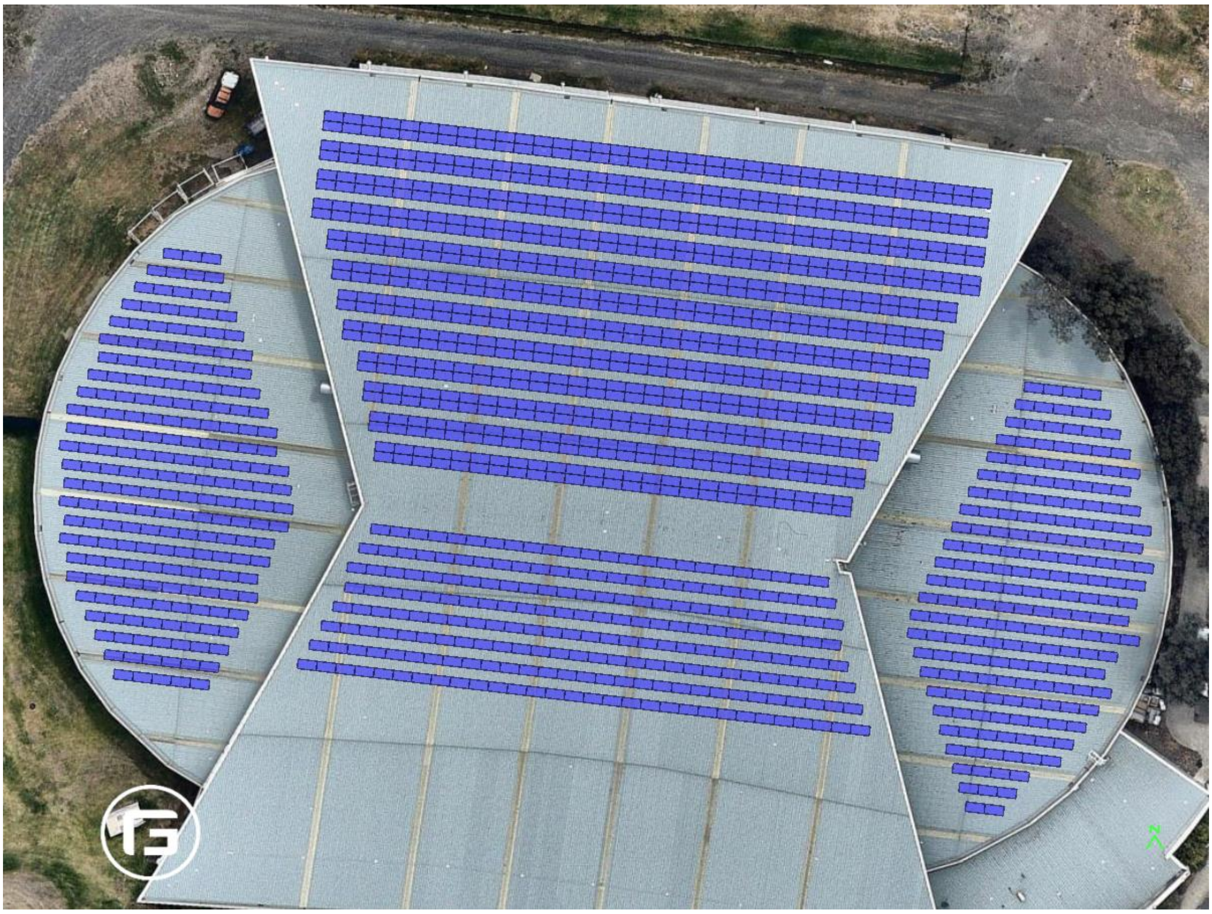


Figure 28: Proposed Solar Design for Darebin International Sports Centre

4.6.3 Scenario 2: Manningham City Council

4.6.3.1 Mullum Mullum Sport Stadium

FGA has not developed a solar concept design for the Mullum Mullum Sport Stadium, as Manningham City Council have completed their own design. This scenario modelled the viability of LET using a solar PV array size of 450 kW, as nominated by Manningham City Council.

4.6.4 Scenario 3: Nillumbik Shire Council

4.6.4.1 Nillumbik Shire Council Depot Tip Site (Recycling and Recovery Centre)

Site Type	Generator
Distributor	AusNET
Retailer	ERMPower
Site NMI	6305226529-6
System Size	1000 kW
Tilt & Azimuth Angles	10^0 tilt, 7^0 azimuth
System Mounting	Ground mounted – corrosion resistance and embedment to structural engineer's requirements. Allow minimum of 1m ground-to-panel clearance for maintenance of ground surface. Arrange in double rows, landscape orientation.
Renewable Energy Production (Annual)	1,311 MWh
Shading Analysis	Preliminary desktop analysis has not indicated that shading will be an issue.
Maintenance	Maintenance costs have been based on previous project experience, and past $/kW/yr quotes.
Key Design Criteria	This concept design aims to minimise effect of solar on general practices at the site, the solar PV is proposed to be located near the boundary, away from trees which may cause shading issues. A single vehicle path has been maintained, however other paths may wish to be introduced for ease of panel maintenance.

Table 24: Proposed Design Summary for Nillumbik Shire Council Depot Tip Site

Figure 29 Proposed Solar Design for Darebin International Sports Centre

4.6.5 Scenario 4: City of Melbourne

4.6.5.1 Signal Box

Site Type	Generator
Distributor	Citipower
Retailer	Origin/Pacific Hydro
Site NMI	6102004563
System Size	10 kW
Tilt & Azimuth Angles	5^0 tilt, 7^0 azimuth
System Mounting	Fixed Tilt 5^0
Renewable Energy Production (Annual)	8.5 MWh
Shading Analysis	Preliminary desktop analysis has not indicated that shading will be an issue.
Maintenance	Maintenance costs have been based on previous project experience, and past $/kW/yr quotes.
Key Design Criteria	As this site is roof area constrained, a maximum amount of solar is suggested

Table 25: Proposed Design Summary for Melbourne Signal Box

Figure 30: Proposed Solar Design for Signal Box

4.6.5.2 Other Generating Sites

All other generating sites in this scenario do not have any proposed new solar, and the Solar modelled is from existing Solar PV.

4.6.6 Scenario 5: Hume City Council

4.6.6.1 Splash Aqua Park

FGA has not conducted a solar concept design for Splash Aqua Park as Hume City Council have already undertaken their own design. This scenario modelled the viability of LET using a solar PV array size of 59 kW, as indicated in the provided solar drawings.

4.6.6.2 Hume Boardman Basketball Stadium

Site Type	Generator
Distributor	Jemena
Retailer	AGL
Site NMI	60010039140
System Size	350 kW
Tilt & Azimuth Angles	10° Tilt (As req.), 7.5° Azimuth
System Mounting	North and South Sections – Flush Mounted to roofing. Centre Section – Fixed Tilt Mounting.
Renewable Energy Production (Annual)	260.7 MWh
Shading Analysis	Preliminary desktop analysis has not indicated that shading will be an issue.
Maintenance	Maintenance costs have been based on previous project experience, and past $/kW/yr quotes.
Key Design Criteria	Due to large amount of roof area available, and high demand of Splash Aqua Park and Leisure Centre through LET, solar PV sizing was maximised.

Table 26: Proposed Design Summary for Hume Boardman Basketball Stadium

Figure 31: Proposed Solar Design for Hume Boardman Basketball Stadium

4.6.6.3 Broadmeadows Basketball and Netball Stadiums

Site Type	Generator
Distributor	Jemena
Retailer	AGL
Site NMI	Basketball – 60010037283 Netball – 60010041404
System Size	Basketball – 145 kW Netball – 148 kW
Tilt & Azimuth Angles	Basketball – 303° Netball – 319°
System Mounting	Fixed Tilt Racking
Renewable Energy Production (Annual)	Basketball – 108.1 MWh Netball – 110.4 MWh
Shading Analysis	Preliminary desktop analysis has not indicated that shading will be an issue. For the Netball Stadium, multiple panels have been removed from design to account for nearby tree.
Maintenance	Maintenance costs have been based on previous project experience, and past $/kW/yr quotes.
Key Design Criteria	Due to large amount of roof area available, and high demand of Splash Aqua Park and Leisure Centre through LET, solar PV sizing was maximised.

Table 27: Proposed Design Summary for Hume Boardman Basketball Stadium

Figure 32: Proposed Solar Design for Hume Boardman Basketball Stadium

FG Advisory

Melbourne
Level 17, 31 Queen Street
Melbourne, Victoria, 3000

Adelaide
Level 30, 91 King William Street
Adelaide, South Australia, 5000

ABN: 69 165 911 571