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Summary Paper: What Happens When we Un-Plug?

Exploring the consumer and market implications of viable, off-grid energy supply

Research Phase One: Identifying off-grid tipping points

Research project led by Energy for the People
with technical leadership by
the Alternative Technology Association

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About this paper

The following summary paper highlights key findings from a detailed research study into the financial viability of stand-alone power solutions, and communities buying back their local electricity grid to operate their own energy supply infrastructure[1].

The detailed research study will be available from early 2014 and was funded by a Consumer Advocacy Panel Research Grant. To ensure you receive the detailed research paper you can:

- Email contact@energyforthepeople.net directly
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The research paper highlights that the National Energy Market is in a state of profound transition, from a centrally planned and controlled market, to one where local generation, storage and local control of power is common-place. How far this transition goes, and how quickly, are the only questions which remain unanswered.

The research paper suggests the transition may be quick and dramatic – a shift to cost-effective stand-alone power solutions appears highly plausible by 2020, in a wide range of market segments.

The story of this transition is still being written, but the history of the energy market is worth remembering. When today's energy infrastructure was planned and built, it was far easier to transport electricity over land, than coal. Generating power close to where it was consumed caused air-pollution and associated health impacts. For over 100 years, large power stations, located near to coal mines, connected to businesses and homes across the country via power lines, has had a compelling and practical rationale.

Today, new technologies - specifically solar power and energy storage - have created a vastly different rationale for energy market design. They are factory built, and modular. Increasing or decreasing their installation size has a minimal impact on their installed cost. They can be located close to where energy is consumed, with no impact on air quality or health.

These new technologies, combined with complimentary advances in energy metering, data management and communications, are the building blocks for a very different energy market. The potential for a more customer-centric, local energy system is now very real. Stand-alone power infrastructure can be locally owned and locally managed, with positive flow-on affects for local economies, particularly in regional areas that may suffer from poor power quality or unreliable supply. The risk of high prices to regional customers, enabled by more cost-reflective tariff structures, can also be proactively managed by transitioning to stand-alone power solutions or micro-grids.

[1] Note: the study considers financial viability only. Other important factors influencing whether these solutions can be implemented include social factors and how energy market rules and regulations impede or enable them.

The research paper is an addition to public discourse on the transition our energy market is experiencing. It examines various scenarios, using energy and economic modelling, where new and existing communities own and operate their own power supply infrastructure. Central to scenarios considered is the role of different business models that can align the incentives of customers and energy suppliers – we find this critical to the value proposition for stand-alone power infrastructure.

We will be organising a series of forums to continue this dialogue with important stakeholders. To ensure you are able to participate, or if you would like to discuss organising a specific event with us

- Email contact@energyforthepeople.net directly
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Research Findings: When off-grid will be viable

The research explored the viability of stand-alone power solutions across a range of Victorian climate zones and household scenarios. The various infrastructure scenarios assessed are described below:

Scenario: Location and description	Gas and electricity available – Scenario names	No gas available[2] - Scenario names
Werribee – Urban fringe, new-build house	Greenfield, single, gas	Greenfield, single, no gas
Melbourne – Retrofit of existing inner-suburban house	City, single, gas	n/a
Bendigo – Retrofit of existing regional house	Regional, single, gas	Regional, single, no gas
Werribee – 500+ homes, urban fringe greenfield development	Greenfield, 500, gas	Greenfield, 500, no gas
Melbourne – 500+ home, inner-suburban retrofit of homes and grid	City, 500, gas	n/a
Bendigo – 500+ home, regional retrofit of homes and grid	Regional, 500, gas	Regional, 500, no gas

[2] Note, it was quickly assessed that an all-electric stand-alone power solution would be cost-prohibitive, therefore an electric/wood hybrid, where wood was the primary fuel source for space heating, was considered in lieu of an all-electric system.

The following table details when stand-alone power solutions will be viable across the scenarios considered. In each scenario, a range of energy efficiency measures were implemented in parallel with the stand alone power solution. It was assumed no behaviour change will occur.

Scenario	Description	Viable by
Regional, 500, no gas	Community buys back the grid; solution is delivered by a specialist energy service company; bottled gas is displaced by wood for space heating[3]	**Today**
Regional, 500, no gas	Community buys back the grid; solution delivered by a specialist energy service company; natural gas connection or network augmentation cost of $8,000 per home is avoided[4]; switch from electric heating to wood heating	**2020**
Regional, 500, gas	Community buys back the grid; solution delivered by a specialist energy service company; network upgrade cost of $2,000 per home is avoided[5]	**Today**
Regional, 500, gas	Community buys back the grid; solution delivered by a specialist energy service company	**2020**
Regional, single, gas	Communities organise bulk-buy and retrofit homes; sufficient roof space for 8kW solar pv per home	**2020; earlier where bottled gas or network cost can be avoided**
Greenfield, 500, gas	Solution delivered by specialist energy service company; Passive design optimised; reduce average home size by 1% (2.5sqm)	**2020**
Greenfield, 500, gas	Solution delivered by specialist energy service company; Passive design optimised; Cost of capital 7% over 10-years	**2020**
Greenfield, single, gas	Reduce average home size by 3.5% (9sqm)	**2020**

[3] We note that the switch to wood fuel will not be unanimously supported by energy market stakeholders, including customers, and that the overarching consideration in this considering this scenario, was financial

[4] This scenario refers to a situation where a regional town may be considering connecting to the natural gas network, and instead, chooses to switch to wood fuel for space heating at the same time as implementing a stand-alone power solution

[5] This scenario refers to a situation where an upgrade to the local network is being considered, and an alternative to the upgrade is to switch to stand alone power supply

More specifically the report's findings include:

- Stand-alone micro-grids for greenfield housing developments, delivered by a specialist energy service provider, are highly likely to be viable by 2020, where natural gas is available, and may be viable where wood fuel displaces natural gas[6].
    - Key variables, such as the avoided centralised infrastructure costs, the weighted cost of capital and energy service company overheads (including infrastructure maintenance costs) determine the difference between a commercial model that is viable[7] over 10-years , or not. Over 25 years, the model is clearly viable;
    - A short-term reduction in the energy service company's weighted cost of capital, from 8.6% to approximately 7%, is likely to be sufficient to make a stand-alone micro-grid viable over a 10-year period, after which the cost of capital could increase again without affecting the commercial viability. Alternatively, reducing the size of homes by as little as 1%, and using the construction cost savings to offset stand-alone power infrastructure costs, is likely to be sufficient to make the model viable by 2020.
- Stand-alone micro-grids delivered by an energy services provider are likely to be viable by 2020 in regional areas with natural gas, particularly where the short-term weighted cost of capital can be reduced – a reduction from a weighted cost of capital of 8.6% to 8.4% is sufficient to go from cost-neutral over 10-years, to profitable over 10 years.
    - Where natural gas is available and there is the potential to avoid an electricity network upgrade cost of approximately $2,000 per home within the area serviced by that network, it is more cost-effective to switch to a stand-alone micro-grid based on current prices for a stand-alone micro grid solution;
    - Where natural gas is not yet available and electricity is currently used for heating; and heating is switched to wood fuel to displace a centralised gas connection cost, or network augmentation cost, of $8,000 per home, the stand-alone micro-grid model becomes viable over a 25-year period by 2020;
    - Where wood displaces bottled gas, the model is as good as cost-effective[8] today based on current prices for stand-alone micro-grid infrastructure and energy, and clearly viable over a 25-year period based on 2020 prices.
- Stand-alone power solutions for individual homes in regional areas, with high winter and summer thermal loads[9], are likely to be viable before 2020 where communities can self-organise and realise cost-reductions on stand-alone power infrastructure. However, they are constrained by the size of PV systems required (8.2kW is needed which will be difficult for many household roofs to accommodate). Where wood is used to displace natural gas as part of an appliance replacement cycle (for example, old gas heaters and cook-tops need replacing), stand-alone power solutions may also be viable by 2020. Where bottle gas is displaced by wood, the viability improves substantially;

[6] Stand alone micro grids utilising wood fuel for space heating are viable where the combined cost of connecting to centralised electric and gas networks exceed $8,000

[7] We defined "viable" as being cash-flow positive on a cumulative basis, over a given time period. We used a simple pre-tax cash flow model for assessing viability.

[8] The increase in cost is immaterial

[9] The Bendigo climate was used for all our regional scenarios.

- Stand-alone power solutions for individual homes in greenfield developments are unlikely to be viable before 2020 without a significant step-change in stand-alone power infrastructure costs, or customers choosing to reduce the size of their home to save on construction costs and offset stand alone power infrastructure costs. We found that reducing the size of a home by 9m^2 (3.5% of the average new Victorian home) would be sufficient to make stand-alone power infrastructure viable by 2020.

Stranded-asset risks

Infrastructure planning for new housing developments must be carefully managed by local authorities. Business as usual grid connections to electricity and gas networks are likely to already be sub-optimal today, given we find stand-alone power solutions are viable prior to 2020.

In particular, local authorities, developers and builders will need to work closely together during long-term infrastructure planning processes to develop the knowledge, policies and systems required to enable truly efficient energy infrastructure planning, and to avoid locking in inefficient centralised infrastructure.

Processes and controls for managing network investment are also critical, including pricing controls. Nodal pricing[10] has the potential to highlight opportunities where centralised network assets can be re-purposed to a more cost-effective stand-alone power solution. However risks to energy affordability remain, as nodal prices, without an efficient transition of the grid at that node, would simply result in higher energy costs.

The Australian Energy Regulator will need to be vigilant as part of 5-year network investment reviews to ensure that network companies have fully investigated the potential for non-network solutions to grid-constrained areas, and where networks are in need of replacing. It will be critical that network companies are engaged in the efficient transition of their grid – if they lack incentive, or effective discipline, the risk of stranded network assets emerging, and the related impacts on future energy prices, will only grow.

It is important to note that in none of the assessments has the report accounted for the real cost of supplying regional customers – the results rely on current retail tariff structures only - this is likely to significantly under-value the transition to stand-alone power solutions and implies that, in some markets, off-grid may already be viable, even at today's relatively high stand-alone energy infrastructure prices.

[10] Nodal pricing entails the true cost of network infrastructure at any given point of the energy network be priced relative to its true cost. For those not familiar with energy pricing, it is important to note that electricity and gas networks do not price their services strictly based on the cost of serving customers in specific locations, and that this masks the true cost of serving customers, particularly those in regional and fringe of grid locations.

Further, the analysis undertaken considered Victoria only. In other areas of Australia, such as NSW QLD, and SA, milder climate zones and better solar radiation would make stand-alone power solutions more viable, more quickly.

Implications for energy consumers

The report's findings have significant implications for consumer protections in the energy market and for efficient investment in centralised gas and electricity infrastructure more broadly.

The current energy market design is premised on the idea that customer choice, enabled by information and a disaggregated competitive market, will lead to the lowest possible prices for customers. However, our analysis shows that stand-alone power solutions, led by a specialist energy services company, is likely to entail no choice of retailer yet offer the potential for lower energy prices for the scenarios assessed.

Energy delivered by a service company, making use of stand-alone power infrastructure, is also likely to improve the incentive for designing and offering products and services that help customers reduce energy demand, as reduced energy demand translates more directly into local infrastructure savings, in particular reductions in back-up generator use and/or battery capacity and cycling demands - this contrasts to the current energy market where reduced energy demand in any given location does not necessarily translate into savings for customers in that location due to price smoothing across locations.

Lastly, stand-alone power solutions are likely to entail greater price certainty for customers, including the potential to proactively manage the risk of major price restructuring under a "utility death spiral" scenario.

Greater price certainty occurs because the stand-alone power infrastructure model is far less exposed to variable fuel prices (energy supply is predominantly from solar power which utilises free fuel – the sun) and fluctuations in asset utilisation because prices are set based on a combination of energy services delivered (space heating, hot water, etc) and energy used – not just energy used as per the incumbent energy supply model[11].

"Utility death spiral" risks would be managed by buying out local network infrastructure and re-purposing it to enable a new energy supply model that is less dependent on sales volumes to retain viability – that is, instead of a sub-optimal business model constantly re-pricing services to remain

[11] When prices are set to reflect the quality of energy services, such as provision of thermal comfort, reductions in energy use do not impact on the viability of the supply model – customer payments are set to reflect the value of the service, and not just how much energy is consumed. In this way, enhancing energy efficiency does not undermine the viability of the service model, whereas where customer payments reflect energy use only, energy efficiency undermines asset utilisation and causes prices to increase – eroding the financial benefits of energy efficiency.

viable, the infrastructure could be bought out and the business model for energy supply reconfigured.

In the case of regional customers, the transition to stand-alone power solutions may also entail improved power quality and reliability, including improved resilience to outages caused by extreme weather, such as storms and fires.

Collectively, the results suggest that the premise upon which the current energy market is designed should be challenged in the interest of all consumers. A future energy market in which customers are supplied by stand-alone power and micro-grids also implies new regulatory challenges and specifically, begs the following questions:

- What processes should be followed for customers who cannot afford to pay for their energy requirements? It would not be possible for a customer to be disconnected from one retailer and re-allocated to another, in a market where stand-alone power solutions limit retailer choice;
- What would become the equivalent of a "retailer of last resort" in the event that an energy services company, delivering stand-alone power solutions, became insolvent? Prudential requirements for such infrastructure providers, including insurance policies, would need to be carefully designed and managed to ensure financial insolvency would not leave customers without power;
- How would the discipline of price and service competition be maintained on stand-alone power infrastructure providers, given customers would not be able to switch retailers in the event they became dissatisfied with energy prices and/or customer service?

These questions point to the need for specific community service obligations on providers of stand-alone power infrastructure, and possibly tighter prudential requirements, to ensure the risks are effectively managed.

Implications for the National Electricity Market

A future in which stand-alone power infrastructure emerges at scale, and in an unplanned way, suggests the risk of significant network and generation infrastructure becoming stranded assets. This report suggests a number of measures, which could be implemented to mitigate and/or manage this risk:

- Co-ordinated trials of small-scale stand-alone power solutions, potentially through the distributors' demand management incentive scheme, to enable accelerated learning by energy market participants and regulatory authorities;
- Facilitated purchase of centralised network assets, where they have been shown to be inefficient as part of a centralised supply model. Projects could be identified and flagged for action by the Australian Energy Regulator to State Governments, as part of its network investment review processes. State governments could then co-ordinate a targeted, localised response, using a network of energy market stakeholders;

- The clear and transparent publication of network constraints, made available in easily accessible language and format to the public, organised by postcodes - this will allow community groups, councils and energy service providers easy access to the data needed to assess stand-alone power infrastructure models and may obviate the need for State Government co-ordination;
- Adjustment of the Regulatory Investment Test for distribution (RiT – D), with networks' threshold to be based on a cost-per-customer basis, as opposed to a capital cost figure alone. The report demonstrates that, even at $2,000 per customer, upgrading the electricity network and continuing its operation as part of the centralised energy market, is highly likely to be inefficient, where natural gas is available for space heating. The implication of this finding is that the RiT – D threshold could be set as low as $2,000 - $3,000 per customer served in the network;
- Assessing network planning and investment requirements more stringently in areas where stand-alone power solutions are likely to be viable – specifically regional areas, and particularly either where bottled gas exists and/or in residential growth corridors where new network assets will be planned;
- The implications of a move to virtual net metering, where generation of energy at one location could be offset against the retail bill of a customer located nearby, but on a separate land title, needs to be carefully considered. Such metering arrangements would create a strong incentive to maximise generation of energy at any given location, and reduce the incentive for energy storage, as storage would not be necessary for avoiding local network costs.

We recognise these network measures are necessarily brief, reflecting the early stage and scope of the research. Further work would be required to develop measures that can be implemented, with support from energy market stakeholders.

Research Method

Three locations where chosen for the analysis - Werribee, Bendigo and an inner-Melbourne suburb. Locations were chosen to reflect a range of climate and property types across Victoria, and to highlight particular challenges and opportunities likely to be faced by a potential shift to off-grid energy supply.

It is important to note that with Victoria's relatively harsh climate and poor solar resource, and low energy costs compared to other State's across Australia, the locations chosen represent close to a "worst-case" scenario for the viability of off-grid energy supply in Australia.

In each scenario, a housing type was developed in line with the predominant housing types of the three locations, and a baseline energy load profile was developed for each home and scenario. Key characteristics considered were:

- Size of the home;

- Star-rating of the home; and
- The type and efficiency of appliances/systems used inside the home for space heating and cooling, water heating, lighting, refrigeration and washing.

For each scenario, we considered a range of possible measures aimed at reducing energy demand cost-effectively, before sizing and pricing stand-alone power infrastructure.

A financial hurdle rate of return of 10% was chosen for retrofit measures – this hurdle rate was chosen due to the premise that such a hurdle rate, at a minimum, would be required to make stand-alone power infrastructure financially attractive and, by default, such a hurdle rate should be applied to assess measures that reduce energy demand. In this way, the retrofit measures we selected for implementation did not unduly influence the viability of the stand-alone power solution assessed.

In each location, assumptions were made about what percentage of the thermal load would be used for heating or cooling, including the fuel type and efficiency by which heating and cooling demand would be met, before and after retrofit measures were implemented.

Once a load profile was developed, a stand-alone power system was sized and priced, before the viability of the stand-alone energy package (demand reductions and power infrastructure) was modeled. In this modeling process, we made the following judgments:

- That the stand-alone energy package would be delivered by a professional energy services company;
- That systems would be designed to minimise the need for back-up generation (to avoid local particulate emissions and exposure to fuel price risk) – all systems were designed for solar to supply 92-96% of all energy needs;
- That the professional energy services company would be purchasing infrastructure at wholesale prices and recovering the profit margin on that infrastructure, plus labour for installation and their corporate overheads, over the lifetime of said infrastructure. The assumption naturally implies a lower installed capital cost than if a household was purchasing infrastructure at retail prices. Discount factors applied to retail costs were in the order of 35-40% for all components, other than PV, which had an assumed retail discount of 10%[12] and the centralised diesel generators for the 500 home solutions, which were assumed to be purchased at retail price from a suitability qualified supplier, and placed on a service contract with that supplier for ongoing maintenance.
- The energy service company would take on warranty risk, implying a 16.5% premium on wholesale costs – the entity importing becomes responsible for the enactment of any warranty.

These judgments were based on our direct experience in this domain and our belief that stand-alone energy solutions for the "mass-market" will need to be delivered by a professional energy service company, which manages risk and complexity on behalf of the household.

12 The rationale for not discounting PV and PV-related materials was that in reality, 2013 panel prices are currently likely to be somewhat depressed, given the global oversupply of Chinese panels and panel manufacturers, and that potentially a small increase may be experienced in the market over the next few years as the global PV industry adjusts to a more stable, long term economic future.

We examined the business case for delivering the stand-alone energy solution from the perspective of the energy service company, with the assumption that, if this can be done for the equivalent price of energy incurred by the household, regardless, it will be attractive to the mass market.

The SAPS chosen for the purposes of all scenarios were based on the most cost effective, proven and currently available technology in the Australian energy market – that is:

- a solar photovoltaic (PV) array;
- batteries and battery management system;
- inverter-charger/s and regulator/s; and
- backed up by a small petrol generator, for the individual home scenarios; or
- large-scale diesel (potentially fuelled by bio-diesel) generators for the clustered scenarios.

For the clustered 500 home scenarios, both the PV and the battery banks were distributed, with not every home needing to house all or part of the stand alone system.

Starting prices for electricity and gas, including GST, were assumed to be:

- peak electricity – 35c/kWh
- off peak electricity – 15c/kWh
- daily electricity connection charge – 80c
- gas use – 6.3c/kWh (2.3c/MJ)
- bottled gas - 16.2c/kWh (4.5c/MJ incl bottle delivery)
- daily gas connection charge – 60c

By 2020, based on our forecast price assumptions, these become:

- peak electricity – 43c/kWh
- off peak electricity – 18c/kWh
- daily electricity connection charge – 85c
- gas use – 10c/kWh (3.7c/MJ)
- bottled gas – 23c/kWh (8.4c/MJ)
- daily gas connection charge – 85c

The future price of PV and battery storage is naturally contested. We have taken the view that the primary driver of cost reductions in stand-alone power systems will be changes to battery storage prices.

While further drops in solar panel costs are certainly possible, we have taken the view that system price reductions of the last 2-3 years in Australia will slow down and plateau. This reinforces the conservative nature of our method.

To inform our future battery price assumption, we considered a range of publicly available research into forward battery price curves with a focus on lithium-iron technology. While lithium-iron will be challenged by other technologies, we have made the assumption that as it is the dominant storage technology currently being developed for transport energy applications and small-scale stationary energy storage applications, is a sensible proxy for future energy storage costs.

Forecasts for lithium-iron battery storage tend to converge at, or slightly above, a retail price of \$200/kWh[13] by 2020. The figure below presents a consolidated view of battery price forecasts from a range of sources.

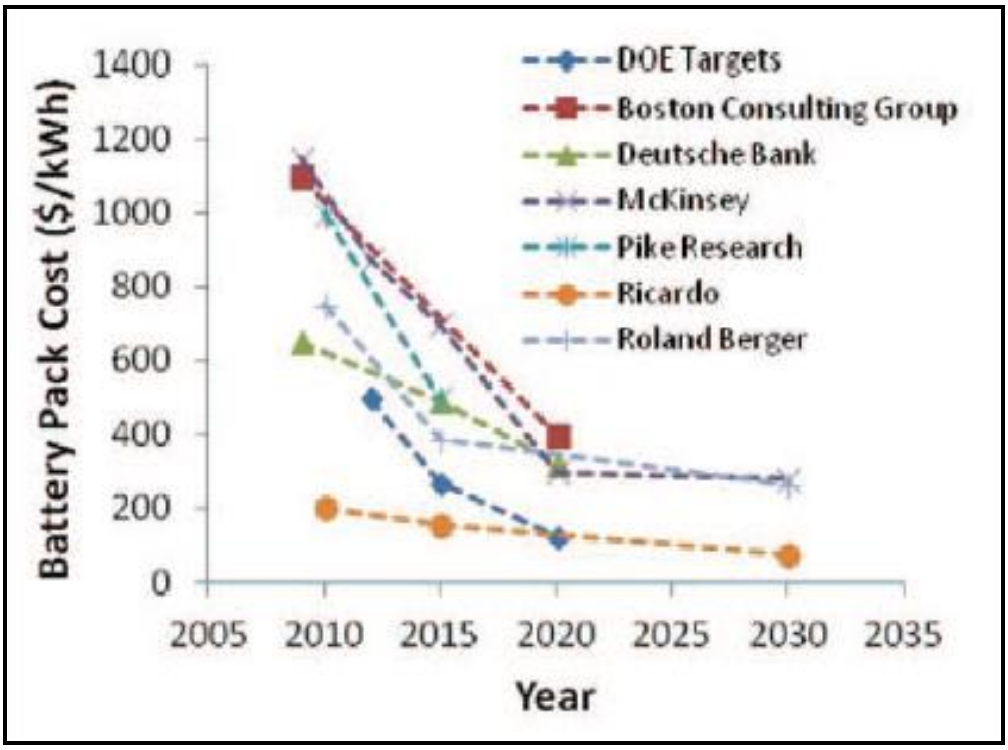

Figure 1: Lithium Iron cost projections (EV updated, viewed online at: <http://analysis.evupdate.com/batteries-power-trains/battery-prices-could-lower-costs-make-evs-competitive-2020>

This implies a 7.5%pa drop from today's retail price of around \$350/kWh[14] and depending on assumed margins across the retail supply chain, a production cost of approximately \$145/kWh. The experience of PV, which dropped in price by approximately 80% over 3-4 years suggests a price reduction of this order is plausible and conservative for batteries.

Given we assume batteries will be purchased wholesale, and effectively leased to customers as part of a contracted service, we assumed a wholesale purchase price of \$175/kWh including warranty risk.

Across different scenarios, we varied the assumed reduction in balance-of-system costs, including the inverter, solar panels, wiring, back-up generator and labour from 0%-2%. This was done to test

[13] Note, this \$/kWh figure represents usable storage – that is, it accounts for depth of discharge constraint of 80%

[14] Note, this \$/kWh figure may appear low as it does not include system integration costs. Costs for inverter, battery housing and wiring are considered separately

the sensitivity of the analyses to these assumptions, and identify future price points at which stand-alone power systems could become viable.

As noted previously, we have assumed that, should stand-alone power systems emerge as a mainstream energy supply option, it would be facilitated by an energy service provider that procures, designs, installs and maintains the infrastructure on behalf of customers.

For the purposes of this research, we have assumed that such a business model is likely to work through an initial period of demonstration pilots, before scaling up to provide a mass-market service solution. In all financial modeling, we have assumed the energy service business operates with efficient internal costs and is able to purchase and finance stand-alone power infrastructure at scale.

ESCo cost assumption	Assumption value
Equity investment portion	20%
Cost of equity	15%[15]
Debt investment portion	80%
Cost of debt	7%
Implied weighted cost of capital, 20% equity, 80% debt	8.6%
Infrastructure insurance cost	Captured in wholesale price premium assumption for stand-alone power infrastructure
Customer acquisition cost (per customer)	Varied across scenarios to test sensitivity, with default value being $500
Customer service cost (including business overheads) – single home solution (per customer)	$700 – is this on top of the opex costs that we included in the SAPS model for System Monitoring, comms and on-site maintenance?
Customer service cost (including business overheads) – 500 home cluster solution	Varied across scenarios to test sensitivity, with default value being $400
Service fee (start price)	Equal to the “business as usual” household energy cost
Service fee and service overhead cost - annual escalation	2.5%
Year 12 appliance replacement cost	1% cost reduction per annum reduction in real terms from year 1

[15] This is the rate of return paid to equity investors in the ESCo

Year 15 inverter replacement cost	1% cost reduction per annum reduction in real terms from year 1
Year 15 battery replacement cost	1% cost reduction per annum reduction in real terms from year 1
Value of centralised infrastructure offset – single home, dual fuel, greenfield scenario	$2500 per customer to reflect avoided network infrastructure costs
Value of centralised infrastructure offset – single home, all electric, greenfield scenario	$2500 for avoided electricity network, $2200 for avoided gas network[16]
Value of centralised infrastructure offset – 500 home, dual fuel, greenfield scenario	n/a – it is assumed the cost of building the islanded network required to support a stand-alone power solution is equivalent to a business as usual network[17]
Value of infrastructure offset – 500 home, dual fuel, retrofit scenarios	Built into SAPS capital cost assumption – electricity network valued at 20% of its raw cost of $2500 per home, with grid O&M costs set at 5% of full capital value ($50,000 per annum). A range of avoided gas network cost assumptions are used as part of a sensitivity analysis

Using these business model assumptions, a simple (pre-tax) cash-flow model was developed to reflect the business case for providing a stand-alone energy solution. The cash-flow model included dividend payments to equity investors and debt financiers reflecting their respective financing costs.

[16] Note, in a typical subdivision, gas network costs are often fully subsidised by the network provider and/or the State Government. The $2200 avoided gas network assumption was derived by taking the current daily gas connection charge and multiplying it by 10-years as a conservative estimate of the capital cost.
[17] Note, in practice this may underestimate the value of a stand-alone power solution as in a typical greenfield development, the property developer contributes approximately 50% of the infrastructure cost (they pay 100% up front, then receive a cash rebate).

Conclusion

The National Energy Market is in a state of profound transition, from a centrally planned and controlled market, to one where local generation, storage and control of power is common-place. How far this transition goes, and how quickly, are the only questions that remain unanswered. This research paper suggests the transition may be quick and dramatic – a shift to cost-effective stand alone power solutions appears very plausible, by 2020.

Investment decisions are being made every day in the energy market, resulting in capital-intensive energy assets being built. Communities are considering building their own, community-owned power generation assets. In this time of profound change, a clear view of what our energy market will look like in five, ten and twenty years, is critical to have in mind. An incremental transition, where new technologies are integrated within the incumbent energy system is possible. However a more dramatic transition, where new technologies shape an entirely new energy market, appears financially compelling - in the long-run, economic fundamentals will be hard to withstand.