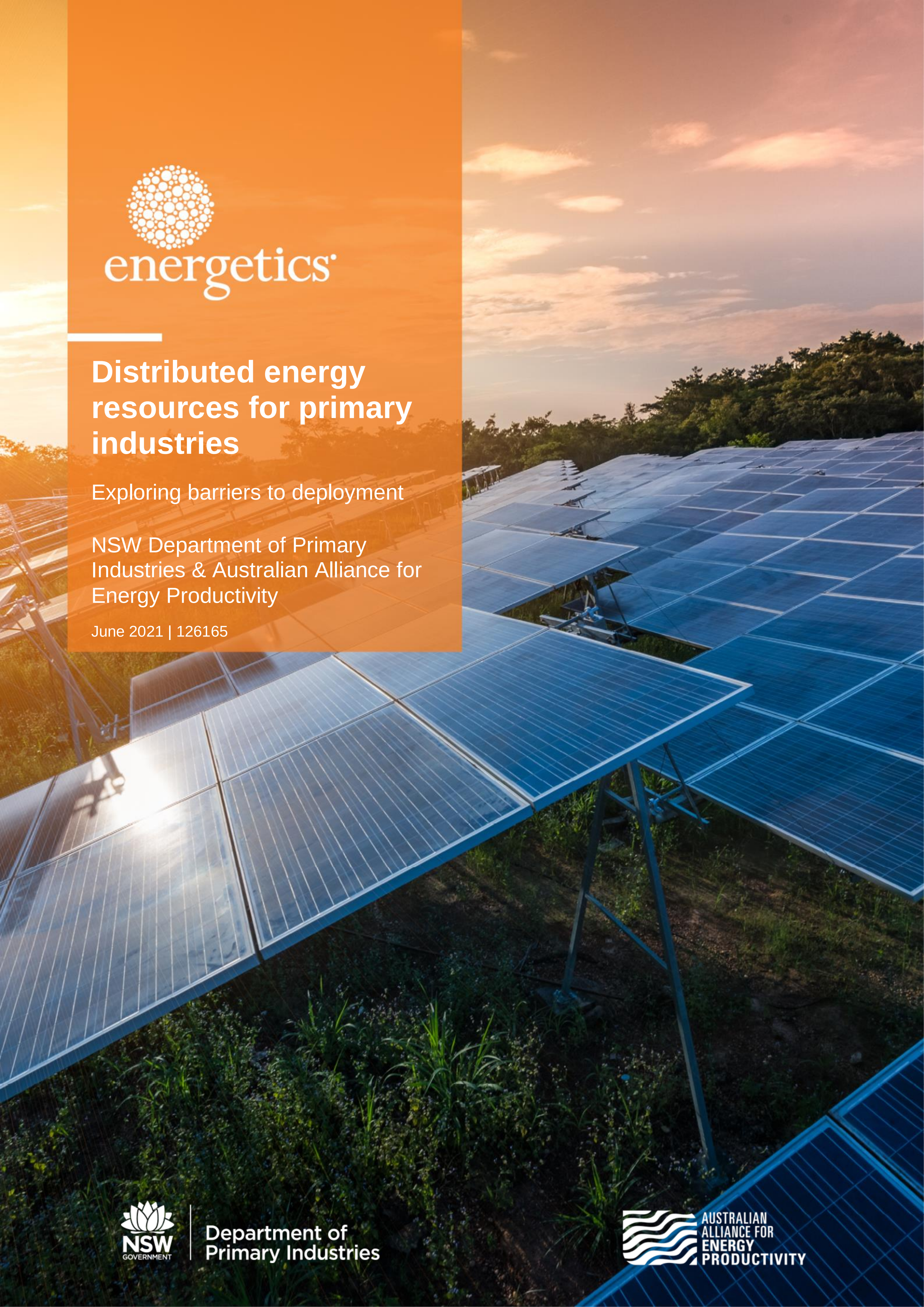

Distributed energy resources for primary industries

Exploring barriers to deployment

NSW Department of Primary
Industries & Australian Alliance for
Energy Productivity

June 2021 | 126165

AUTHORSHIP OF THIS REPORT

This research was commissioned and managed by the Australian Alliance for Energy Productivity (A2EP) for the NSW Department of Primary Industries. The work was funded through the Climate Change Research Strategy (Project 1: Clean energy solutions). The team at Energetics [energetics.com.au] researched and wrote the report. A2EP wishes to acknowledge the contributions and advice received from Cathy Waters, Michael Cashen and Liz Hutton at the Department. A2EP wishes to acknowledge the contributions and advice received from Aidan Moore, Karin Stark and Nick Bullock in the field.

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CLIMATE CHANGE RESEARCH STRATEGY

To ensure the continued growth of NSW Primary Industries, and safeguard the future of the regional communities, the sector needs to be resilient and adaptable to changes in economic and environmental conditions. Supported by an investment of $29.2 million from the NSW Climate Change Fund, the Strategy invests in project and program areas that could support the primary industries sector to adapt to climate change.

The Strategy seeks to identify through research, and innovation, energy supply and demand solutions, carbon opportunities and climate resilience building programs to enable our primary industries to prepare for the challenges and opportunities climate change presents. The results of this research will be useful in informing forward work programs and policy to support the long-term sustainability of primary industries for NSW. More at dpi.nsw.gov.au

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ABOUT A2EP

A2EP is an independent, not-for-profit coalition of business, government and research leaders helping Australian businesses pursue a cleaner and more successful future by producing more with less energy.

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Executive summary

In 2018/19 New South Wales primary industries had a gross economic output of more than $15.7billion. Directly employing nearly 88,000 people the sector, covering livestock production, broadacre cropping, forestry and fisheries, is a keystone of the NSW and Australian economy.

Volatile commodity prices, challenges and changes in consumer markets, energy security and Australia's changing climate all pose challenges to the sector. Distributed energy resources (DER) encompassing renewable generation, battery storage and microgrids have been identified as offering solutions to some of these challenges.

DER has the potential to diversify business models, build energy resilience for remote and rural communities and decarbonise sectors and supply chains – supporting NSW shift to a low carbon economy and NetZero ambitions.

The National Electricity Market (NEM) transmission and distribution networks geographically cover the majority of NSW and any potential DER project must be viable in the regulatory and commercial environment of this energy-only gross pool electricity market. Anecdotally, it has been noted that many attractive DER opportunities are deemed to be unfeasible due to the limitations of the NEM. This document aims to identify common barriers to DER deployment and propose potential focus areas for improvement.

It should be noted that this research focuses on NEM connected DER opportunities. The deployment of zero-export behind the meter renewable generation to service on-site needs is not covered in this document and may present the most cost-effective option for primary industry participants wishing to reduce electricity expenditures and lower emissions.

Through desktop research and stakeholder engagement four test scenarios were developed. The scenarios chosen represent DER opportunities which present primary industries participants a range of benefits including;

- Easy deployment within current on-farm infrastructure constraints
- Are simple and straightforward
- Require limited administration or day-to-day decision-making input
- Improve energy resilience to either individuals or communities
- Generate benefits for multiple stakeholders
- Present a clear and robust business case
- Limit capital expenditure

The four scenarios underwent a high-level feasibility assessment which covered:

- On-farm infrastructure
- Options for grid alignment
- Trading arrangements
- Financial performance
- Resourcing and administration

The table overleaf describes the four scenarios, highlights the key barriers to deployment, identifies pathways for implementation and discusses the potential role the DPI could play in facilitating each scenario within the primary industries sector.

One of the overarching findings of this study is the current gap in the DER value proposition for mid-sized generation capacity – the size most likely to appeal to primary industries participants.

Domestic customers are well protected in the marketplace, can access local network infrastructure with relative ease and can generate a secondary income through the negotiation of a feed-in tariff with a retailer or by generating and selling small technology certificates (STCs). The typical approach adopted by the majority of system owners is to assign the right to create STCs to a registered agent (e.g., the solar system provider) and receiving an upfront financial benefit corresponding to the amount of renewable electricity expected to be generated or displaced over a maximum deeming period.

At the opposite end of the spectrum large DER deployment is often driven by organisations and investors specifically focused on deriving value from DER. Multi mega-watt capacity solar PV and wind farms, possibly combined with battery storage, can operate on the wholesale market with lucrative trading strategies. However, the financial backing, technical and legal expertise to drive such a scheme to success is out of reach for the average primary industries participant.

One of the only options for generating a secondary revenue for DER with a capacity over 100kW is the generation and trading of large generation certificates (LGCs). However, technical constraints and the expected decreasing value of LGCs limits applications.

The most beneficial option for deploying DER within primary industries remains installing renewable generation which is sized to meet the on-site demand with little or no export. Under this model the participant is able to reduce both network and retail electricity charges without the need to meet technical constraints imposed by the local distribution network. Although up-front capital for installation is still a barrier, alternative funding models are available.

Grid-connected microgrids are currently being explored in several regional locations to diversify local economies, decarbonise supply chains and build independent energy resilience. This study has found there are considerable barriers to implementing such schemes and the current regulatory framework is only set to become more stringent. As a purely commercial endeavour micro-grids do not offer a viable proposition. However, they are well suited to communities whose electricity supply is exposed to single points of failure. In this case a micro-grid becomes a critical infrastructure which should be supported by Local, State and Federal agencies.

Virtual trading networks pose an attractive and easily executed electricity trading model which could be deployed across a diverse range of participants. While the technology is in its infancy independent reviews of the short-, medium- and long-term benefits are needed to validate the value and identify optimum participant profile. Although the technical and regulatory barriers associated with deploying grid connect DER still apply, virtual trading networks could fundamentally shift the way electricity is traded across the NEM.

Table 1: Summary of scenarios, key barriers, implementation potential and the role of the DPI in supporting deployment.

Scenario	Description	Key barriers	Deployment opportunity	Potential DPI role
One: Virtual Net Metering	Individual participants install grid-connected small scale renewable resource (e.g., wind, solar, hydro). Excess generation is purchased by an industrial consumer via a direct commercial arrangement.	• Poor return on investment due to low c/kWh secured by industrial users • Access to capital • Retailer involvement • Contracting arrangements	Potential for deployment if a large number of participants can be aggregated into a portfolio to present a greater value proposition to a facilitating retailer.	• Networking of participants • Facilitator of negotiations between participants and retailers
Two: DER secondary revenue streams	A single participant installs a grid connected renewable resource (up to 500kW) with the intention of generating a secondary revenue stream via on selling the excess generation.	• Generation capacity too great for a standard FiT or STC • Administrative load in becoming a registered generator of LGCs • Technical feasibility of grid connecting large generation • Fluctuating value of LGCs	Size generation to meet on-site demand with minimal or no export. Removes technical barriers for deployment. Benefit driven by reduced energy costs saving on both retail and network charges. Alternative financing arrangements available to limit requirement for up-front capital.	• Independent advice and guidance around alternative financing opportunities • Generation sizing tools

Scenario	Description	Key barriers	Deployment opportunity	Potential DPI role
Three: Grid connected micro-grid	Several geographically co-located participants connect their individual loads and generation capacity (e.g., a mix of renewable energy and diesel power generation) as a microgrid with a single point of NEM connection providing back-up access to the grid should it be required and a route for exporting excess power generation.	• Required to comply with embedded network regulations • Participant risk exposure and consumer protection • Cost of deploying infrastructure and ongoing maintenance • Administrative load of operating an embedded network	Suited to communities which need to improve electricity security and network resilience due to exposure to single points of failure on the distribution network and/or potential risks related to catastrophic events such as bushfires.	• Collaboration with affected communities • Facilitate discussions with key stakeholders • Support applications for funding and grants
Four: Virtual Trading Network	Multiple NEM connected participants of all classifications small and medium sized generators, e.g., domestic solar PV, commercial solar PV, and multi sector consumers, including industrial users, commercial buyers and domestic supplies, trading energy via a cloud-based control and trading platform.	• Very few aggregators operating in this novel space • Limited number of agreeable retailers • Grid connected DER technical barriers still exist • New technology with un-tested track record	Sector wide deployment possible subject to distribution network capacity for the installation of grid connect renewable generation.	• Independent advice and guidance for potential participants • Review and publication of short and long term findings from pilot projects

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Glossary

Phrase	Meaning
Australian Energy Market Commission (AEMC)	Market body responsible for making the *National Electricity Rules* and *National Energy Retail Rules*, which govern the NEM
Australian Energy Market Operator (AEMO)	Market body responsible for managing the NEM
Australian Energy Regulator (AER)	Regulator of the NEM
Community energy	Community shareholders support initial capital expenditure of the installation of DER and in return receive cost savings or potential revenue generation and energy security from local generation
Distributed energy resource (DER)	Localised generation or load assets
Distribution Network Service Provider (DNSP)	Responsible for maintaining the electricity network, including poles, wires, stations and substations
Embedded network	Allows multiple customers to connect to the main electricity grid at one connection point
Feed-in tariff (FiT)	Payment by electricity retailers to renewable energy generators for exporting electricity to the grid
Grid	Used to reference the physical infrastructure of the transmission and distribution networks upon which the NEM operates.
GreenPower	Allows generators' LGCs to be used as GreenPower products which are offered by electricity retailers
Large-scale generation certificates (LGCs)	Renewable generators with a generation capacity of more than 100 kW are eligible to generate LGCs through the Large-scale Renewable Energy Target (LRET)
Large-scale renewable energy target (LRET)	Incentivises the development of renewable energy generation through a market for the creation and sale of LGCs
Microgrid	Arrangements where one or more types of small-scale generation service loads across a single site or multiple geographically local sites. All participants are physically connected by wires. A microgrid may operate entirely independently of the NEM, or may have a metered connection point. Where a microgrid has a connection point to the NEM for importing and exporting electricity it is classified, from a regulatory perspective, as an embedded network.

Phrase	Meaning
National Electricity Law (*NEL*)	The *NEL* is the schedule to the *National Electricity (South Australia) Act 1996* which establishes the governance and enforcement framework and key obligations surrounding the NEM
National Electricity Market (NEM)	Involves wholesale generation that is transported via high voltage transmission lines from generators to large industrial energy users and to local electricity distributors in each region (Queensland, NSW, Victoria, South Australia and Tasmania)
National Electricity Rules (*NER*)	Made pursuant to the NEL and govern the operation of the NEM
National Energy Retail Law (*NERL*)	Govern the sale and supply of energy from retailers and distributors to customers
Parallel grid connection	Arrangements that can operate both parallel to main grid power supply as well as a stand-alone system in the event of centralised power outage (island mode)
Peer to peer (P2P) energy trading	Participants of the energy distribution network buy and sell energy directly with each other encouraging multi-directional trading. Trading will always be facilitiated by a NEM registered retailer with arrangements ranging from two individual entities trading between each other to a network of participants. Under this arrangement participants are not physically connected to one another.
Power Purchase Agreement (PPA)	Contract between a generator and purchaser for the sale and supply of energy
Renewable Energy Target (RET)	A Federal government scheme designed to reduce emissions in the electricity sector and encourage the additional generation of electricity from renewable sources
Small-scale technology certificates (STCs)	Renewable generators with a generation capacity of less than 100 kW are eligible to generate STCs through the Small-scale Renewable Energy Scheme
Virtual Power Plant (VPP)	Using a cloud based software platform multiple small scale generators are aggregated together to enable interaction with the NEM as if it were a single large power plant. The VPP operator is the single point of interacton with the NEM passing through benefits to participants.

1. Introduction

In early 2020 the New South Wales Department of Primary Industries (NSW DPI) conducted feasibility assessments of innovative energy solutions as part of Phase 2 of the Energy Efficiency Solutions Project. Project 20 “Virtual Micro Grid” aimed to harness commercial arrangements between a large dairy producer and its supplier farms to enable peer to peer (P2P) energy trading. Each farm would install on-farm renewable energy generation (solar PV) with the power used on-site. Any excess energy would be exported and purchased by the dairy producer.

In principle, the proposal had significant merit, improving the return on investment for the deployment of on-farm photovoltaic (PV) generation for the supplier farms, providing a secondary income stream to farmers and decarbonising the dairy supply chain. It would also provide benefits to the dairy producer in the form of lower cost renewable electricity.

Unfortunately, during the technical feasibility assessment several barriers and risks to up-take were identified which ultimately resulted in the proposal being deemed unfeasible. The most notable barriers concerned capacity within the existing distribution and transmission networks and the requirement for an electricity retailer to facilitate the trading transaction. Both hurdles came about as a direct result of the project proponents being serviced by the National Electricity Market (NEM) and its associated infrastructure. Anecdotally there appears to be a trend in similar projects also struggling to achieve a positive feasibility assessment due to limitations in existing electricity retail regulation and network access arrangements.

1.1. Introduction to DER

A distributed energy resource (DER) refers often to smaller generation units that are located on the consumer’s side of the meter or close to the local loads and can also capture, in its broad definition, dispatchable flexible loads that can be curtailed (demand response). A common form of DER is a **microgrid** where one or more types of small-scale generation technologies – typically solar PV coupled with standby reciprocating engines, potentially coupled with demand response – are used to generate electricity for use on site. These are often ‘behind the meter.’ Within a microgrid, the ‘owner’ of the generation could be a combination of participants, a community or a single individual. Figure 1 illustrates the types of assets which may form a microgrid.

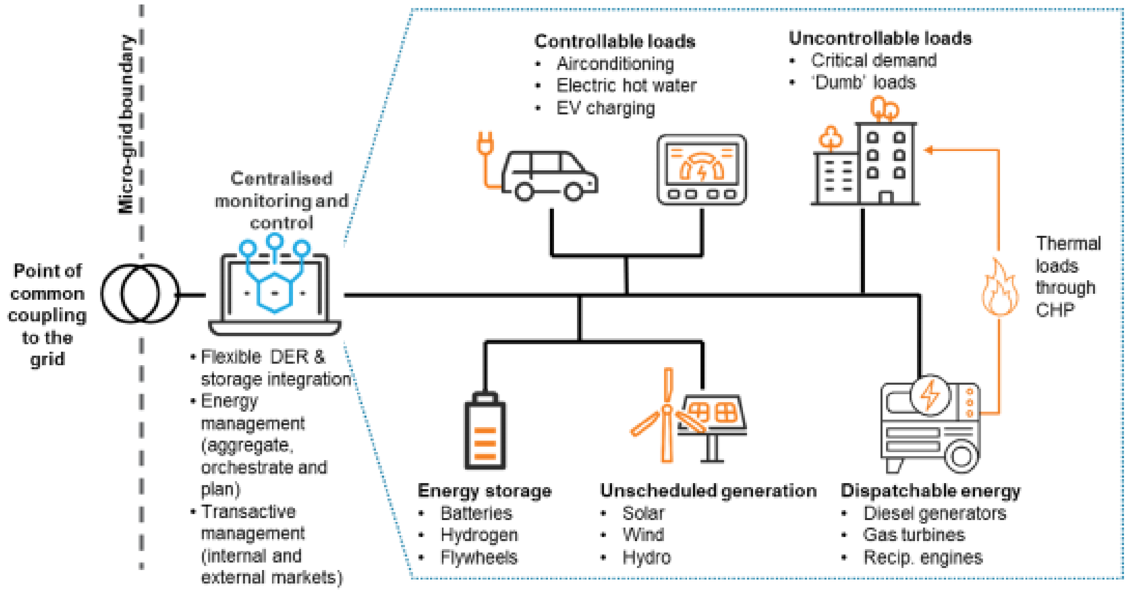

Figure 1: Basic building blocks of a microgrid.

Increasingly microgrids may also include battery storage to even out peaks or mis-matched supply and demand profiles. The primary characteristics of a microgrid is that it can operate both parallel to main grid power supply (synchronised to the 50 Hz frequency of the power system) as well as a stand-alone system in the event of centralised power outage (islanded mode of operation). This type of arrangement is referred to as a **parallel grid connection**.

An **embedded network** allows multiple customers to connect to the main electricity grid at one connection point. Typically, this arrangement will entail one entity or individual 'owning' the energy generation asset and distribution network and then on-selling to additional parties directly connected and supplied from the generator behind the connection point to the power system. Such arrangement likely involves individual metering of supply[1] and specific regulatory requirements related to licencing or formal exemption to licencing requirements for both the retail / on-selling arrangement and the distribution network connection.

Proposals such as Project 20 aim to aggregate multiple distributed generation resources (the dairy supplier farms) to meet the load of the dairy producer. Under such arrangement, excess power available from the participating distributed power generators is used to support participating loads and reduce reliance on power from the more centralised generation, transmission and distribution infrastructure. This arrangement is referred to a **Virtual Net-metering.**

With the expansion of smart metering and internet enabled devices new and innovative ways of trading have been developed. One such example is the aggregation of generators and loads into a **Virtual Power Plant (VPP)** arrangement. A VPP uses a cloud-based software controller to aggregate and manage generation capacity and loads within the portfolio. The controller is owned privately either by an organisation, collection of owners or an individual and can operate as a single generator for distribution and trading purposes. A VPP can be a collection of generators that are located across a large area, do not need to be directly connected[2] and remain independent in their operation and ownership. The controller can monitor generation and weather forecasts from multiple sites and optimise the distribution across multiple loads and capture power export

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[1] *https://www.aer.gov.au/consumers/information-for-electricity-consumers-in-embedded-networks*
[2] *https://www.next-kraftwerke.com/vpp/virtual-power-plant*

opportunities in the wholesale market. All connections to a VPP require a stable internet connection.

Distributed energy resource has seen significant investment, research and development over the past decade. A range of innovative DER projects are in progress across Australia. Table 2 below details a selection of initiatives and their current status.

Table 2: DER examples across Australia

Project	DER Example	Driver	Location	Status
Kalbarri Microgrid	Wind and solar generation with battery storage and mains grid backup	Building power resilience for remote communities	Kalbarri, WA	Commissioning
Monash University	Embedded network with multiple solar arrays, battery storage and demand management technology.	Exploring the management of urban, grid connected DER.	Melbourne, Vic	Operational
Latrobe Virtual Microgrid	Mass participation virtual power plant using blockchain trading across 200 dairy farms, 100 households and 20 commercial customers.	Virtual demand management and self-sustaining generation and trading for isolated communities.	Latrobe valley, Vic	Feasibility
Hepburn Community Energy	Community owned 4.1MW wind farm, certified GreenPower generator with an offtake agreement with a major energy retailer.	Community driven investment opportunity to support local economic growth.	Hepburn, Vic	Operational
Riverland Poultry Farm	Large scale deployment of battery storage and solar PV allowing trading on the wholesale market.	Emissions reduction and revenue generation.	Riverland, SA	Operational

1.2. Pathway to implementation

The pathway to implementation of any DER project is independent of the type of technology used or commercial arrangement. All potential schemes will travel along a similar initiation and feasibility trajectory usually incorporating the following six stages:

Stage 1: Concept vision

All projects start as a concept, usually centred around the solving of a problem or overcoming a challenge. The nature of the challenge may be specific (e.g., replacing diesel-driven irrigation pumps with solar PV-driven pumping systems) or broad in nature (decarbonising a supply chain).

Stage 2: Driver identification

The driver is the core belief which underpins the project concept and the main motivating objective. Some common drivers for DER projects include building resilience (security of supply), an attractive financial proposition, avoiding or deferring expensive and lengthy network infrastructure augmentation or social purpose. It is important that the core driver is identified early on and provides enough momentum for the project to overcome likely delays and difficulties.

Stage 3: Technical feasibility

Technical feasibility aims to identify and overcome any on-site limitations for the deployment of the chosen DER solutions, local distribution network issues and any implications to the wider transmission network or power system. This stage includes due consideration for the existing electricity market and network regulatory frameworks.

Stage 4: Commercial feasibility

Commercial feasibility assesses key financial aspects such as required capital expenditures, operation and maintenance costs, and expected return on investment against agreed thresholds to ensure the project will achieve economic expectations within participants' risk appetite.

Stage 5: Operational feasibility

During operational feasibility, the requirements of retail agreements and trading arrangements are assessed against participants acceptability criteria. In addition, the level of involvement for each participant for administration of the proposed agreement is also assessed.

Stage 6: Planning / connection approvals and construction

Once a project has been deemed feasible it will progress to planning approval (from the local Council(s)) and network connection approval (from the local distribution network service provider). Once approvals are obtained and funding/financing is secured contractors can be appointed and contracts signed. The type of ownership structure and contractual arrangement will vary (e.g., design build operate and maintain contract; separate design & construct and operate & maintain contracts; etc.). Potential barriers and challenges relating to this stage of works are beyond the scope of this document.

1.3. The role of this document

Government and private sector energy users and regulators have an increasing interest in the role DER, demand response (DR) and innovative energy retail and trading arrangements could play in building grid network resilience, supporting the decarbonisation of electricity, and delivering economic growth within primary industries. However, the bulk of NSW is supplied by NEM regulated transmission and distribution power networks and operates within the NEM electricity market. As a result, the need of a project to comply with both network and retail contemporary regulatory frameworks is a preeminent constraint in its development and deployment as adjustments to these rules to new technologies and business models follow a lengthy review process.

This document aims to comprehensively identify potential barriers to deployment of DER within primary industries based upon the framework outlined above. To meet this objective, Energetics has:

- undertaken a full review of the challenges facing primary industries in NSW
- explored the potential benefits of DER in overcoming the challenges identified
- provided an overview of different DER technology solutions
- conducted a top-down review of the regulatory requirements for network connected projects to identify potential barriers and compliance needs

- identified co-ordination options most suited to NSW primary industries
- documented the current limitations related to the electricity market rules, especially related to electricity retail services.

Based on our research into project concepts and drivers for DER applications in primary industries, Energetics has developed four test scenarios. Each scenario presents a targeted potentially attractive DER concept. Each scenario has been assessed against technical, operation and commercial feasibility criteria to identify common barriers, challenges and potential solutions.

2. Exploring primary industries in NSW

To identify potential drivers for exploring DER, it is important to first understand the nature of primary industries in NSW and the challenges the sector faces, both current and emerging.

The NSW primary industries sector covers a broad range of sub-sectors including cattle and sheep livestock production, livestock derived products such as dairy and wool, forestry, wine grapes, horticulture, and fisheries. In 2019/20 primary industries activities had a combined economic output of $15.7 billion[3].

The diverse nature of NSW landscape results in region specific activities and product specialisms. For example, western regional outputs focus on sheep rearing, wool and vineyards. The north west produced $404m of cotton lint and $349m in beef cattle during 2018/19, while Riverina has a fifty-fifty split between livestock outputs and broadacre cropping.

As of November 2020, approximately 87,800 people were employed in “Agriculture, Forestry and Fishing” in NSW.[4] Multiple supply chains, commodities, local and global economies rely on sustained, high-quality and affordable outputs from all agriculture sub-sectors.

Although NSW has a range of primary industries activities, livestock meat production and livestock derived products dominate, accounting for more than 50% of NSW primary industries output in 2018/19[5]. Figure 2 illustrates the ‘top 10’ primary industries activities in NSW as a proportion of economic output.

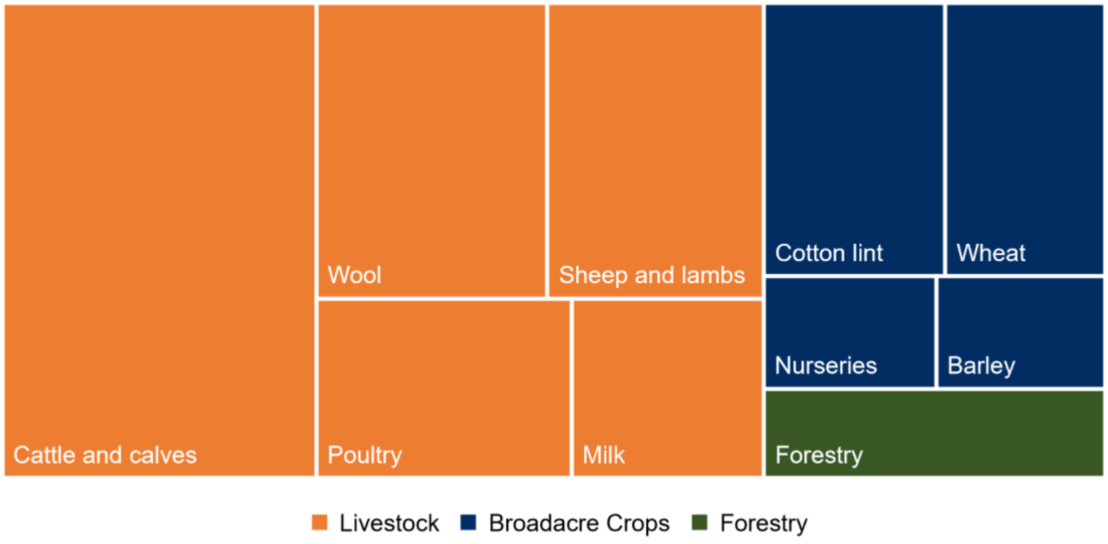

Figure 2: NSW 'top 10' primary industries activities based on economic output for 2018/19.

The 2019/20 fiscal year presented unprecedented challenges to the sector. Drought conditions persisted into early spring affecting crop yields and reducing herd sizes. Summer bushfires

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[3] NSW Primary Industry, Performance Data and Insights – 2020, *https://www.dpi.nsw.gov.au/about-us/publications/pdi/2020*

[4] Australian Bureau of Statistics, Table 05. Employed persons by State, Territory and Industry division of main job (ANZSIC), *https://www.abs.gov.au/statistics/labour/employment-and-unemployment/labour-force-australia-detailed/latest-release*

[5] *https://www.dpi.nsw.gov.au/about-us/publications/pdi/2020/regional-output*

devastated communities with the loss of 2,000 homes and over 5 million hectares of land affected[3]. The global COVID-19 pandemic saw volatile commodity prices and widespread market uncertainty as Australia and the world entered lockdown. With the easing of restrictions, markets are recovering, nevertheless primary industries will continue to face acute and chronic risks.

2.1. Risks to primary industries

Following consultation with key stakeholders, four risks which could negatively impact primary industries have been identified: Australia's changing climate, volatile commodity prices, changing market conditions, and energy costs and security. Impacts are summarised in Figure 3 with further detail provided in sections 2.1.1 to 2.1.4.

Figure 3: Potential risks and impacts to primary industries.

2.1.1. Australia's changing climate

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations' body for assessing the science related to climate change. The IPCC provides regular assessments on climate change, its implications and risks, and suggests adaptation and mitigation options. Conclusions from the latest reports illustrate that concentrations of atmospheric greenhouse gases have increased, the atmosphere and ocean have warmed, the quantities of snow and ice have diminished, and sea level has risen.

At a national level, data from CSIRO and the Bureau of Meteorology (BoM) demonstrates that climate impacts have already been experienced in Australia. For example, data published in early November in the CSIRO/ BoM “State of the Climate” report shows that Australia has warmed by 1.44°C since 1910, with 1°C of warming occurring since 1960[6]. Alongside averages, extremes have also increased in frequency and intensity, with 8 of Australia’s top 10 warmest years on record having occurred since 2005. Similarly, total annual rainfall is decreasing in southern Australia, with an increase in the concentration of rainfall. Thus, a higher proportion of total annual rainfall is coming from heavy rain days, with a greater potential for flooding and damage. Heavy rainfall is expected to become more intense. There has also been an increase in the length and intensity of the fire weather season due to higher temperatures, lower rainfall, stronger winds and higher vegetation fuel loads.

Although climate-change mitigation actions can be presently undertaken, Australia’s worsening climate change trajectory will remain unchanged until 2040. This is due to past emissions and inertia in the system, causing current climate actions to have no impact on the projected greenhouse gas (GHG) concentrations until 2040. After 2040, several divergent physical scenarios could arise due to decisions in current climate actions. These scenarios are characterised by different GHG concentration trajectories. These different GHG concentrations give rise to divergent physical scenarios that are described by different Representative Concentration Pathways (RCPs), as Figure 4 illustrates.

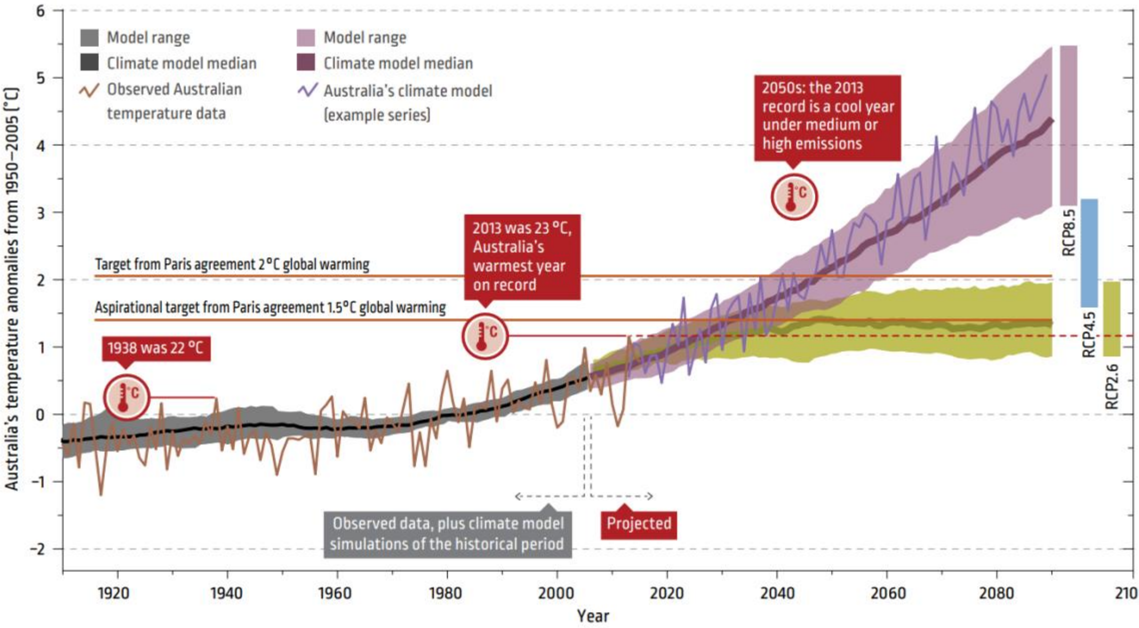

Figure 4: Australian mean annual surface warming in the past and for future emissions pathways[7]

The success in terms of output, quality, sustainability and profitability of primary industries is fundamentally reliant upon climate, land and water ecology, and interlinked ecosystems. Shifts in climate such as increases in temperature, changing rainfall patterns and a trend towards increasing extreme weather events pose very specific challenges to primary industries.

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[6] State of the Climate 2020, CSIRO/BoM, accessed at *https://www.csiro.au/en/Showcase/state-of-the-climate*

[7] Extracted from ‘Australia’s Changing Climate’ report, CSIRO, 2016, *https://www.climatechangeinaustralia.gov.au/media/ccia/2.1.6/cms_page_media/176/AUSTRALIAS_CHANGING_CLIMATE_1.pdf*

In summer across all regions in NSW, record breaking maximum temperature days have increased over the last 10 years[8]. Heatwave conditions, where days above average temperatures are experienced across consecutive days, are also become more prevalent. Heatwave events pose significant health and welfare risks to both people and animals. This chronic rise in temperature is also exacerbating drought conditions leading to diminished and variable crop and livestock outputs.

Rainfall is becoming increasingly variable with a trend towards lower cumulative rainfall totals but more intense rainfall events. Crop production was impacted by continued drought conditions across the state in 2019-20, with total crop production falling 16% year-on-year and 63% compared to the moving five-year average.[9] Total summer cropping area across NSW declined sharply by 80%.

In addition, poor rainfall reduces the quality of grazing pastures resulting in cattle requiring supplementary feed and a shift to cattle spending longer on feedlots. This increase in demand for grain derived feeds in a market suffering low supply has increased costs and lowered cattle profitability.

The reduced production and greater domestic demand for grain left limited surplus for export to trade partners and in the case of rice, has dropped so far rice is expected to transition to an imported commodity.[10]

Rising temperatures and drought conditions also significantly increased the risk of bushfires[11]. The increased volatility in rainfall and falling soil moisture content reduces the lands' ability to absorb moisture, particularly during intense rainfall events. Combined with the increased evaporation from hotter days and longer lasting warm conditions, the woodland and forest areas of NSW area experiencing a drying trend. This, alongside an increase in the number of extreme fire weather days increases the likelihood of bushfires occurring and burning with elevated intensity.

2.1.2. Volatile commodity prices

Volatility in the commodity markets is caused by unanticipated fluctuations in supply and demand. Responses to demand variations are often slow as there are long delays between investment in and production of commodities. Agricultural commodities are also susceptible to adverse weather conditions which impact the yield and thus the ability to meet demand. There are also exposed to international markets, leading to arbitrage positions that can further exacerbate volatility.

Primary industries are exposed to both the demand and supply sides of the commodity market which increases risk exposure. Further strain on revenue and profit is seen when low selling prices for products such as beef coincide with high purchase prices, for example grain for cattle feed.

2.1.3. Changing market conditions

Primary industries are exposed to both global and national shifts in market conditions. On a global level there have been rising tensions between the US and China which has increased pressures

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[8] *http://www.bom.gov.au/climate/climate-guides/*

[9] NSW Department of Primary Industries, Cropping, *https://www.dpi.nsw.gov.au/about-us/publications/pdi/2020/cropping-overview*

[10] NSW Department of Primary Industries, Cropping, *https://www.dpi.nsw.gov.au/about-us/publications/pdi/2020/cropping-overview*

[11] *https://www.climatechangeinaustralia.gov.au/en/climate-campus/climate-extremes/*

on Australian farmers to meet international demands.[12] As one of Australia's biggest trading partners, exports to China are essential for stability of Australian primary industries, however, in the past year, trade tensions between Australia and China have also increased and tariffs have been raised on Australian produce which has put downwards pressure on demand. Barley and wine have been particularly impacted.

In local markets social, environmental and economic drivers are seeing shifts in consumer behaviour which further impact primary industries.

- Social – consumers are becoming increasingly educated and informed on farming practices and the composition and sources of their food. This is driving behaviours towards greater ownership and engagement in the process of choosing products and suppliers. Selections are not simply driven by price-point, with considerations including genetic modification, organic vs. non-organic, fair trade, plant-based and animal welfare impacting decision making.
- Environmental – similarly to social considerations, consumers have greater awareness of the environmental impacts of farming activities and their personal choices. Understanding of the carbon intensity of livestock rearing, biodiversity degradation due to land clearing and scrutiny on food waste to meet retail standards is increasingly widespread and is again driving consumer preference and behaviours[13]. In response to the above industries bodies such as Meat and Livestock Australia (MLA) and Dairy Australia, alongside all State and Territory governments have set ambitious NetZero targets and aspirations.
- Economy – retailers are continually striving for lower prices to attract and maintain their customer base. This often puts pressure on small to medium sized farms by reducing profit margins and on-farm revenue[14].

All of the above apply pressure to primary industries and require innovation and investment in adaptive practices to improve efficiency and reduce costs while maintaining output.

2.1.4. Electricity costs and security

Energy costs make up a significant proportion of annual expenditure for primary industries and access to an affordable and secure power supply is critical for the long-term sustainability of the sector.

In recent years there has been an increase in electricity costs both in terms of the retail price element and network charges. Rural and regional areas have experienced a greater increase in network costs in particular due to the higher costs associated with maintaining transmission and distribution networks across large geographic areas for a small number of customers. Around 40% to 50% of a regional users' electricity bill can be attributed to network charges.

Changes in farming practices have also seen electricity expenditure rise with a shift to digital and automated processing (such as automatic milking system) increasing reliance upon the power network.

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[12] *https://www.graincentral.com/trade/export-trade/china-extends-anti-dumping-investigation-into-australian-barley/*
[13] *https://academic.oup.com/aepp/article/40/1/5/4863687*
[14] *http://web.missouri.edu/~ikerdj/papers/SFT-New%20Farm%20Marketing%20(5-08).htm*

Reliability of power supply is a key concern within primary industries and wider communities in remote and rural areas with critical infrastructure as well as process equipment such as cold storage and refrigeration requiring uninterrupted supplies.

The below table illustrates the number of power outages in 2019/20 across all three distribution network service providers in New South Wales[15]. Essential Energy is primarily responsible for distribution of power to rural / regional areas occupied by primary industries (refer to Figure 5 below). As can be seen in the table below, Essential Energy experienced a substantially higher number of power outages than other distributers. Part of this can be attributed to the size of the area supplied by each distributer, with Essential Energy servicing approximately 95% of New South Wales land area[16] but only 24% of energy users in NSW[17].

Table 3: Average frequency and duration of outages per distribution network in NSW (2019/2020)[18]

Reliability indicators	Ausgrid	Endeavour Energy	Essential Energy
System Average Interruption Duration Index (minutes per customer)	344.1	303.5	605.3
System Average Interruption Frequency Index (interruptions per customer)	0.9	1.1	2.2
Customer density (customer per km)	44.6	35.6	5.1

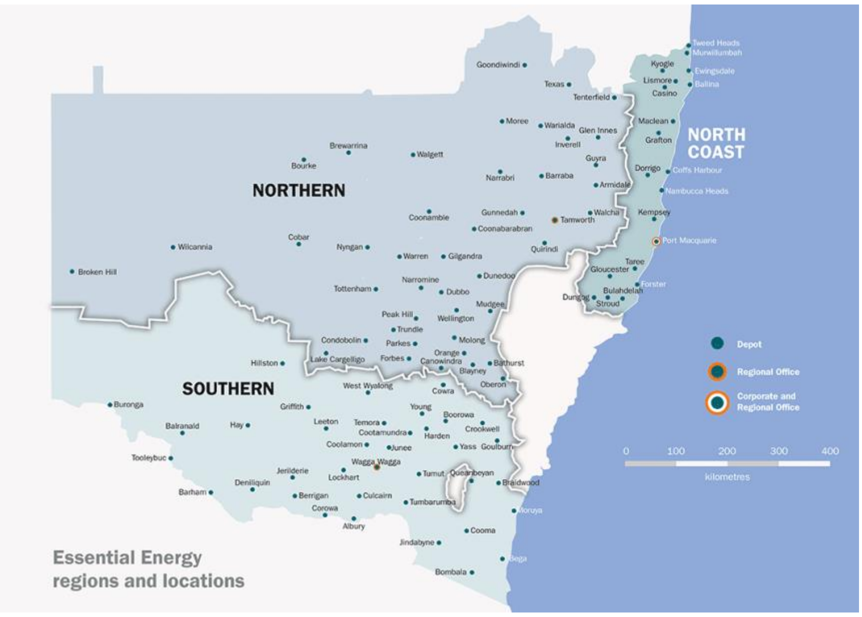

Figure 5: Essential Energy service area map[19]

Approximately 97% of power outages within Australia are caused by distribution interruptions[20], that is, physical interruption to the poles and wires caused by animals, fallen trees, lightning

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[15] *https://www.aer.gov.au/node/62912*
[16] *https://www.essentialenergy.com.au/about-us/our-network-area*
[17] *https://www.aer.gov.au/system/files/AER%20Annual%20Retail%20Markets%20Report%202018-19_0.pdf*
[18] *https://www.aer.gov.au/node/62912*
[19] *https://www.essentialenergy.com.au/about-us/our-network-area*
[20] *https://microgridknowledge.com/blackouts-in-australia/*

strikes, vehicle crashes, vandalism, or equipment failure (overload or deterioration)[21]. As noted above, maintenance of the distribution network is expensive and much of the cost is transferred to the consumer through network charges (recovery of revenue requirements approved by the Australian Energy Regulator to meet agreed capital and operating expenditures and return on regulated asset base). There is a fine balance between affordable pass-through regulated network tariffs for end-users and maintaining a reliable and future-proofed network infrastructure with increasing penetration of intermittent renewable energy and flexible demand.

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[21] *https://www.ipart.nsw.gov.au/files/52185732-ea50-4bd8-ac43-9f5c00c1f0dd/InformationPaperNo3-ReliabilityandqualityofsupplyofelectricitytocustomersinNSW-pdfFINAL_000.pdf*

3. Benefits of DER in primary industries

Primary industries are experiencing a number of significant challenges which will continue to put pressure on the sector in future. However, there are also substantial opportunities to be leveraged through optimisation, efficiency and innovation. An increasing area of focus is the role DER can play in reducing electricity costs, diversifying income streams and improving reliability of power supply. Through careful deployment of DER primary industries could also capture indirect benefits such as diversification of rural economies, strengthened partnerships between sector and community stakeholders and improved environmental outcomes.

The technology behind DER is relatively mature with most on-farm infrastructure challenges able to be overcome. Innovations in trading arrangements have helped stimulate the development of new pathways to a greater number of direct and indirect benefits.

It is, however, worth noting that a thread of distrust and uncertainty relating to renewable energy and DER runs through primary industries[22]. For DER to become more widespread, participants need to access independent and high-quality advice relating to technologies and their suitability within their unique situation. The dynamic nature of market and network regulations, policy and pricing mechanisms has also led to potential participants delaying involvement due to uncertainty[23].

3.1. Direct benefits

Reducing electricity costs

Generating electricity through on-site behind-the-meter renewable power generating systems reduces both the volume of electricity purchased from the grid and, but to a much lesser extent because of the intermittent nature of this supply, instantaneous demand drawn from the grid. Understanding a site's load profile is critical in determining how much and when power is needed and thus what generation source best meets that need. By reducing power imports, a DER capacity will reduce retail and network charges for the DER proponent. Also, an end-user able to set up a material and reliable DER capacity can, by changing its retail contracting model generate savings from a more direct market participation but this would involve taking some price and/or volume risks typically taken by the retailer.

Resilience and energy security

The distribution network that services rural NSW is susceptible to physical interruptions to supply between centralised generation facilities and end users due to the physical size and exposure of the network. If the connection arrangement is appropriately set up, DER can reduce a user's reliance upon the distribution network and vulnerability to interruptions[24], with DER supplying segregated critical loads in islanded mode of operation following a grid outage. Grid-connected DER can support the local network (generation closer to local loads leading to less susceptibility to transmission and distribution network congestion risk). Depending on the network configuration,

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[22] *Final Report: Irrigators – the flow-on benefits of regionally embedded generation (worldsecuresystems.com)*
[23] *Microsoft Word - 2016 Cotton Practices Survey REPORT.docx (insidecotton.com)*
[24] *https://www.energy.gov/sites/prod/files/2015/03/f20/GridWise%20Improving%20Electric%20Grid%20Reliability%20and%20Resilience%20Report%20June%202013.pdf*

DER also provide an added layer of redundancy to immediate communities, providing essential back up power in the event of emergencies.

Appropriately sized and combined with storage capacity, such as batteries, DER can enable a user to operate 'as normal' with complete independence to the grid but with typically a lower reliability performance level.

Decarbonising supply chains

The use of DER by primary producers can lower their operational emissions which in turn lowers the scope 3 (or indirect) emissions of the primary industries supply chain. Through growing awareness of climate change and its associated impacts, there is increasing consumer pressure on these retailers to boost their corporate social responsibility credentials and engage suppliers that are committed to lowering their carbon footprint.

3.2. Secondary revenue

While DER presents significant opportunities for building resilience, they can also be capitalised upon via a number of trading arrangements to generate secondary revenue for owners.

Power export

Currently, feed-in tariffs (FiT) from electricity retailers are one of the most common revenue generation methods of renewable DER exporting power to the grid. Essentially the owner of a renewable DER (e.g., solar power generation system) is paid a fixed price for each unity of renewable electricity exported to the grid.

Feed-in tariffs have helped stimulate uptake of renewable generation by reducing return on investment and enhancing the value proposition. The introduction of FiT also increased competition between suppliers resulting in lower purchase costs for the end consumer and availability of technical solutions.

However, with the price of electricity in the wholesale spot market now suppressed (because of the high penetration of coincident rooftop solar and utility-solar generation) electricity retailers are valuing less and less such power exports from behind-the-meter solar systems.

Value of renewable electricity generation

Under the Federal Government Renewable Energy Target (RET), two schemes have been created to incentivise renewable energy generation.

Large-scale generation certificates (LGCs) can be created from eligible renewable energy systems with an installed generation capacity over 100kW. A solar system of such size would be eligible to create 1LGC per MWh of net generation.

Small-scale technology certificates (STCs) can be earnt for systems below this threshold (e.g., a solar PV system, a solar hot water system). They are typically claimed upfront through a deemed valuation process by the solar system installer, leading to a rebate in the installation cost for the end-user.

These renewable energy certificates are tradable certificates. Under the RET schemes, liable entities (wholesale purchasers of electricity i.e., typically electricity retailers) are requested to surrender a volume of certificates each year to the Clean Energy Regulator (CER) who regulates and administers these schemes. There are therefore buyers and sellers of these environmental certificates. The party who owns the LGCs (e.g., a primary industry end-user with a large on-site solar system, assuming it negotiated this ownership right with the solar developer) can therefore sell them (on the spot, or forward). It can alternatively transfer them to its electricity retailer to reduce its indirect obligations under the RET (self-surrendering of LGCs via the electricity retailer). LGCs can also be retired to the CER to reduce/offset emissions related to electricity supply (see Climate Active – Electricity Accounting) and renewable energy purchasing credentials.

Trading via a market mechanism means LGC prices are not fixed, and their value may increase or decrease over time. Table 5 details the current spot market price for LGCs and the forecast trend in value over the next three years.

Table 4: Current LGC Spot trading price as of 21/04/2021 and forward prices to 2024

LGC vintage	Price
Spot trading	$ 33.75
CAL 21	$ 34.00
CAL 22	$ 27.25
CAL 23	$ 19.60
CAL 24	$ 10.60

Demand response and frequency regulation

Maintaining power system security and reliability necessitates that the physical requirements of the power system are satisfied at all times. This means ensuring resource adequacy (sufficient generation capacity for real-time balancing of electricity supply and demand), frequency management (maintaining system frequency within acceptable limits), stable voltage waveform (system strength). With increasing penetration of variable renewable energy resources (wind, solar) and less inertia in the power systems from conventional synchronous generators (gas and coal-fired generators) the market operator is increasingly looking for DER to actively participate in the market.

There is an opportunity for operators of DER to provide fast and preferentially automatic response to price signals from the electricity markets (energy market or frequency control ancillary services market) or response to network constraints from the network service provider (network-driven demand response). Depending on the revenue stream that can be generated through the application of a DER, the electricity retailer, a demand response aggregator, the network service provider and in the future a power "trader" (under the two-sided market mechanism proposed under the Post 2025 market design review) compensates the DER owner for participating or allowing access and use of the DER asset[25].

This is a fast-moving new market. Primary industries may look to participate in demand response mechanisms through the use of flexible loads such as irrigation pumps and robotic dairies, on-site

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[25] *https://arena.gov.au/blog/what-is-frequency-control-ancillary-services/*

dispatchable generation (e.g., standby generation, battery storage in the future). To further support the identification of possible DER opportunities we list below a taxonomy of demand response services[26]:

- Shaping DR captures DR that reshapes customer load profiles through price response with different level of advance notice (months, days, hours).
- Shifting DR represents DR that encourages the movement of energy consumption from times of high demand (e.g., end of the afternoon/early evening in summer – sometimes early morning in winter) to times of day when there is a surplus of renewable generation (middle of the day/early afternoon).
- Shedding DR describes loads that can be curtailed to provide peak capacity and support the management of the power system (e.g., NSW power grid as a whole) under contingency or emergency conditions.
- Shimming DR involves using loads to dynamically adjust demand on the system to alleviate short-run ramps and disturbances at timescales ranging from seconds up to an hour, a service that will be more valuable in the future with increasing penetration of variable renewable energy generation in the power system.

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[26] Taxonomy applied by the US Department of Energy Lawrence Berkeley National Laboratory – see for example LBNL, March 2017, 2025 California Demand Response Potential Study - Final Report on Phase 2 Results

4. Developing test scenarios

From the review of challenges facing primary industries, it is clear DER presents a range of opportunities for participants to leverage secondary revenue streams, build resilience and drive positive outcomes for the wider primary industries community.

In order to design test scenarios which are realistic and offer an attractive value proposition, research and stakeholder consultation has been undertaken to understand and identify limitations and considerations in the following areas:

- On-farm infrastructure
- Options for grid alignment
- Trading arrangements
- Financial performance
- Resourcing and administration

Full insights are detailed in sections 4.2 to 4.4, however, in summary we found participants are seeking DER opportunities which:

- Are easy to deploy within current on-farm infrastructure constraints
- Require limited administration or day-to-day decision-making input
- Improve energy resilience to either individuals or communities
- Generate benefits for multiple stakeholders
- Present a clear and robust business case
- Limit capital expenditure

Based on these insights four test scenarios have been developed. The test scenarios aim to present realistic and achievable opportunities for primary industries participants to derive a range of direct and indirect benefits. The scenarios chosen to represent real-world opportunities which are currently directly marketed to primary industries participants within Australia. In section 5 each test scenario undergoes a high level technical and commercial feasibility study. Through this process barriers and challenges for deployment will be identified and their root cause explored. The ambition is to be able to identify solutions or mitigation pathways which would improve the viability of each scenario.

4.1. Scenario descriptions

Following desktop research and stakeholder consultation the following four test scenarios have been developed.

Scenario One – Virtual Net-metering

In scenario one we explore the technical and commercial arrangements of virtual net-metering. Under this scenario individual participants install small scale renewable generation on site. Excess generation is exported to the grid with a large industrial user purchasing the renewable export directly from the individual DER participants.

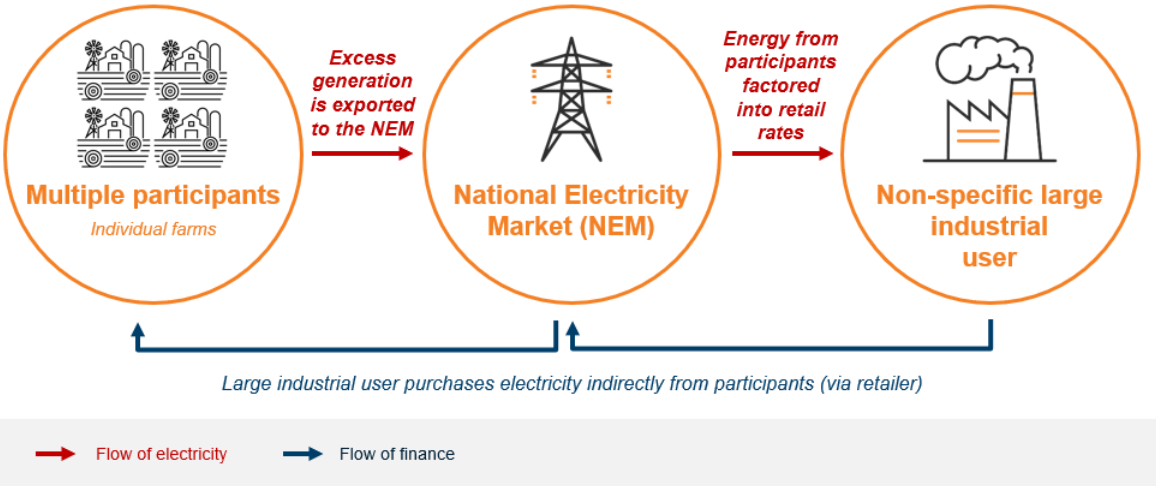

Figure 6: Scenario One explores peer-to-peer energy trading.

Scenario Two – Exploring secondary income streams

In scenario two we focus on an individual participant with the capacity to install a medium sized solar PV system (500kW assumed). With significant excess generation available for export to the network, this scenario assesses the viability of different revenue generation options including Feed-in Tariffs, STCs and LGCs.

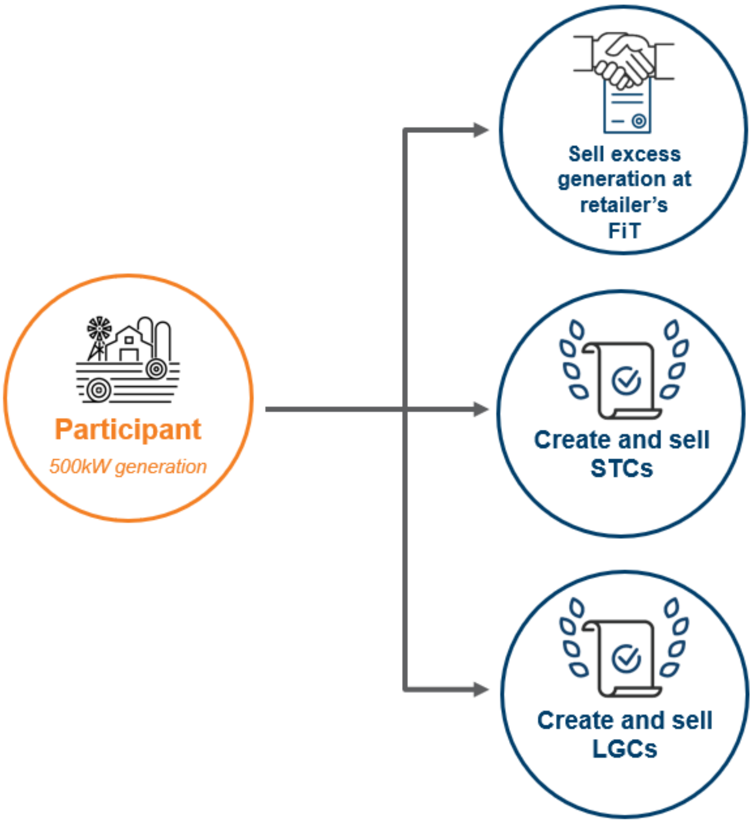

Figure 7: Scenario Two examines the potential revenue streams from large-scale renewable generation.

Scenario Three – Grid-connected microgrid

In scenario three several participants located in the same geographical area connect their on-site power generation assets, potential electricity storage assets, and electricity consuming loads in a private wired microgrid. Each participant is individually metered to allow pro-rata billing and revenue distribution. A single connection links the microgrid to the NEM allowing excess generation to be sold and additional electricity to be purchased should there be a shortfall.

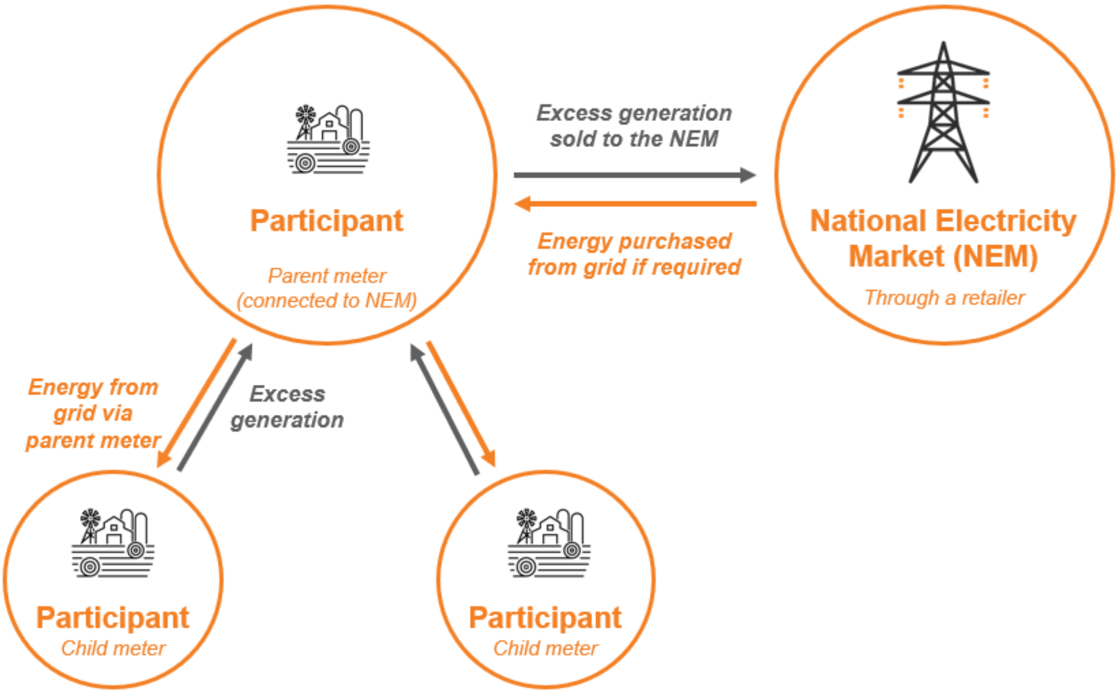

Figure 8: Scenario Three investigates the potential of grid connected microgrids.

Scenario Four – Virtual peer-to-peer energy trading

Scenario four studies the potential benefits of primary industries participants engaging in a virtual peer-to-peer trading arrangement. Covering hundreds of participants across a range of sectors and sub-sectors, scenario four is an innovative approach to managing electricity supply and demand. Our focus is on the feasibility of deployment and the potential benefits such a trading arrangement offers by allowing individuals to take ownership of their risk profile and energy trading strategy.

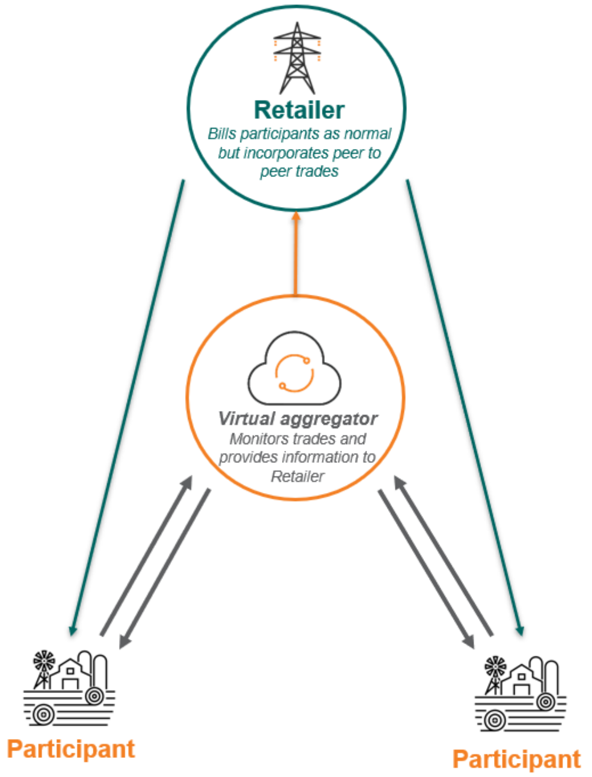

Figure 9: Scenario Four investigates the feasibility of an innovative virtual trading arrangement.

4.2. Test scenario development: On-farm infrastructure

The physical configuration and composition of on-farm infrastructure will largely depend on power requirements and maximum demand of individual locations; however, all DER will require, and must take account of, the following elements.

Small-scale generation

Common on-farm renewable energy generation includes small-scale wind turbines or solar PV arrays. However, depending on the available resources of the property, other options may become available including mini-hydro, geothermal resources and biomass driven technologies.

Size and location of the generator will need to be optimised for each individual site and will need to consider available resources and required minimum power generation for feasibility. More than one generation source can be used on a site[27].

Beyond limitations related to network connections (set by the local distribution network service provider to manage its power system), generation capacity is often limited by available capital (if self-funded or self-financed) or project risk (if set up under a power purchase agreement with a third-party providing equity and debt). Within the scope of this study an individual participant's deployment capacity is not expected to exceed about 500kW.

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[27] *https://www.abc.net.au/news/rural/2019-12-03/microgrids-set-to-transform-how-we-use-energy/11756672*

Energy storage

DER projects may or may not include energy storage. However, including a storage element (such as batteries, flywheels or pumped hydro) can add flexibility to a project “revenue stack” allowing a greater proportion of the on-site consumption to be met through renewable generation, shifting loads to minimise demand charge impacts, or generating income through demand side and frequency response contracts.

Electrical switchgear and control gear

The electrical switchgear and control gear is essential for operation of the above components as well as ensuring safe operation and electrical protection. Implementing DER would typically require modification of existing switchgear and control gear and will require particular attention to isolation of generator supply for maintenance. Switchgear will need to be installed in accordance with most current version AS3000 Australian Standards, NSW Service and Installation Rules, particularly sections 7 and 8[28]. Stringent requirements will be imposed by the network service provider during the connection approval process and then at commissioning.

Controller

While not strictly necessary for functional operation, the controller provides a level of intelligence that can capitalise on the full range of capabilities and value DER can bring[29]. Intelligent control can enable greater flexibility in generation, monitor weather data and time of day demands for generation strategies and most importantly, facilitates programming control and management for engaging with different trading and distribution strategies, using preconfigured requirements, preferences and conditions for buying and selling power. Use of a controller will require internet connectivity and appropriate data security mechanisms.

Back-up generators

Many primary industries participants may already have on-site backup generation. Often diesel driven, such generation can be incorporated into a DER scheme providing many of the benefits of demand response detailed in section 3.2.

4.3. Test scenario development: Grid connection, co-ordination and trading

All test scenarios will be NEM connected and must therefore consider the limitations of grid connections, co-ordination, and trading strategies. A range of energy trading strategies are available; however, regulatory requirements can make navigating the energy market difficult for small and independent entities. Following extensive research and stakeholder consultation three potential trading arrangements for primary industries participants have been identified: simple transactions, community investment schemes and peer-to-peer trading.

4.3.1. Parallel grid connection

In this configuration, the DER generates electricity and operates in parallel with the main distribution network. Several connection arrangements are available which can enable the

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[28] *https://energy.nsw.gov.au/government-and-regulation/legislative-and-regulatory-requirements/service-installation-rules*
[29] *https://researchmgt.monash.edu/ws/portalfiles/portal/312930471/303543806_oa.pdf*

generator to operate as the primary generator with grid back up or the main grid to operate with DER back up. When the DER is operating independently from the grid it is considered to be operating in island mode and will continue to generate energy for the local load[30].

4.3.2. Virtual Power Plant (VPP)

A virtual power plant is a network of decentralised energy generation sites, typically solar, wind and storage technologies, which are distributed through a central virtual controller. Essentially the controller aggregates numerous small generation sites into a single entity which can then interact with the NEM as if it were a large power station. The controller is owned privately either by an organisation (such as a retailer), collection of owners or an individual and can operate as a single generator for distribution and trading purposes. In contrast to an embedded network, a VPP can be a collection of generators that are located across a large area and do not need to be directly connected[31]. The controller can monitor generation and weather forecasts from multiple sites and optimise the distribution across multiple loads and export opportunities. All connections to a VPP require a stable internet connection.

4.3.3. Simple transactions and Virtual Net Metering

A simple trading arrangement offers participants the opportunity to generate a secondary income via established schemes such as feed-in tariffs or the sale of STCs or LGCs.

Virtual Net Metering (VNM) is an arrangement which allows a participant with on-site generation to allocate excess generation as a credit to other sites owned or linked by the participant. In reality, there is no physical transfer of energy between the two sites – the excess generation is exported to the grid, and the receiving site is supplied by the grid.

In addition to reduced energy charges, VNM can allow for additional savings on network costs, if the generating and receiving sites are located within the same distribution network area. The network cost saving is referred to as a 'wheeling' charge and is illustrated in the figure below[32].

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[30] *https://westernpower.com.au/our-energy-evolution/grid-technology/microgrid-technology/*
[31] *https://www.next-kraftwerke.com/vpp/virtual-power-plant*
[32] Langham, E., Cooper, C. & Ison, N., 2003. *Virtual net metering in Australia: Opportunities and Barriers;* University of Technology, Sydney

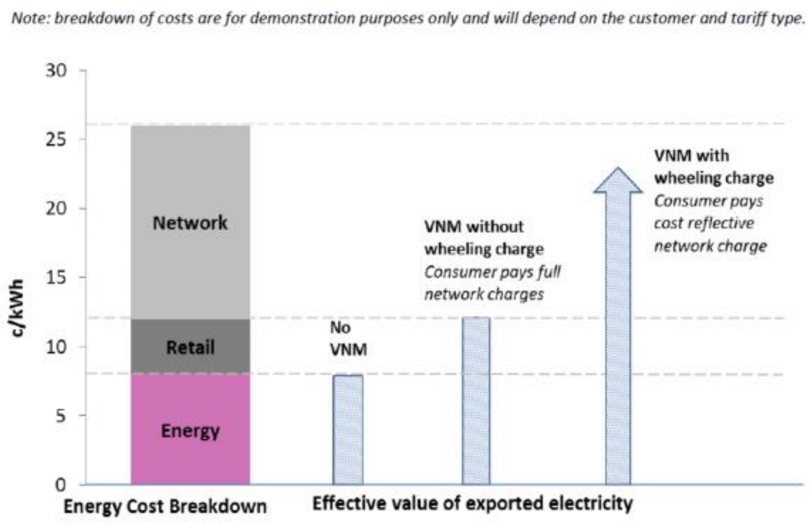
Note: breakdown of costs are for demonstration purposes only and will depend on the customer and tariff type.

Figure 10: Potential value received for electricity exported to the grid (Source: UTS)

Broadly speaking, virtual net-metering between participants can also be considered a simple transaction.

4.3.4. Community Energy

Community Energy is a trading strategy similar in principle to a simple trading strategy however the owner of the DER is a community conglomerate. Through this arrangement, community shareholders support initial capital expenditures of the installation of the DER facilities and in return, are afforded cost savings or potential revenue generation and energy security benefit from the local generation[33].

In this configuration, the community would be responsible for the management of the control facilities and would have ownership of the agreement with an electricity retailer. Dependant on the arrangement, the participating farmer may be a majority shareholder, lease the land to the community for the generation, partner with the community conglomerate or other methods of ownership.

Community generation is an established trading strategy within Australia, one of the most notable examples being Hepburn Wind, which is a community owned generator comprising of two wind turbine generators with the ability to generate 4MW of power.[34] Hepburn Wind is currently a GreenPower certified generator.

4.3.5. Peer to Peer Trading (P2P)

Peer to peer (P2P) energy trading sees participants of the energy distribution network buy and sell energy directly with each other encouraging multi-directional trading locally. Participants can act as energy producers, energy consumers or both – a prosumer. This diversity is particularly important when using renewable energy for generation as it allows flexibility in generation and consumption,

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[33] *https://www.advisian.com/en/global-perspectives/community-microgrids---offering-grid-modernization-and-community-development*
[34] *https://www.hepburnwind.com.au/wind-farm/*

that is, when one generator is experiencing conditions that prevent optimal generation, another generator that is experiencing a surplus of generation can support the other directly[35].

Utilising online trading platforms, peers either operate as individuals or a community can aggregate as a single, active entity on the market. The controller is a key element in P2P trading enabling participants to manage their trading arrangements, configure preferences and risk profiles; for example, preventing export of power when prices are below a certain threshold.[36] Once parameters have been established the controller and virtual platform will automate day-to-day transactions.

4.4. Test scenario development: Financial and administrative considerations

DER projects are often determined feasible based on on-farm technical constraints. Renewable generation, battery storage and back-up generation are in the main mature technologies with well understood and accessible solutions to most on-farm limitations. Commercial feasibility, however, often presents significant challenges to projects with careful consideration needed regarding:

- Up-front capital investment – many primary industries producers have limited access to capital which can preclude their involvement in DER projects
- Return on investment – DER participants are seeking to leverage the best return on investment they can, stakeholders indicated a simple payback period of between 5-8 years is considered attractive.

In addition, via consultation, stakeholders indicated primary industries participants are time and resource poor, with minimum availability or interest, in administrating a complicated trading arrangement. In conclusion, DER projects must be simple and straightforward to action and understand, deliver an attractive return on investment and require minimal up-front capital investment.

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[35] *https://www.sciencedirect.com/science/article/pii/S2211467X19301105?via%3Dihub#bbib23*

[36] *https://www.sciencedirect.com/science/article/pii/S0306261918303398*

5. Feasibility of test scenarios

The following sections detail the outcomes of the high-level feasibility assessments completed for each of the test scenarios. The feasibility assessments ask fundamental questions of the trading, commercial and technical arrangements to identify ideal pathways for deployment which take account of any challenges or barriers posed.

5.1. Scenario One: Virtual net-metering

Under scenario one, individual participants would deploy on farm renewable generation (e.g., solar PV) with any excess generation exported to the grid and purchased directly by a large industrial user via a commercial arrangement. This would provide individual participants with an additional revenue stream and the industrial user access to a competitive retail price and low carbon electricity.

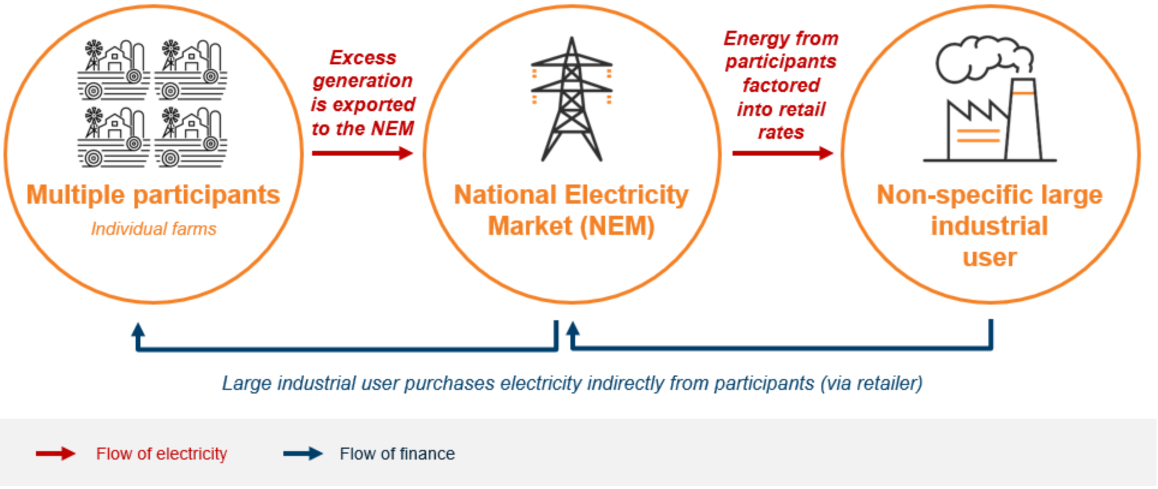

Figure 6: Scenario One explores peer-to-peer energy

5.1.1. Feasibility of the trading arrangement

Scenario One is based on a virtual net metering arrangement between participants with the individual farms exporting excess renewable generation as 'credit' which is then purchased by the large industrial user.

The advantage of a VNM arrangement is that is allows participants to install renewable energy generation where optimum resources exist with less consideration of individual site loads. This is particularly pertinent for the dairy sector which has a load profile that is almost completely offset to the peak generation of a PV system.

This is a wholly virtual arrangement, in real terms electricity is exported and supplied by the grid. As all participants are connected to the NEM, under the *National Energy Retail Law (NERL)* the netting off of the credit between meters must be undertaken by a registered retailer.

The retailer's role is to calculate the metering credits and if applicable, wheeling charges, and charge the industrial customer accordingly while passing through the payment to the supplier farms.

Very few retailers are currently implementing VNM and those that do offer the service usually add a premium or administrative charge. The electricity market operates on a low-margin high volume model. A VNM arrangement between a handful of participants does not present an attractive value proposition and can increase the risk exposure of the retailer.

5.1.2. Commercial feasibility

The successful deployment of Scenario One relies on the commercial arrangements resulting in an attractive return on investment for participants. Fundamentally the price at which the industrial user will purchase export from the participants must exceed that of a standard feed-in tariff from a retailer.

Large scale industrial energy users, particularly those with stable loads, would currently be able to negotiate unit prices of less than $60 per MWh (6 cents per kWh) from their electricity retailer. As Scenario One requires a retailer to facilitate the transaction, the export purchase price passed through to participants will be lower than $60 per MWh to account for the retailer administration charges and risk premium. Note that such level of compensation is not too different from the NSW solar feed-in tariff benchmark set by IPART for 2020-21 (benchmark range 6 to 7.3 cents per kWh with expectations that will be drop because of recent price suppression experienced in the middle of the day in the wholesale spot price).[37]

As with many DER projects, Scenario One would benefit from economies of scale as it would attract the interest of electricity retailers. However, the larger the solar exported volume the more uncertainty there will be for the large industrial user buying this exported power as it will be entering into a contract with a buying price potentially higher than what it could get at the middle of the day from its electricity retailer without the VNM arrangement.

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[37] *https://www.ipart.nsw.gov.au/files/sharedassets/website/shared-files/pricing-reviews-energy-services-publications-solar-feed-in-tariffs-202122/information-paper-solar-feed-in-tariff-benchmarks-february-2021.pdf*

5.1.3. Technical feasibility

Solar PV systems are a mature technology, and any limitations of on-farm infrastructure can be rectified with tried and tested solutions. There are however potential technical constraints when considering the connection of the solar PV system to the local distribution network. Essential Energy will automatically approve energy export for generation up to $30kW_{peak}$ per connection point[38]. Generators with capacity exceeding 30kW require technical enquiries or a "Contestable Works" review before approval. Essential Energy may require customers to financially contribute to any necessary upgrades to the local network infrastructure.

5.1.4. Summary

While attractive in principle the commercial arrangement of Scenario One is limited by regulatory requirements associated with trading energy as NEM connected entities. Although an electricity retailer could facilitate the transaction, commission and contracting arrangements would likely preclude participation. The value proposition of Scenario One also relies on the industrial user potentially purchasing exported electricity at a premium to the price of electricity it can get from the grid in the middle of the day. Unfortunately, current market conditions are resulting in low unit costs for consumers (around $60 per MWh flat equivalent for retail charges). It is unlikely the industrial user would be willing to accept a feed-in tariff at much higher level than electricity retail import prices to support the project except if it values other non-financial benefits (e.g, greening its supply chain, supporting its suppliers).

Scenario One would benefit from economies of scale and the aggregation of like-minded participants. As all participants would need to enter into a retail contract with the facilitating retailer, if enough participants were interested in a VNM configuration a retailer may be more inclined to accommodate the contractual arrangement as a means to expanding their customer portfolio. The Department would be well placed to support the networking of interested participants and their aggregated approach to a retailer.

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[38] *https://www.essentialenergy.com.au/-/media/Project/EssentialEnergy/Website/Files/Our-Network/ConnectingToTheNetworkInfoPack.pdf?la=en&hash=1F2904E1CAC85018B09131FCB3878CD48F820F30*; *https://engage.essentialenergy.com.au/ec*

5.2. Scenario Two: exploring secondary revenue streams

Scenario Two focuses on a single participant. The participant uses upfront capital to install a grid-connected medium scale renewable resource (up to 500kW)[39]. With significant excess generation the participant wishes to explore the options for generating a secondary revenue stream via on selling the excess generation. This scenario explores the viability of common revenue generation options which primary industries participants may be aware of, including Feed-in Tariffs (FiTs), Small Technology Certificates (STCs) and Large Generation Certificates (LGCs).

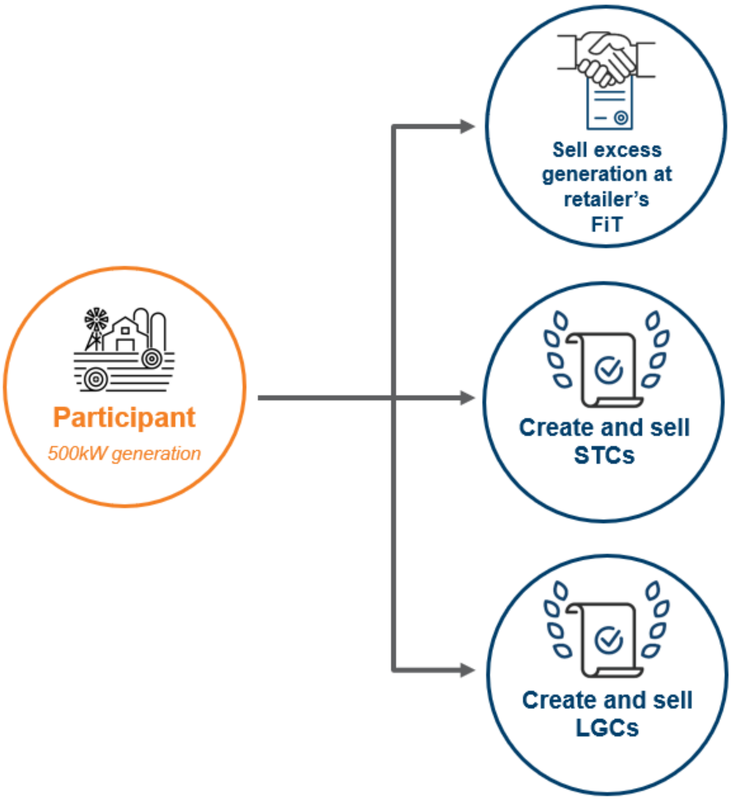

Figure 7: Scenario Two examines the potential revenue streams from large-scale renewable generation.

5.2.1. Feed-in Tariffs and Small Technology Certificates

Renewable energy generators can receive a Feed-in Tariff (FiT) for exporting electricity to the grid by entering into an agreement with an electricity retailer. FiTs offered vary depending upon the retailer and location of the system. Alternatively, the Renewable Energy Target set by the Federal Government rewards the generation of renewable electricity via the Small Technology Certificate (STC) mechanism. In most cases the STCs are treated as a rebate with a participant agreeing to

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[39] Other funding/financing arrangements exist whereby, for example, the end-user enters into a long-term power purchase agreement with a power producer who will design, build, operate and maintain the on-site solar system during the term of the agreement. This power producer will organise equity funding and debt provision from lenders and will be paid a pre-agreed power purchase price by the end-user for the use of on-site generated electricity and possibly the provision of large-scale generation certificates.

sell all generated certificates to the solar PV installer in return for a discount on the initial installation cost.

In the case of Scenario Two however, the size of the system would preclude the participant from receiving a feed-in tariff from a retailer. A retailer-sponsored FiT scheme is generally limited to domestic customers and many retailers cap generation capacity at 10kW. The participant would also be excluded from generating STCs which have a maximum generating capacity of 100kW.

5.2.2. Large generation certificates

The key policy framework to support the uptake of large-scale renewable energy generation in Australia has been the Commonwealth Government's Renewable Energy Target (RET) scheme, which is designed to incentivise the supply of 33,000 GWh of renewable generation from "large-scale systems" by 2020. The current target is legislated until 2030.

To achieve this annual target of 33,000 GWh, eligible power stations over 100kW capacity can create LGCs, which are bought by liable entities to meet their renewable energy obligations.[40] Liable entities, mostly retailers, must surrender a volume of LGCs (i.e., compliance LGCs) equivalent to the RET percentage specified by the Clean Energy Regulator (CER) in a given year (Renewable Power Percentage per calendar year).

Trading via a market mechanism means LGC prices are not fixed, and their value may increase or decrease over time. Table 5 details the current spot market price for LGCs and the forecast trend in value over the next three years.

Table 5: Current LGC spot trading price as of 21/04/2021 and forward prices to 2024

LGC vintage	Price
Spot trading	$ 33.75
CAL 21	$ 34.00
CAL 22	$ 27.25
CAL 23	$ 19.60
CAL 24	$ 10.60

As seen in Figure 11, LGC prices across all contract years have risen over the last twelve months. This is mainly due to delays in renewable generators coming online; speculation about medium term additional demand due to liable entities, mostly electricity retailers, carrying forward large-scale generation shortfalls[41]; as well as increasing demand for renewable energy certificates from Australian corporations.

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[40] Solar system up to 100kW may be eligible to create small-scale technology certificates (STCs). Whilst an STC may be used as an avoided emissions reduction instrument it seldom is used for this purpose.

[41] http://www.cleanenergyregulator.gov.au/RET/Pages/Scheme%20participants%20and%20industry/Renewable%20Energy%20Target%20liable%20entities/Scheme%20compliance/Certificate-shortfall-register.aspx

These forward price curves are also showing that each year out there is a significant price reduction due to the expectation that more renewable capacity will come online in later years, meaning more supply of certificates.

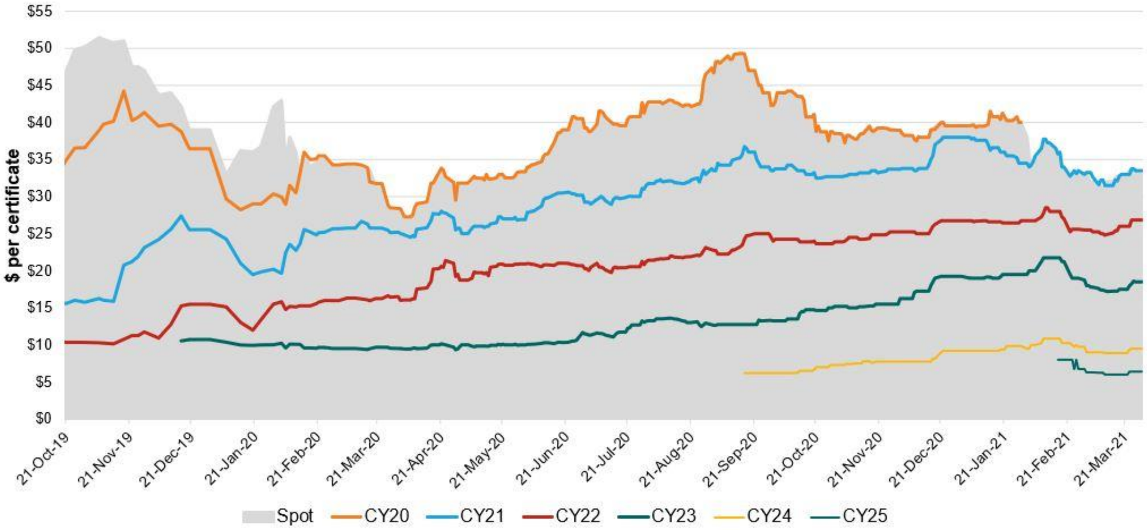

Figure 11: LGC spot trading and forward prices (sources: High Voltage Brokers, Energetics)

Table 6 and Table 7 outline the different factors that are likely to impact the price of LGCs from both a demand and supply side perspective.

Table 6: Domestic demand drivers and directionality of anticipated price impacts

Driver	Key impacts on demand	Price impact?
Growing interest from corporates to achieve net-zero	The substitute use of LGCs as a high quality “avoided emissions” instrument to support carbon reduction strategies. This is inextricably linked to the growing commitment by corporates to net zero targets, Science Based Targets, and carbon neutral commitments. Therefore, in the long term, the LGC floor price is expected to be set by the relative emissions reduction value of an LGC, compared to the price of a tonne of carbon as reflected in the price of an Australian Carbon Credit Unit. A continued demand for LGCs will maintain price levels, even following the achievement of the RET.	↑
Shareholder activism	A rise in shareholder activism has been witnessed in recent years. This increased desire for climate leadership by the companies may lead to an increase in demand for LGCs.	↑
State Government initiatives and emissions reductions	All state and territory governments now have targets for net zero emissions by 2050.Over time policies to achieve the targets are likely to stimulate both demand and supply for LGCs. Further increases in renewable energy targets, such as the one in Victoria announced following its election win (50% by 2030) would greatly incentivise the uptake of renewables and increase demand of LGCs.	↑
Demand for ‘green’ hydrogen	Hydrogen is an emerging technology that the Australian Government has chosen to invest considerable research and development in. Industry and the Government both view a domestic industry as possessing severe competitive advantages vis-à-vis global	↑

Driver	Key impacts on demand	Price impact?
	competitors. Any upscaling in hydrogen technology to produce ‘green’ hydrogen will result in a significant rise in demand for LGCs to be able to claim the production pathway as being ‘green’.	
Policies of a future government increasing the RET	A future Commonwealth Government may decide to increase the RET. This would require retailers to meet more of the electricity they supply to be backed by LGCs, increasing the demand for the certificates.	↑

Table 7: Domestic supply drivers and directionality of anticipated price impacts

Driver	Impact on supply	Price impact?
Investment in renewable energy projects slowing down	The pace of investment in renewable energy assets has somewhat slowed since 2019 due to a range of factors, including network connection challenges, grid constraints (existing renewable energy generators facing production curtailment by the market operator), a softening in electricity prices (increasing merchant risk and reducing offtakers’ interest). These impacts are playing out over the short, medium and long term.	↑
Deferral of obligations	The rules of the scheme allow liable entities to defer their obligations, lending price support to LGCs for some years beyond 2020. If liable entities, mostly electricity retailers, choose to carry forward their obligations in the term, this will lead to a softening in short term demand, and increased demand in the medium term and more speculative behaviour from LGC holders.	↑
Increased decarbonisation efforts of the electrical grid	The NEM is going through a period of unprecedented change, characterised by an almost unanimous replacement of existing generators with renewables. This influx of supply will subsequently lead to large volumes of certificates entering the market.	↓
Delays in transmission investment	The rise in variable and distributed forms of generation are leading to projects being built in parts of the grid where not enough transmission infrastructure has been built. This has led to a large backlog of works required to unlock the potential of some of Australia’s highest yielding renewable resource regions. Any delay in this transmission network augmentation will likely lead to a delay in renewable energy investment decisions and consequently result in a shortening of supply.	↑

5.2.3. Wholesale market participation

Under scenario two, the participant could participate in the wholesale market and sell electricity to retailers. According to the National Electricity Law, any person that owns, controls or operates a generating system in the NEM must register as a generator with AEMO. However, there are exemption criteria, including automatic exemption for a generator with capacity less than 5MW.

5.2.4. Technical feasibility

A key technical barrier to this scenario is the capacity of the local network and the ability to regulate grid voltage. The management of voltage issues in the low voltage (LV) network can limit the amount of generation that can be exported to the grid. Automatic management of voltage issues occurs via in-built inverter settings and response modes such Volt-VAR and Volt-Watt in solar PV systems. These settings and response modes cause the system to trip when voltage exceeds or falls below the relevant network limits, when solar generation peaks and dips at different times of the day respectively[42].

In addition to inverter characteristics and settings, distribution network service providers (DNSPs) have started to restrict the level of electricity that DERs can export to the grid[43]. Whether a customer is constrained from exporting will depend on a range of factors, including timing of DER exports on a given day, local network characteristics and how the participant is connected to the network[44]. Accordingly, some participants face very low or even zero export limits in areas of the LV network with high levels of solar PV penetration[45]. As DER uptake increases, DNSPs have signalled that export limits are likely to be reduced even further.

For rural participants, Essential Energy will automatically approve energy export of 30kW per connection point[46]. Generators with capacity exceeding 30kW require technical enquiries or a “Contestable Works” review before approval. Essential Energy may require customers to financially contribute to any necessary upgrades to the local network infrastructure. Given the higher penetration of solar PV per customer, longer LV network line length per customer and higher proportion of rural customers relative to other networks, Essential Energy imposes hard static limits at the time of connection[47].

At present DNSPs have limited visibility over their LV networks (in terms of voltage level at connection points).[48] With improved visibility, DNSPs could impose dynamic export limits that vary over time and location. This would involve DNSPs taking on a more active role in managing flows in their networks by remotely communicating with the active DER, such as batteries, to allocate spare export capacity on a locational and time-varying basis. Under this solution, DNSPs would only need to constrain DER output in certain circumstances, therefore increasing the amount of generation that could potentially be exported to the grid. Essential Energy has taken steps towards implementing dynamic export limits through its “Network Visibility Trial Program”.[49] This aims to establish what level the network can host DER and allow for cost-efficient dynamic network management. The market operator is also fast-tracking requirements for short duration voltage disturbance ride-through for all new distributed PV inverters in South Australia (and Western Australia, with other NEM regions encouraged) and investigating the need for updating existing distributed PV fleet to comply with short duration voltage disturbance ride-through requirement.

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[42] *https://www.aemc.gov.au/sites/default/files/2019-09/Final%20report%20-%20ENERFR%202019%20-%20EPR0068.PDF*

[43] *https://www.aemc.gov.au/sites/default/files/2019-09/Final%20report%20-%20ENERFR%202019%20-%20EPR0068.PDF*

[44] *https://www.ipart.nsw.gov.au/files/sharedassets/website/shared-files/pricing-reviews-electricity-publications-electricity-distribution-reliability-standards/consultant-report-houston-kemp-distributors-incentives-to-efficiently-incur-der-export-expenditure-july-2020.pdf*

[45] *https://www.aemc.gov.au/sites/default/files/2019-09/Final%20report%20-%20ENERFR%202019%20-%20EPR0068.PDF*

[46] *https://www.essentialenergy.com.au/-/media/Project/EssentialEnergy/Website/Files/Our-Network/ConnectingToTheNetworkInfoPack.pdf?la=en&hash=1F2904E1CAC85018B09131FCB3878CD48F820F30*; *https://engage.essentialenergy.com.au/ec*

[47] *https://www.ipart.nsw.gov.au/files/sharedassets/website/shared-files/pricing-reviews-electricity-publications-electricity-distribution-reliability-standards/consultant-report-houston-kemp-distributors-incentives-to-efficiently-incur-der-export-expenditure-july-2020.pdf*

[48] *https://www.ipart.nsw.gov.au/files/sharedassets/website/shared-files/pricing-reviews-electricity-publications-electricity-distribution-reliability-standards/consultant-report-houston-kemp-distributors-incentives-to-efficiently-incur-der-export-expenditure-july-2020.pdf*

[49] *https://www.essentialenergy.com.au/our-network/network-projects/network-innovation*

AEMO collaborates with the solar industry, through Standards Australia committees, to progress an update to the national standard for distributed PV inverters (AS/NZS4777.2) to incorporate bulk system disturbance withstand and autonomous grid support capability.[50]

5.2.5. Summary of findings and pathway to deployment

Under Scenario Two we assumed the deployment of a solar PV system with 500kW generating capacity. At this level the participant is precluded from generating small technology certificates or negotiating a feed-in tariff with a retailer. The participant has two remaining options, generating large generation certificates and selling export on the wholesale market.

Both of these options have significant administrative complexities which are unlikely to be viewed as a wise investment of time and resource by primary industries participants. Additionally, the long-term outlook of falling LGC prices presents little incentive for investment.

Examples of primary industries participants achieving attractive returns through deployment of DER is predominantly limited to large scale systems. AAM successfully installed 1.4MW of solar PV and a 2.28MWh Tesla lithium-ion battery at their Riverland poultry farm. Requiring a circa $5M investment the scheme is expected to reduce emissions by around 60%. Through the use of battery storage AAM are able to trade on the wholesale market, selling export during high price events and purchasing during periods of low demand when prices fall. Through lucrative trading arrangements AAM are able to achieve an excellent return on investment.

AAM as a large enterprise have the capacity to employ dedicated resource and independent experts to facilitate the design, installation, commissioning and operation of a DER project. This is out of scope for most primary industries participants. It should also be noted that the AAM project was supported by $1.3M of funding from the South Australia government. These funds helped to improve the viability of deploying battery storage. Although prices are falling, payback periods for batteries are still over ten years.

Fundamentally the optimum value proposition for on-site renewable generation remains sizing the system to meet the on-site loads, offsetting the purchase of grid electricity, with little or no export to the NEM. At which point the main barrier for participation is access to capital to deploy the system. Alternative financing arrangements are available, such as on-site Power Purchase Agreements (PPAs) and land lease arrangements. Under these arrangements a contractor covers the cost of system installation and enters a long-term contract with the participant agreeing a purchase price for the generated electricity. At the end of the contract term there is often a mechanism for the participant to take ownership of the system for a reduced cost.

There is currently a gap in provision of accessible independent advice for primary industries participants wishing to explore options such as on-site PPAs and land lease arrangements. The market is increasingly competitive which can lead to participants struggling to compare proposals and evaluate the relative benefits of different arrangements. The Department is well placed to develop and sign-post participants to independent information sources and resources to aid decision making and possibly to set up a buying group for sourcing of such power generation systems, thus increasing buying power and reducing transaction costs per participating entity.

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[50] *https://aemo.com.au/en/energy-systems/major-publications/renewable-integration-study-ris*

5.3. Scenario Three: Grid-connected microgrid

Under Scenario Three, several geographically local participants connect their generation capacity and loads in a private microgrid. Each participant is individually metered to allow pro-rata billing and revenue distribution. A single connection links the microgrid to the NEM allowing excess generation to be sold and additional energy to be purchased should there be a shortfall.

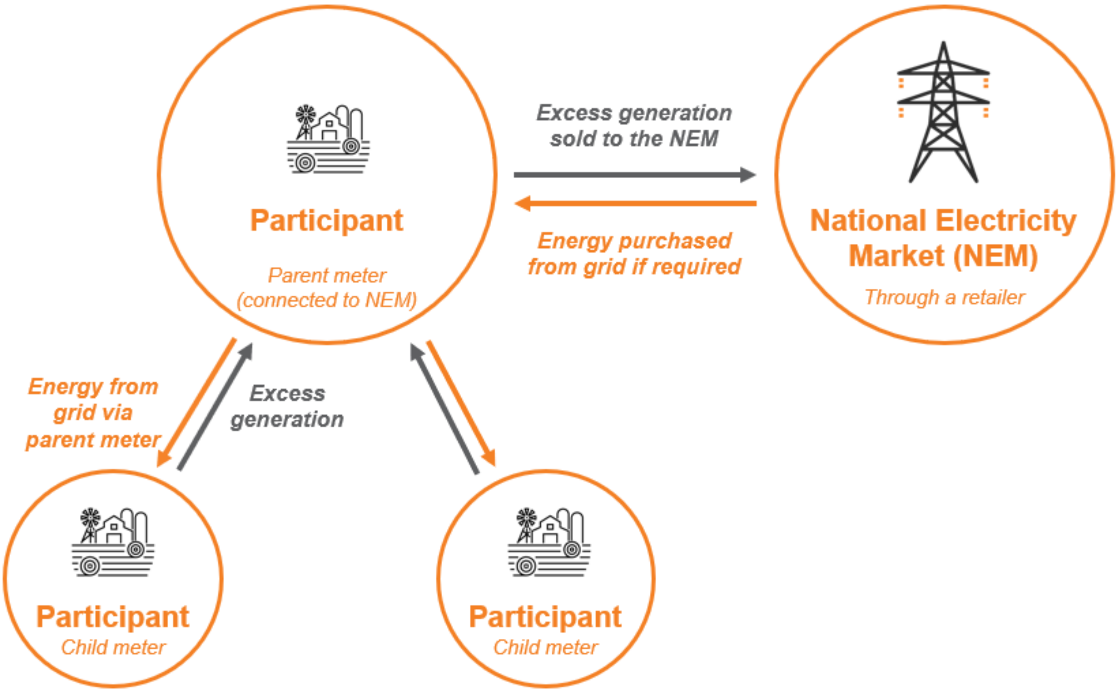

Figure 8: Scenario Three investigates the potential of grid connected microgrids.

5.3.1. Microgrids as embedded networks

An embedded network allows multiple customers to connect to the main electricity grid at one connection point. Typically, this arrangement will entail one entity or individual 'owning' the energy generation and then on-selling to additional parties directly connected and supplied from the generator and likely involves individual metering of supply[51]. Under current regulations Scenario Three would be considered an **embedded network** and must therefore comply with all associated legal requirements.

Under the *National Electricity Law* (*NEL*) and *National Electricity Rules* (*NER*), anyone who intends to sell electricity through a private embedded network must, in addition to gaining retailer authorisation or exemption under the *NERL*, register with the AEMO as a network service provider or gain an exemption from this requirement from the AER[52].

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[51] *https://www.aer.gov.au/consumers/information-for-electricity-consumers-in-embedded-networks*

[52] Australian Energy Regulatory, Electricity Network Service Provider – Registration Exemption Guideline version 6, March 2018 *https://www.aer.gov.au/system/files/AER%20electricity%20NSP%20Registration%20Exemption%20Guideline%20-%20Version%206%20-%201%20March%202018.pdf*

Network configuration

For geographically local farms to form a grid-connected microgrid, one of the farms would be connected to the NEM via a "parent meter." This farm ("parent farm") would be responsible for facilitating the collective purchase of electricity from the grid as required by the farms and the export of excess power generation. According to the *Network Exemption Guideline*, all paid energy consumption must be metered except where the AER has determined an unmetered supply is permitted. This typically only occurs in unique situations where no charge is levied for electricity for example. The other farms would therefore require "child meters" (not NEM-connected), allowing the parent farm to accurately bill each of the farms separately for the back-up electricity they use from the grid and reimburse them for their contribution to the electricity generation sold back to the grid.

As the *Network Exemption Guideline* is currently framed, the above arrangement is considered an embedded network and possibly falls into registrable exemption NR6 *Persons supplying metered or unmetered energy to small customers at a site or premises adjacent to a site that they own, occupy or operate*. The parent farm would be considered the operator of the network and would therefore need to register the exemption with the AER. If NR6 does not apply, the parent farm would need to apply for an individual exemption which would need to be assessed by the AER.

The parent farm would need to comply with various obligations which have been imposed to promote consumer protection within private networks. Operators must, among other things:

- Ensure that their network is safe
- Have a dispute resolution mechanism
- Ensure that network pricing is compliant
- Ensure that electricity meters are compliant.

Gaining exemption

The AER's Network Exemption Guideline outlines deemed and registrable exemptions. These class exemptions apply to certain groups of participants or classes who sell or supply energy to a third party. Generally, deemed exemptions are targeted towards individuals or businesses who sell or provide a connection to electricity incidentally, for example a landlord with multiple tenants. Energy sales and supply is not their primary business or is an incidental part of their business model. An individual exemption is required where no class exists which covers the activities for which the applicant seeks exemption.

Many of the arrangements that would be suitable for use by primary industries participants likely fall within the deemed class of exemption, NDO1: *Off–market energy generation by equipment owned, operated or controlled by a third party and connected to the NEM via a private electricity connection or equipment intended solely to provide emergency energy supply, or third–party renewable energy system providers*. No application is required since deemed exemptions are automatic.

If the participant wishes to supply network support or market-driven demand response, the network to which the generator is connected must be registered under NRO1, a registrable class of exemption. This exemption is not automatic and must be registered by completing an online form on the AER website. Despite this, obtaining an exemption is relatively easy and low cost (there is no application fee).

Although obtaining network exemptions for the above configurations is straightforward, the obligations of exempt network operators are onerous due to the need to ensure a sufficient level of consumer protection.

As the AER acknowledges in its Network Exemption Guideline:

> *… there are significant regulatory hurdles which must be overcome before a microgrid or private selling of excess electricity can be implemented. We will work with proponents to develop models that respect and enhance the rights of customers to access new energy options but our ability to facilitate microgrids is limited by the constraints of the current regulatory framework.*

It should be noted that regulatory changes are underway to bolster protections and access to more competitive retailer offers for consumers in embedded networks[53]. The scope of the exemption framework will be narrowed which will increase the regulatory requirements that embedded network operators will need to comply with.

Selling electricity to microgrid participants

As explained previously, according to the *NERL* any person who sells energy to another person for use at premises must obtain either a retailer authorisation or a retail exemption from the AER. The parent farm will require a retail exemption since it would be responsible for buying electricity from a retailer from the grid and on-selling to the child farms. This arrangement does not fall within any of the deemed or registrable exemption classes outlined in the *Retail Exempt Selling Guideline*, meaning the parent farm would need to apply for an individual exemption.

The participants could form a separate legal entity (for example an incorporated association or distributing co-operative) and seek exemption for this legal entity. This could provide protection to participants from liability arising from contractual disputes in relation to the purchase and sale of electricity.

Regardless of the setup the parent farm or legal entity will be responsible for the generation of bills, on-charging of electricity and disbursement of revenue generated from export generation.

5.3.2. Microgrid development costs

The feasibility of Scenario Three must also consider the practicability and cost associated with installing the microgrid infrastructure. Existing infrastructure will typically be owned by the local and regulated distribution network service provider (Essential, Endeavour or Ausgrid in NSW) who has no interest in selling its network assets. In this case participants, or an outsourced solution provider, will be responsible for the construction of the required infrastructure adding significant time and costs.

Further, according to the *Network Exemption Guideline*, State or Territory approval is required for private wiring to cross a site boundary or public land. Typically, only an electricity distributor registered with the AEMO is authorised to provide this service.

Assuming a microgrid can be built, the legal entity responsible for operating the microgrid as an embedded network attached to the NEM will be responsible for the on-going cost of maintenance

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[53] *https://www.aemc.gov.au/market-reviews-advice/updating-regulatory-frameworks-embedded-networks*

and compliance. Any connection agreement will impose rigorous testing and verification of safety equipment all of which require administrative resource, time, and finance.

To facilitate the grid connection the DNSP may request participants financially contribute to any necessary upgrades to the local network infrastructure.

5.3.3. Summary and ideal pathway to deployment

There are significant regulatory, technical and commercial barriers to the deployment of grid connected micro-grids. While micro-grids may offer a range of benefits to remote and rural communities, systems which plan to interact with the NEM will always face considerable obstacles.

The treatment of NEM connect microgrids as embedded networks requires participants to comply with rigorous and onerous regulations. In a 2017 report, the AEMC found that under the current regulatory regime, many embedded network customers are not able to access retail competition or other important consumer protections.[54] To enhance consumer protection these policies are currently under review and are only set to become more stringent.

In 2019 the AEMC outlined final proposed legislative and rule changes to address these issues, which have yet to be implemented.[55] Once these changes are implemented, a parent farm attempting to operate a grid-connected microgrid will be required to register with AEMO as an Embedded Network Service Provider (ENSP) – and cannot gain an exemption from the AER. It would be subject to similar regulatory requirements that currently apply to DNSPs, and all child connection points would need to be registered with the AEMO to improve access to retail market competition.

Further, under the new framework the parent farm as an on-seller of electricity would be required to obtain a form of retailer authorisation from the AER and would be subject to most of the requirements affecting existing authorised retailers.

In addition, the cost and regulation surrounding the deployment of the initial infrastructure, coupled with the ongoing maintenance will prevent mass uptake. Any participants wishing to explore the option of operating a NEM connected micro-grid will need considerable support in the areas of financing, legal obligations and technical design.

The deployment of a grid connected micro-grid is a complex undertaking requiring significant capital investment, time and resource to navigate technical and regulatory constraints. As a purely commercial undertaking a micro-grid arrangement makes little sense. However, for remote and rural communities they offer a pathway to building resilience and energy security. This is particularly pertinent for areas where the distribution network may be exposed to single points of failure and / or the area is exposed to the impact of catastrophic events such as cyclones and bushfires.

In these circumstances the Department could leverage expertise to help co-ordinate participants, support collaboration between communities, DNSPs, local Government, State Departments and Federal Agencies, and identify funding pathways.

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[54] *https://www.aemc.gov.au/market-reviews-advice/updating-regulatory-frameworks-embedded-networks*

[55] *https://www.aemc.gov.au/sites/default/files/2019-06/Updating%20the%20regulatory%20frameworks%20for%20embedded%20networks%20-%20FINAL%20REPORT.PDF*

5.4. Scenario 4: Virtual trading network

Scenario 4 explores an innovative trading arrangement which allows participants with on-site renewable energy generation to buy and sell energy to one another via a virtual trading platform. The virtual trading platform matches participants supply and demand in the most cost effective manner and exports any surplus to the NEM via a retailer. Should the generation portfolio not match demand, the shortfall is purchased as a normal transaction between the participant and their chosen retailer.

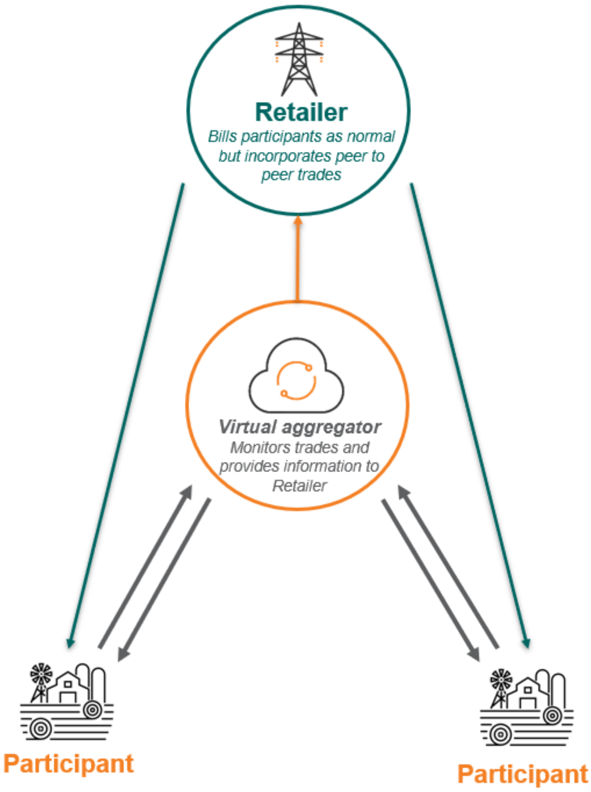

Figure 9: Scenario Four investigates the feasibility of an innovative virtual trading arrangement.

5.4.1. The future of energy trading?

A core limitation of scenario one is the requirement of the transaction between participants to be facilitated by a retailer. The reluctance of a retailer to be involved in such a scheme is predominantly driven by a poor value proposition; essentially a retailer cannot make enough of a profit to justify taking the market (volume and price) and credit risks related to such an intermediary role.

Under scenario four an intermediary virtual aggregator monitors import and export between participants via smart metering or a dedicated hardware solution[56]. The participants agree a single import/export price with the aim to settle on a c/kWh value which is greater than a standard FiT but less than standard unit purchase rates. In this manner the exporting party secures a higher

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[56] https://www.rethinksustainability.com.au/wp-content/uploads/2021/04/ReThink_Virtual-Energy-Network_Sept2020.pdf

revenue while the purchasing party saves on their energy bill. Ideally participants would have offset generation and load profiles to enable maximum return on investment.

The virtual aggregator is responsible for negotiating contracts with an AEMO registered retailer on behalf of participants. Whereas scenario one only brought a handful of participants to a facilitating retailer, under scenario four the aggregator can present a portfolio of customers to a retailer which is far more attractive. In exchange for facilitating the netting-off of energy between participants each participant must enter into a standard retail contract. In this manner a retailer is able to grow their customer base.

For participants the virtual trading of energy simply appears as an additional line item on their standard energy bill from the retailer. Participants are free to switch retailers at any time, noting that doing so will effectively remove them from the trading portfolio.

The aggregator operates via a subscription model with participants paying a monthly fee per meter point for inclusion in the trading portfolio. Under this arrangement participants can easily determine if the size of their export would result in a net-gain over the course of a year.

Scenario four is still in its infancy within Australia. While it offers a straightforward and engaging value proposition there are limitations such as:

- only a handful of retailers currently participate in such schemes
- savings on network charges are not universally applied and must be negotiated individually
- very few aggregators are currently operating in this space.

It should be noted that the technical barriers related to deployment of grid connected DER, such as export restrictions and on-farm infrastructure limitations, plus the need to secure up-front capital for installation still exist in this scenario.

5.4.2. Summary and pathway to deployment

For participants who are able to install on-site renewable electricity generation, scenario four presents an excellent opportunity for reducing electricity expenditure and potentially generating secondary revenue. The nature of the electricity market is changing with a push for greater diversity in trading arrangements and accessibility for participants. While still in its infancy, scenario four could cause a fundamental shift in the dynamic of the retail electricity market.

As a new opportunity independent advice and guidance which clearly explores the benefits and potential risks to participants is needed. The NSW DPI Energy Efficiency Solutions project is piloting technologies to improve energy efficiency and deploy clean energy solutions at ten farm sites around NSW. In particular three pilots are trialling electrification, solar PV, flow batteries and peer to peer energy trading systems at three farms; Rosnay Organic Wines, The Pines Dairy and Pecora Dairy. A full review of the scheme, including engagement from participants, DNSPs, the aggregator and retailer should be undertaken to help develop materials and tools to aid and inform deployment across the primary industries sector.

6. Key findings

Distributed energy resources present a range of attractive value propositions to primary industries, particularly, reducing electricity costs, lowering emissions, diversifying revenue streams and improving power resilience in remote and rural communities. However, through the exploration of the four test scenarios a range of regulatory, technical and commercial barriers to deployment have been identified.

The test scenarios were selected based on their appeal to small and mid-sized primary industries participants. Reviewing the outcomes of the test scenario has identified four areas where support for such participants could be improved:

- DER value propositions,
- Access to independent expertise and guidance,
- Transmission infrastructure accessibility, and
- Regulatory support.

The above areas are discussed in detail in sections 6.1 to 6.4.

Although there are barriers, there are also opportunities to be leveraged. In the case of virtual net metering economies of scale are paramount to securing a facilitating retailer. Although secondary revenue streams do not pose a realistic value proposition, on-site renewable generation still holds a number of benefits, including reducing retail and network electricity charges, and improving electricity resilience and independence. While access to capital for the initial installation can be a constraint, alternative contract models and financing arrangements are available.

For remote and rural communities experiencing poor continuity of electricity supply a micro-grid arrangement could provide the necessary infrastructure to improve energy security. In such circumstances, the opportunity is less about commercial viability and more a discussion of enabling critical infrastructure to provide electrical independence, particularly if the community is exposed to distribution network single points of failure, or prone to experience catastrophic events such as bushfires.

While virtual trading networks are in their infancy this innovative trading solution offers a near universal route for participation. Independent and impartial reviews of the long-term benefits will be needed to build consumer support; however, this model could fundamentally shift the nature of electricity trading by increasing the diversity of trading participants.

Table 8 provides a summary of each of the four scenarios, notes the key barriers identified, highlights the opportunities for deployment with primary industries and sets out the potential role the NSW DPI could play in supporting that deployment.

Table 8: Summary of scenarios, key barriers, deployment options and potential DPI supporting role.

Scenario	Description	Key barriers	Deployment opportunity	Potential DPI role
One: Virtual Net Metering	Individual participants install grid-connected small scale renewable resource (e.g., wind, solar, hydro). Excess generation is purchased by an industrial consumer via a direct commercial arrangement.	• Poor return on investment due to low c/kWh secured by industrial users • Access to capital • Retailer involvement • Contracting arrangements	Potential for deployment if a large number of participants can be aggregated into a portfolio to present a greater value proposition to a facilitating retailer.	• Networking of participants • Facilitator of negotiations between participants and retailers
Two: DER secondary revenue streams	A single participant installs a grid connected renewable resource (up to 500kW) with the intention of generating a secondary revenue stream via on selling the excess generation.	• Generation capacity too great for a standard FiT or STC • Administrative load in becoming a registered generator of LGCs • Technical feasibility of grid connecting large generation • Fluctuating value of LGCs	Size generation to meet on-site demand with minimal or no export. Removes technical barriers for deployment. Benefit driven by reduced energy costs saving on both retail and network charges. Alternative financing arrangements available to limit requirement for up-front capital.	• Independent advice and guidance around alternative financing opportunities • Generation sizing tools

Scenario	Description	Key barriers	Deployment opportunity	Potential DPI role
Three: Grid connected micro-grid	Several geographically co-located participants connect their individual loads and generation capacity (a mix of renewable energy and diesel power generation) as a microgrid with a single point of NEM connection providing back-up access to the grid should it be required and a route for exporting excess power generation.	• Required to comply with embedded network regulations • Participant risk exposure and consumer protection • Cost of deploying infrastructure and ongoing maintenance • Administrative load of operating an embedded network	Suited to communities which need to improve electricity security and network resilience due to exposure to single points of failure on the distribution network or experience catastrophic events such as bushfires.	• Collaboration with affected communities • Facilitate discussions with key stakeholders • Support applications for funding and grants
Four: Virtual Trading Network	Multiple NEM connected participants of all classifications small and medium sized generators, e.g., domestic solar PV, commercial solar PV, and multi sector consumers, including industrial users, commercial buyers and domestic supplies, trading energy via a cloud-based control and trading platform.	• Very few aggregators operating • Limited number of agreeable retailers • Grid connected DER technical barriers still exist • New technology with un-tested track record	Sector wide deployment possible subject to distribution network capacity for the installation of grid connect renewable generation.	• Independent advice and guidance for potential participants • Review and publication of short and long term findings from pilot projects

6.1. Value proposition

When considering the overarching findings of the four test scenarios it becomes clear that at present the value proposition for easy to deploy, small to mid-sized grid connected DER is limited.

For installed generation capacity up to 100kW capacity, STCs are a simple and cost-effective method to generate a secondary revenue from on-site generation or to claim upfront benefit through deemed valuation to decrease capital expenditures.

For renewable generation capacity beyond 100kW, participants are limited to generating and selling LGCs and reducing power import or exporting into the wholesale market. LGC creation and connecting large power systems to the grid require registration to the Clean Energy Regulator and approval from the local network service provider respectively. Negotiating and entering into a commercially attractive contract with an electricity retailer, alongside other administrative requirements, may prohibit participation. Additionally, the reduced value of solar power dispatched to the grid at time of depressed spot market prices (because of the high coincidence of large volume of solar generation) and the long-term trend in declining LGC prices further reduces the commercial viability of deploying large exporting generation capacity.

On the other hand, projects which have seen the successful and lucrative deployment of DER are commonly large-scale. Hepburn Wind, for example, is a multi-megawatt wind farm and certified GreenPower generator. The recent success of AAM’s Riverland poultry farm solar PV and battery storage system is due to its size; the generation capacity ensures participation in the wholesale energy market is profitable. Both of these projects had the potential to generate enough revenue to justify the time, effort and resource to facilitate their deployment.

Although opportunities exist to leverage revenue streams from DER the contracts and underlying regulation are complex and prohibitively expensive or time consuming to comply with. It is also difficult to stack different value streams in an effort to improve return on investment. For the average primary industries participant pursuing such schemes is an inefficient use of resource and new business models proposed by outsourced partners will be needed to facilitate take-up of DER.

The main value proposition for the deployment of DER remains installing generation sized to meet on-site demand with little or no export. Although access to the up-front capital for installation remains a barrier alternative financing options are available (e.g., long term power purchase agreement with a power producer designing, building, operating and maintaining the DER).

Virtual Net Metering and mass participation virtual trading network arrangements do stack up commercially. However, a VNM arrangement is difficult to negotiate as it provides little commercial incentive for a retailer unless undertaken on a large scale. Large virtual trading networks continue to be an emerging market with most opportunities still in the pilot stage. Planned updates to regulatory and market conditions (e.g., the AEMC two-sided energy market reform) may expand offerings in the mid-term.

6.2. Independent expertise and guidance

The law, regulation and policy surrounding the NEM is complex and determining a participant’s obligations and responsibilities can be complicated. Domestic customers are served relatively well with easy-to-follow schemes, while large scale projects are often backed by investors outside of the sector who can leverage legal and market expertise.

There is currently a gap in affordable and independent expertise for participants wishing to explore their DER options. Ideally this support would be free or low-cost and focus on supporting potential participants through the identification of suitable DER opportunities and facilitating application processes and contract negotiations as part of pilot projects.

The Department is well placed to provide such resources, tools and advice which must be robust, unbiased, up-to-date and specific to primary industries.

6.3. Transmission network accessibility

The influx in DER across the transmission and distribution networks has resulted in some areas, particularly those in remote and rural areas becoming constrained. As a result, local DNSPs are limiting the level of behind the meter generation that can be attached to a NEM connection. Beyond 30kW installed capacity, independent reviews are required, DNSPs are under no obligation to improve network infrastructure to facilitate a DER projects and can require participants contribute financially towards any necessary upgrades.

For the average potential primary industries participant conducting in-depth technical appraisals of their electricity infrastructure and undertaking detailed DER design work will be beyond their capability. Expert support in this area is expensive and may ultimately be fruitless should the DNSP refuse network access or request a prohibitively expensive upgrade of the grid connection.

In addition, the ability of DNSPs to curtail export to manage the power system frequency and voltage and change those limits without consultation poses uncertainty and risk for even relatively small DER projects. When the return on investment for projects is already marginal this additional risk further reduces the risk/return value proposition.

For DER to flourish in remote and rural communities’ access to the network will need to improve. The main barrier to improved access is linked to available funding for DNSPs to replace aging infrastructure to increase capacity. Although DNSPs are exploring variable export limits using smart metering and real-time analytics, for many marginal projects the decision to invest will be driven by a guaranteed return on investment which at present cannot be given.

The Department could seek to support a better integration of DER as non-network alternative solutions to network augmentation through its working relationships with the three distribution network service providers servicing NSW electricity end-users.

6.4. Regulatory support

Regulatory and policy support has focused on consumer protection and domestic households having accessible routes to small-scale DER opportunities. Large DER projects are often backed by sector specialists with access to the expertise and financial resource to navigate the complex regulatory landscape. The complex nature of policy, market requirements and administrative load result in DER simply being ‘too hard’ for most participants to want to engage in.

A collaborative approach between primary industries participants, policy makers, DNSPs and retailers is needed to design targeted products which offer an attractive value proposition, build resilience within the network and have streamlined regulatory requirements.

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