Barrier Summary Report: Irrigators - the flow on benefits of regionally embedded generation

PREPARED FOR:
Energy Consumers Australia

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About the authors

The Institute for Sustainable Futures (ISF) is an interdisciplinary research and consulting organisation at the University of Technology Sydney. ISF has been setting global benchmarks since 1997 in helping governments, organisations, businesses and communities achieve change towards sustainable futures. We utilise a unique combination of skills and perspectives to offer long term sustainable solutions that protect and enhance the environment, human wellbeing and social equity.

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Research team

Kriti Nagrath

Senior Research Consultant

Institute for Sustainable Futures

Franziska Mey

Senior Research Consultant

Institute for Sustainable Futures

Chris Briggs

Research Principal

Institute for Sustainable Futures

Joseph Wyndham

Research Consultant

Institute for Sustainable Futures

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Institute for Sustainable Futures
University of Technology Sydney
PO Box 123 Broadway, NSW, 2007
www.isf.edu.au

Contents

Glossary

Abbreviation	Term
ACCC	Australian Competition and Consumer Commission
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ANZ	Australia and New Zealand Banking Group
CBA	Commonwealth Bank of Australia
CEC	Clean Energy Council
CEFC	Clean Energy Finance Corporation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DMIA	Demand Management Innovation Allowance
DMIS	Demand Management Incentive Scheme
DNSP	Distribution Network Service Provider
DRE	Distributed Renewable Energy
DER	Distributed Energy Resource
ENA	Energy Networks Australia
FIT	Feed in Tariff
LCC	Lifecycle Cost
NAB	National Australian Bank
NOM	Network Opportunity Map
NSW	New South Wales
NSWIC	NSW Irrigators’ Council
PPA	Power Purchase Agreement
QFF	Queensland Farmers’ Federation
Qld	Queensland
RE	Renewable Energy

Key Terms Summary

Term	Description
Network Constraint	Where the network is constrained, customers can’t connect or export electricity to the network when and where they would like. Network constraints can be due to hosting capacity issues or reliability issues. Constraints are the product of the technical limits of the network: broadly thermal limits (the volume of power), voltage regulation, and fault-levels.
Hosting Capacity	Hosting Capacity refers to the capacity of the distribution system to absorb distributed energy flows. The hosting capacity of a feeder in the distribution circuit is defined by the limiting elements and electrical limits of the circuit. It’s a way of quantifying for example, how much solar the utility can allow on a feeder before upgrades are needed.
Reliability	Reliability of electricity systems is a measure of the ability of the electricity system to meet customer demand — that is, having capacity available in the right place and at the right time. One of the key indicators is the average number of unplanned outages per year – in terms of duration and frequency.
Non-Network Solutions	Non-network solutions are alternatives to network augmentation to address a potential shortfall in electricity supply in a region. They can be used to defer or avoid capital expenditure associated with network investment and deliver benefits to consumers through lower transmission prices. Non-network solutions include distributed energy resources and demand management initiatives which lower peak demand and network support which may provide additional local power generation during peak demand periods.
Demand Management Incentive Scheme (DMIS)	AER launched the DMIS in 2017. The Scheme's objective is to provide electricity distribution businesses with an incentive to undertake efficient expenditure on demand management alternatives to network investment. Consumers can choose whether to engage in demand management schemes.
Demand Management Innovation Allowance (DMIA) Mechanism	AER launched the DMIA in 2017. The DMIA’s objective is to provide distribution businesses with funding for research and development in demand management projects that are not currently cost-effective but have the potential to reduce long term network costs.

Executive Summary

Context

Rising electricity prices are having a major impact on the competitiveness of irrigated and other agriculture in NSW and Queensland. The cost of electricity is between ten per cent to almost a third of the total cost of production (Sapere Research Group, 2017; Heath, Darragh and Laurie, 2018). Rising input costs, combined with lower production volumes and sales prices, has led the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) forecast a 21% reduction in the real net value of farm production to $19 billion in 2017-18 (ABARES, 2017).

Growers are increasingly seeking options to reduce energy costs, including investigating the installation of renewable energy (RE), but have encountered a range of operational, financial and regulatory barriers. One of the key barriers identified by growers is grid connection; as energy demand is highly variable for many forms of irrigated agriculture and therefore feeding excess energy back into the grid has an impact on financial returns and the size of systems that can be installed. The complexity of grid connection processes and inability to connect or limitations on export of electricity are a key barrier to the growth of RE in the agricultural sector.

Energy Consumers Australia have provided funding to NSW Irrigators Council, Cotton Australia and the Queensland Farmers' Federation for a review of issues for growers connecting RE to the distribution network and ways of better aligning Distribution Network Service Providers (DNSP) and grower interests. The driver for the study is feedback from across the agricultural industry trying to reduce their energy costs by installing RE who have experienced challenges and barriers connecting RE to the grid. The objectives of the study were to:

- Identify and record the challenges and obstacles experienced by growers who have installed RE generation assets on farm including those who have tried to feed excess energy generated back into the grid.
- Analyse network connection applications with regard to technical, operational and process barriers that limit growers from feeding on-farm generated energy back into the grid.
- Assess the implications of Chapter 5A amendments to the National Electricity Rules to assist embedded generators under 5MW to connect to the electricity distribution network.
- Identify and communicate possible future opportunities with the network DNSPs for RE projects throughout rural Queensland and NSW with a view to better aligning growers and network business' interests.

Research Approach

The study adopted a bottom-up evidence based approach using a multi-method research design (case studies, focus groups, survey) to collect information. The focus was on engaging with growers and DNSP to understand their concerns and develop viable opportunities for them to work together. The methods included a literature review, case studies, an online grower survey and telephone interviews with the DNSPs.

Four case studies were conducted across regional Queensland and NSW to explore these issues in more depth across a range of different crop types, irrigation practices and water availability constraints and network constraints and opportunities. The case studies collected data through interviews and focus group discussions with selected growers.

An online survey was administered, with link shared with growers through member organisations. The combination of the three forms of data collection allowed us to synthesise and triangulate the results and gain a richer picture of the barriers and challenges experienced by growers. This barrier summary report captures the challenges and barriers shared by the growers and the DNSP.

Findings

The research focused on the process of installing and connecting or attempting to connect RE systems to the grid from the growers' and DNSPs' perspective. The key stakeholders in this process besides the growers and the DNSPs, include in varying capacities, the RE suppliers and consultants.

One of the key findings of the research was to understand the process growers follow when considering the installation of on farm RE generation assets. The research revealed that RE projects are initiated mostly by suppliers and in a few instances, by growers themselves.

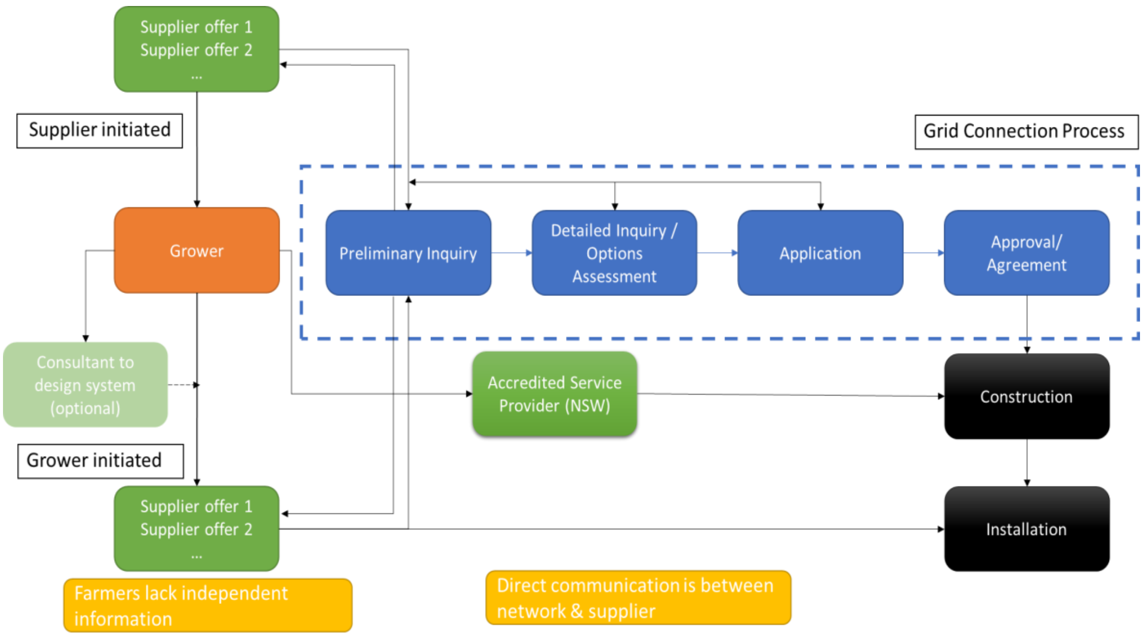

Figure 1: Process to connect on-farm RE to the grid

In the supplier initiated approach (Figure 1), supplier(s) reach out to growers to sell solar PV systems. They are also responsible for the grid connection approval. It was observed that this approach often resulted in a lack of trust, leading to confusion and inaction.

The grower initiated approach was less commonly observed. In this approach, a consultant was often engaged to help design and integrate the RE system with the exiting farm equipment. As such, the grower-led approach was often able to engage with the RE supplier(s) in a more informed manner.

However, in both approaches the RE supplier is the key contact with the DNSP. Thus, our research found very little direct contact between the DNSPs and growers; grid connections are managed by a range of third-parties for growers (either the solar supplier, an installer or consultant). The third-party that mediates the relationship between the growers and DNSPs is usually selected when growers are purchasing the RE systems. The issues and barriers identified by growers stretch across the process for installing and connecting RE, both before and during the involvement of the network connection process. The lack of independent information or support for growers when they select the supplier - who will also generally manage the grid connection process – and confusion and mistrust was a very strong theme throughout the research. Consequently, solutions need to encompass solar suppliers as well as the DNSP and grower relationship.

The key difference between NSW and Queensland is that NSW rules require the presence of the Accredited Service Provider (ASP) who undertakes the contestable works on the grid on behalf of the grower[1]. This offers greater competition but also adds another party that mediates the relationship between networks and growers. Despite the jurisdictional differences in the two states, many of the issue faced by the growers were common across the case studies. A barrier matrix was developed to succinctly capture these findings. The challenges are broadly classified as technical, economic, information and contractual as seen in Figure 2.

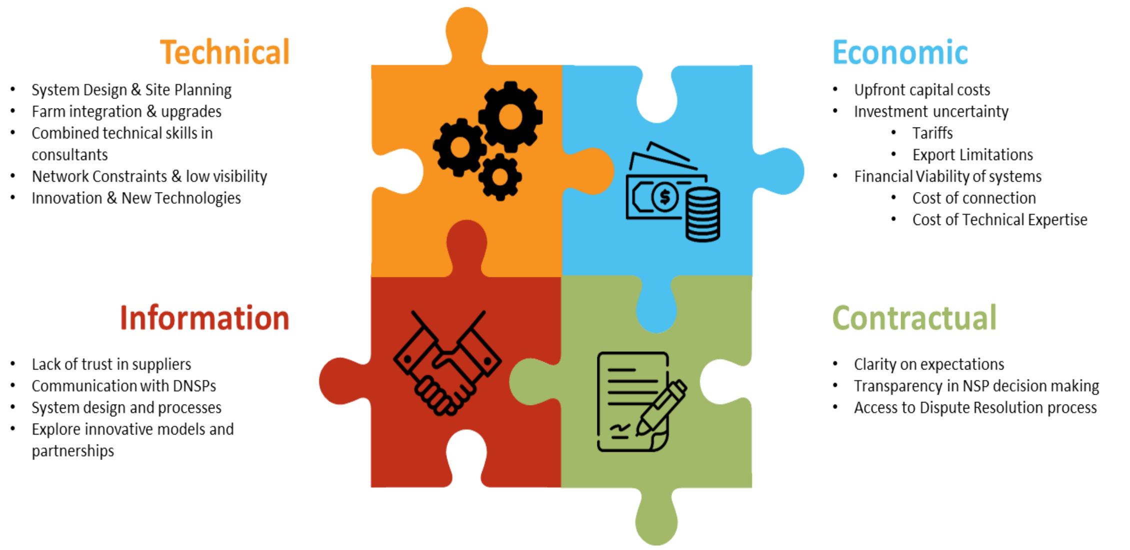

Figure 2: Challenges faced by growers when installing on farm RE generation assets

Technical Challenges

Growers face a range of technical challenges across the lifecycle of projects to install RE, both before and during the network connection process.

System Design, Farm Integration adds complexity and cost

Integrating RE systems into farm settings is often more complex than households or commercial buildings. For example:

- *Spatial integration*: irrigation pumps and bores are often dispersed across fields making them difficult to access and may not be connected to grid infrastructure.

[1] As per the Accredited Service Provider Rules administered by the Department of Fair Trading (Energy NSW, 2018)

- *Operations integration*: it was observed in both states that irrigation equipment was often dated and integration with irrigation needs and existing equipment increases the complexity and cost.

Skill gaps in consultants: combined expertise in farming and RE is hard to find

There is a lack of personnel who are knowledgeable on RE system integration with farm equipment, particularly irrigation systems. It was reported that consultants understand either RE or irrigation systems – but few with expertise in both. Water access conditions associated with water licences and the operational constraints of irrigation channels for example were also not well understood by equipment/system providers. The importance of combined expertise was highlighted by some of the successful projects identified in the case study research.

Network Constraints

There are technical constraints which can limit the size of RE systems that can be connected to the grid or the exports that can be made. Export limitations may be put in place either due to the lack of thermal capacity (VA) to accommodate higher power flows or other power quality issues (voltage, power factor, harmonics, fault current limits) on that part of the grid.

Currently, DNSPs[2] often have low visibility of network hosting capacity for RE at the low voltage level in regional areas where growers are seeking to connect. Networks need to ensure adding RE will not exceed thermal and voltage limits in low-voltage lines on which they often have poor visibility and use static modelling. This may lead to limitations on grid export that are more conservative than necessary or require further investment where there are physical constraints. As such, some growers are required to design their RE system so that it cannot export to the grid. This often requires more system complexity and cost to the grower.

Growers were also concerned that large solar farms being developed in regional areas would squeeze out their capacity to connect to the grid.

Economic Challenges

Across the 4 case studies, the opportunity to reduce their energy bill and have more control over energy costs was the prime motivation for growers to consider RE. Solar power is generally understood to be cheaper across the project lifecycle than diesel generators or grid electricity but there were other factors that can impact on the financial returns or create investment uncertainty that leads growers not to proceed.

Upfront capital costs

In both NSW and Queensland, the upfront capital costs and payback periods were considered to be an impediment. Discussions in both states found growers did not always value RE systems in the same way as other investments (e.g. decision making on payback period vs rate of return[3]) and therefore placed a higher weighting on the upfront capital cost. This was especially the case for young growers starting out.

[2] The research focussed on two predominantly regional DNSPs; Ergon Energy in Queensland and Essential Energy in NSW

[3] There are pros and cons with use of different metrics. In general, rate of return is more accurate as it calculates total costs and benefits. However, projects with shorter payback periods do not always deliver the best return over their lifetime. Farmers use rate of return on other investments and use of payback period is a factor in lower take-up.

Investment uncertainty: network tariffs, connection costs and export limitations

Network processes can add to the investment uncertainty in a number of ways.

Firstly, there is uncertainty around future tariffs. In Queensland, particularly the uncertainty around the loss of transitional and obsolete tariffs in 2020 as well as future tariffs over the next regulatory period was a major deterrent for growers to commit to an investment in RE. There is speculation that the costs / charge associated with grid electricity tariffs may fall which reduces the returns from RE.

Secondly, the uncertainty of the additional costs of connecting to the grid and the potential for export limitations was another factor that created investment uncertainty and deterred growers. This was especially so for those with large variable irrigation loads.

Costs for technical assessments and network augmentation

The onus to pay for any grid infrastructure upgrades or augmentation can fall partially or completely on the grower. The current system is a 'last-in, worst-dressed' process where past applicants do not pay and the costs fall on the applicant that experiences the constraint. There is uncertainty about the timing and quantum of any cost recovery where it applies for later connections. Growers in both states reported the cost of paying for technical assessments of the feeder was another factor.

Low retailer feed-in tariffs

In general, the low feed-in tariff rates paid for export leads most installers to size RE within the maximum site demand. Since the financial incentive is low, growers choose to have smaller systems that only meet their on-farm demand, without exporting electricity. However for irrigators with high energy usage for 4-6 months of the year grid connection might be essential. Low retailer feed-in tariffs also impact on financial returns even where grid connection is secured.

Awareness and use of available finance

Access to finance was not noted as a major challenge in any of the case studies, but there seemed to be limited awareness of available funding support such as concessional loan facilities established by banks with the support of the Clean Energy Finance Corporation (CEFC). Most growers who had installed solar reported either self-financing the system or were offered a payment plan by the supplier.

Information & Communication

Lack of trust in suppliers

One of the most pressing challenges shared by growers was the lack of trust in suppliers. Growers report that they have been misled and cheated by unscrupulous suppliers. This was a common theme in both states. Growers were unsure of whom to trust and identified independent advice and information on the different equipment available in the market as a key barrier.

From the perspective of the networks, the key problems arise either from inadequate information provided by the third-parties that manage the connection process for farmers (and therefore create delays).

Communication between DNSPs and Growers is not working well

In both NSW and Queensland, it was observed that growers are not directly engaged with the DNSPs. This engagement is facilitated by third parties, generally the supplier, and the ASP in NSW. From the networks perspective, the third-party managing the connection is the 'customer' and communication with growers is the responsibility of the third-party. However, the current situation is creating high levels of confusion, frustration and misunderstandings of process requirements and outcomes by growers – and growers attribute blame to the DNSP rather than the third-party.

DNSPs typically provide a large amount of information at the beginning of the application process. However, the volume and complexity of information is likely overwhelming to consumers. DNSPs have attempted to streamline the process by diverting applicants into different streams and categories, however there remains a burdensome level of information to applicants.

There appear to be issues with information flow in both directions between DNSPs and growers. DNSPs reported that in all cases they communicate, in detail, issues that prevent application approval and furthermore provide suggested options that the grower might consider where their original connection application cannot be fulfilled. However, growers report that they have received outright rejections for applications without explanation. One grower reported the network requested the system be downsized on three separate occasions without an adequate explanation. In Queensland, many growers reported that they were not allowed to export at all as there was no capacity on the grid. This is contrary to the explanation of the process by Energy Queensland, that applications were not rejected but alternatives were suggested for network augmentation or export limitations. In NSW, growers complained they were receiving arbitrary, shifting export limitations. DPSPs also reported that they rarely deal directly with growers and do not appear to be aware of the issues growers report. The disconnect between the two stakeholders is a likely contributor to existing inefficacy of the process.

Communication to improve system design

Growers highlighted a lack of guidance or feedback on better placement, location or scale of the project – which can lead to several rounds of application without a guarantee of the success of the next step.

Lack of information on suitable locations for RE connections

There is limited information available for growers on the hosting capacity and export thresholds for local network when choosing whether to invest in RE. While information may be publically available, growers are often unaware where to access the information. Further, there might be barriers in technical understanding of the information available. This leads to wasted time for both networks and growers with applications in unsuitable locations or over-sized systems. It also represents a missed opportunity to collaborate in areas where non-network solutions may reduce network costs.

Contractual & Legal challenges

Lack of understanding of contracts

For small to medium scale systems, there is a need for growers to understand the contracts they sign with the DNSP. DNSPs often have standard contracts for small to medium scale systems. However, there is also an option to opt for negotiated contracts. The subtleties of the different contracts are not clear for growers.

Lack of dispute resolution mechanisms

Even when growers are unhappy with the process, they rarely approach formal dispute resolution mechanisms. Most are resolved through informal negotiations with the DNSP. In relation to suppliers, there are complaint processes established through the Solar Retailer Code of Conduct but there was no evidence of awareness of the code. Some growers have approached the state ombudsman's office to seek recourse from recalcitrant suppliers. However, the time and resources required to be engaged in a legal battle are often a deterrent for growers.

Conclusion

Overall, our research into grower perspectives found similar issues to those identified in past reviews of Chapter 5A, but in addition issues with other parts of the installation process. The issues growers experience with grid connection are strongly intertwined with other barriers to the uptake of RE: grid connections are managed by third-parties (the supplier, installer or consultant) for growers and our research found high levels of distrust, reports of mal-practice and dis-satisfaction with their performance from pre-sale through the connection process to post-sale. Solutions need to therefore encompass suppliers as well as the DNSPs and growers. There is a **need to make independent advice and support on emerging (energy) technologies available to growers** in regional communities.

There are variations between the approach of the Queensland and NSW DNSPs in managing assessment of RE connections but the building blocks of the process are similar. The main barrier to grid integration of RE are the technical standards that need to be managed by networks to maintain security and reliability, primarily voltage and thermal limits which can be challenged by intermittent RE.

It is important to note there is effectively no process for network-initiated projects for distributed energy resources (DERs) that could potentially lead to lower energy costs, could be identified at this stage. But the emergence of distributed energy technologies creates opportunities for networks to initiate projects with growers that can reduce capital, operating and replacement expenditure. It is generally accepted that DERs will likely deliver network benefits in the future, but the pathway to that future is yet unclear. There is a need to further **investigate opportunities for innovative demonstration projects**.

Another barrier identified through the research was the lack of clarity and understanding of the grid connection processes. All the DNSPs are currently developing model connection processes through their peak body, Energy Network Australia, in collaboration with the Clean Energy Council and other stakeholders. This reflects an agreement among key stakeholders including DNSPs that improvements in grid connection processes will enable DNSPs to better manage their resources as well as facilitating RE. Pilot projects to improve visibility of network constraints in low-voltage lines are underway within the DNSPs. This can help **improve the provision of information to growers**.

As the research reports, there are many initiatives underway to develop model processes and trial innovative ideas. Not many are geared specifically to growers and their unique energy profiles. Thus, there is a need for **growers to engage with DNSPs** to collaboratively develop processes and projects that are mutually beneficial. The next part of this research, reflects further on these opportunities and offers recommendations to overcome these challenges.

1 Introduction

Electricity is an essential input for Australian agricultural production. The cost of energy used by the Australia agricultural sector is estimated to be $5.85 billion, with the cost of electricity at $2.4 billion, equal to almost ten per cent of the gross value of production (Heath, Darragh and Laurie, 2018).[4] Irrigated agriculture is even more energy intensive; energy can account for more than a third of the total cost of production (Sapere Research Group, 2017).

The Australian Competition and Consumer Commission's (ACCC) 2017 inquiry into electricity prices concluded rising costs are making Australian irrigated products less competitive. Electricity bills for irrigators increased by up to 300 per cent between 2009–2014 (Agriculture Industries Energy Taskforce, 2017) and have continued; year on year to the third quarter of 2017, retail electricity prices increased by 11 per cent (Heath, Darragh and Laurie, 2018). Rising input costs, combined with lower production volumes and sales prices, has led the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) forecast a 21% reduction in the real net value of farm production to $19 billion in 2017-18 (ABARES, 2017).

Rising network charges are the key factor underpinning the increase in grower's electricity bills. Typically, regulated network charges and other costs represent half or more of growers' electricity bills (Agriculture Industries Energy Taskforce, 2017). With the discontinuation of irrigation tariffs and the introduction of demand-based tariffs in Queensland and NSW, these prices are expected to increase further. Cost-reflective network tariffs (i.e. demand tariffs) could have a significant negative impact on the competitiveness of agribusinesses (NSW Farmers' Association, 2017; ACCC, 2018)

Many growers have invested in energy efficiency, but water efficiency infrastructure have perversely saved water but increased energy consumption. Growers are increasingly investigating and installing renewable energy (RE) to reduce their energy costs, but have encountered a range of operational, economic and regulatory barriers. One of the key barriers identified by growers is grid connection; energy demand is highly variable for many forms of irrigated agriculture and therefore feeding excess energy back into the grid has an impact on financial returns and the size of systems that can be installed. The complexity of grid connection processes and inability to connect or limitations on export are a key barrier to the growth of RE in the sector.

1.1 About the research

The NSW Irrigators' Council (NSWIC), Cotton Australia and the Queensland Farmers' Federation (QFF) have commissioned this research to understand, document and provide clarity on how to better align grower and DNSP interests in relation to grid-connected on-farm generated energy. The study has been funded by Energy Consumers Australia.

The objectives of the study are to:

- Identify and record the challenges and obstacles experienced by growers who have installed RE generation assets on farm including those who have tried to feed excess energy generated back into the grid.

[4] The sectors included in the analysis were grains, beef, dairy, chicken meat, sheep, horticulture (vegetables, cotton, sugar, wine grapes, pork and eggs.

- Analyse and assess DNSP decision processes and assessing these connection applications with regard to technical/operational and process barriers that limit growers from feeding on-farm generated energy back into the grid.
- Assess the expected implications of new Chapter 5 amendments to the National Electricity Rules to assist embedded generators under 5MW to connect to the electricity distribution network.
- Identify and communicate possible future opportunities with the DNSP for RE projects throughout rural Queensland and NSW with the view to better aligning growers and DNSP interests.

The aim of the project is to enable a more productive dialogue between growers and the DNSP to integrate RE generation to the benefit of both parties.

1.2 About the report

This report builds the evidence base around the existing challenges and obstacles in the installation of RE sources in rural Australia (i.e. with focus on Queensland and NSW). It presents an overview on RE in the agricultural sector and an in-depth look at four case studies across the two states, followed by a summary of key findings.

The key findings of this barrier summary report will be tested in a workshop with peak body representing growers and the DNSPs to produce a final report synthesising the recommendations from the research. The recommendations will be aimed at

- educating growers on the challenges (faced by other growers) and the potential future opportunities in the installation of RE generation on-farm;
- engaging with the DNSP to realise possible future opportunities;
- policy and advocacy by the agricultural representative bodies.

1.3 Research approach

A multi-method research design was used including case studies, focus groups, interviews, literature review and an online survey. Four case studies were conducted across regional Queensland and NSW. The selection of the case studies was based on maximising the geographic spread, range of different crop types, irrigation practices and water availability constraints and diversity of network constraints and opportunities. The primary focus was on growers who have already installed RE generation and tried to feed the excess energy generated back into the grid.

There are two DNSPs active in the study area: Essential Energy in NSW and Energy Queensland in Queensland. Semi structured interviews were used to engage with both DNSPs and growers.

The findings were collated in a barrier summary report (this report). This was then shared with key stakeholders in a workshop to test and develop recommendations.

The scope of the study was limited to distributed, on-farm RE systems – utility-scale RE were not included. A detailed summary of the research approach is provided in Appendix 1.

2 On Farm Renewable Energy: Opportunities & Challenges

Agriculture, especially irrigated agriculture, is an energy intensive space and growers often list energy costs as their biggest challenge, with energy costs represent 11% of growers input costs (CBA, 2018). Since 2000, cotton growers and other irrigators have been exposed to major electricity price rises, in some cases up to 300% (Cotton Australia 2017). An anticipated 50–70 per cent rise in energy costs in 2017–18 for dairy processors could shave 1¢ per litre off the farm-gate milk price if passed on, while growers at the same time are facing up to 20 per cent increases in their shed tariffs (Dairy Australia, 2017).

The Electricity Network Transformation Roadmap developed by CSIRO and Energy Networks Association estimates consumers will determine how $200 billion out of a forecast $1 trillion of energy investment is spend by 2050. Over $16 billion in network expenditure could be avoided through effective orchestration of distributed energy resources (DER) such as RE, smart technology and energy efficiency (CSIRO & Energy Networks Australia, 2017). Networks account for around half of consumer electricity bills. Effective coordination of DER between DNSPs and end-users such as growers to take advantage of opportunities to reduce networks costs will have a big impact on future electricity prices.

In the context of rising energy costs and dramatic falls in the cost of RE systems, particularly solar PV, growers are increasingly investigating and installing on-farm solar PV systems. A recent survey by the Commonwealth Bank found the rising energy costs were having a moderate to significant impact on the vast majority of growers and two thirds would like to invest in solar energy with battery to regain control over their costs. Many growers are considering installing RE systems[5] but a range of barriers have also been experienced by other growers.

Rising network costs have been the primary driver of rising energy costs. For growers, connection to the grid is also often essential for RE to be viable due to the highly variable character of operations and energy consumption. In 2014, a new process was established to make it easier to connect RE generators under 5MW (chapter 5A).

Chapter two presents context to the case studies by:

- briefly summarising the benefits and opportunities presented by RE for growers; and
- providing an overview of the grid connection process, reviews of Chapter 5A and the issues identified for energy users seeking to connect RE to the grid.

2.1 Renewable energy: Benefits & Opportunities

Australia has a very high penetration of distributed RE by international standards. To date, this has primarily been driven by households but Australia is now in the early stages of a building wave of business RE investment. Like other businesses, the interest of growers in installing RE is surging – fuelled by the growth in energy prices,

[5] Nearly half said that they were already using solar without battery on farm (CBA, 2018). Another survey of over 1300 growers across the country echoed this, with eight in ten growers supporting Australia moving towards 100% renewable electricity. More than 600 said they had installed solar power or battery systems on their property (FCA, 2016).

the falling costs of RE and the foreshadowed shift to cost-reflective tariffs which could have a major impact on growers.

Clean energy can help increase the resilience and sustainability of farming businesses by reducing energy bills, reduce exposure to future energy price increases and improve investment certainty. There are three basic options:

- **Energy efficiency**: reducing energy consumption through more efficient technology or behavioural change.
- **Demand or load management**: using energy storage or making operational changes to change the time of energy consumption.
- **RE generation**: bio-energy, hydro power, and solar power in particular are now generally cheaper than grid-electricity. Solar PV is scalable, additional modules can be easily added and can be integrated with a variety of agricultural equipment. Solar PV power can replace a significant proportion of the mains electricity and diesel currently used for pumping (stock and domestic pumping as well as bulk water pumping for irrigation[6]). [7]

When growers install RE, they should ensure the profile of their demand is taken into consideration to get full value from the system (in terms of reducing energy costs). Electricity bills reflect two major components:

- Electricity network charges: around half of the typical bill results from the network charges, primarily based on the peak monthly demand.
- Electricity usage charges: around one-quarter of the typical bill is based on the retailer charges, which typically include a fixed daily rate and the energy used either on a flat rate or during off-peak, peak or shoulder times.

If a solar PV system is installed without using load flexibility or storage options to reduce monthly peak demand, it will reduce the energy usage charges but not the network demand charge. Figure 3, illustrates the pitfalls with a real-life example from an agri-business at a site examined by ISF for another project. The blue-shaded output of the solar PV system did not reduce the peak demand which occurs earlier in the morning - and therefore did not reduce network demand charges.

[6] Diesel generators are another option and rising energy prices has spurred their growth. However, the solar pumping guide from AgInnovators, notes that whilst solar PV is more expensive to install, they are cheaper over their lifetime than diesel systems due to the fuel costs.
[7] Growers interested in solar pumping should consult the how-to guide published by the Office of Environment and Heritage (NSW Farmers and GSES, 2015).

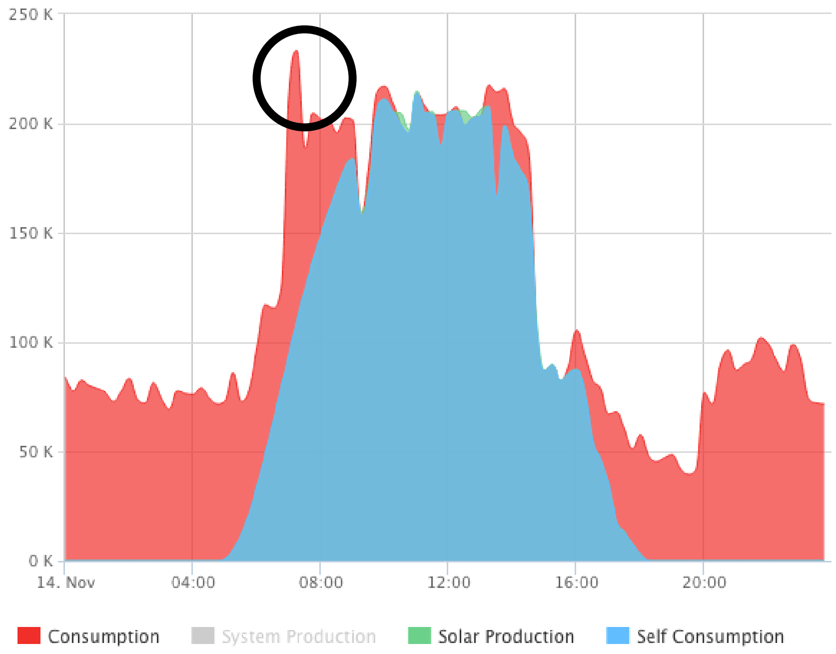

Figure 3: Solar PV & Load Profile

In this case, a small amount of load shaping or storage in combination with the solar PV system would have delivered a much better result. There are a range of options to enhance the value of solar:

- Matching demand better with the orientation of solar: Operations extending into the early morning or evening may be best served by extending the solar generation profile through east-west trackers. Late afternoon peaks may be best addressed through west-facing solar;
- Load shifting: where there is flexibility in operations, they can be shifted to make greater use of solar PV generation or flatten demand peaks to avoid network charges. Growers with flexibility on pumping time can get extra value out of solar and effectively store energy in water reservoirs;
- Storing PV output to make use earlier or later in the day or night-time. New storage and demand control technologies make it easier and cheaper for energy to be stored and used at different times without adversely affecting operations.

  Besides batteries or diesel generators, there are often cheaper alternatives that already exist on-site such as variable speed drives (ramping pumping up and down in concert with solar generation), cold storage and refrigeration (systems can be pre-cooled with solar PV towards the minimum set-points and then switch chillers off to allow the temperature to drift back upwards) and hot-water systems.

For growers to access RE technologies, there are three options in relation to the electricity grid:

- on-site systems that require no network approvals;
- grid-connected solutions (with or without export); and
- off-site energy products where other parties manage the grid relationship such as RE power purchase agreements where the energy user makes a contract to buy power for a set price from a solar or wind farm.

Table 1 summarises the three grid relationships in relation to the technological options available to growers.

Table 1: Clean Energy Technologies and the Grid - the Pathways for Growers

Technology Category	Technology Type	Technology Location	Technology Description	Grid connection context
Energy Efficiency: using less power	Heating & Hot Water, Processing, Cleaning, Lighting, Controls, Behaviour Change, Pumps and Motors, Cooling	On-site	Technology options that can replace or upgrade existing systems to improve energy efficiency	No DNSP approval required
Load Management: changing the time of consumption	On-site storage (cool and heat storage), automated energy controls, batteries, flexible or discretionary uses.		Those technology options have the potential to store energy and therefore change the time of consumption. Changing the time of consumption can reduce network charges based on monthly peak demand, shift consumption to lower-priced times and increase on-site usage of solar power by matching output and demand.	
Distributed Energy Systems (Off-grid)	Solar pumping, ground mounted or rooftop solar PV, bio-mass, diesel generators, biomass/biogas generation, hydro, cogeneration/ trigeneration		Technologies that generate energy near the source of demand but are not connected to the electricity grid. These can either use RE sources (e.g. solar or wind) or use fossil fuels (e.g. diesel or natural gas).	
Distributed Energy Resources (On-grid)	Solar pumping, ground mounted or rooftop solar PV, bio-mass, diesel generators, biomass/biogas generation, hydro, cogeneration/ trigeneration, microgrids		Technologies that generate energy near the source of demand and are connected to the electricity grid. These can either use RE sources (e.g. solar or wind) or use fossil fuels (e.g. diesel or natural gas).	DNSP approval required
Commercial Arrangement	RE Power Purchase Agreement (PPAs), Virtual power plants, energy trading	Off-site	Off-site models for accessing RE. For example, under a RE PPA, agri-businesses can agree to buy power at a fixed rate for a longer-term (generally 7-years +) from a RE generator.	Approval managed by other parties

Whilst there are opportunities for growers to access the benefits of RE through off-grid and off-site models, the limitations of off-grid or off-site models at present are such that most growers require a grid-connected system:

- **Off-grid RE**: The variable character of irrigation farming means there is a very large demand for 3-4 months and a much lower demand for the remainder of the year. Consequently, limitations on energy export can negatively impact the business case for RE. Off-grid RE with storage is an option, but batteries are currently not cost-effective. Off-grid RE can also potentially work for crop types that have less variable load profiles. Otherwise, systems need to be sized to the off-peak demand (limiting its value) or accept lower returns from lower utilisation.
- **Off-site commercial models**: RE PPAs are growing in significance and there are cases of growers signing PPAs. However, at this stage they are relatively new and therefore can be complex transactions beyond the capacity of many

growers. An emerging trend is retailers offering RE PPA's as part of their standard offer for 'market customers' with pass-through of the wholesale price for energy. This is a much simpler model and can potentially deliver large savings. However, wholesale prices are volatile so users need to have flexibility through load management, storage or a diesel generator to avoid consuming during high-price periods (Prendergast *et al.*, 2018) .

Consequently, grid connection is generally essential for most growers that want to install on-farm RE.

2.2 Grid Connection processes: NSW & Queensland

2.2.1 National Electricity Rules

Grid connection for distributed RE generators is regulated primarily by Chapter 5A under the National Electricity Rules which covers generators less than 5MW. There is a set of basic obligations in relation to grid connection:

- Both DNSP's and proponents have an obligation to negotiate in good faith, the DNSP must consider applications in a timely fashion and applicants must provide the information reasonably required to assess the application;
- Networks have an obligation to maintain network security, safety and reliability. Unlike new sources of load, DNSP's do not have an obligation to connect new generation or provide a guaranteed level of access to the network for generation once they are connected;
- The applicant has an obligation to comply with reasonable requirements of the DNSP; (See Section 7.4)
- DNSP's are required to publish an information pack on their website outlining the technical requirements for grid connection and a public register of connections.

Only systems installed by accredited installers registered with the Clean Energy Council are eligible for incentives under the Australian Small-Scale Renewable Energy Scheme.

For the majority of systems greater than 30 kW, the negotiated connection process applies (see Section 7.4). The basic structure of the process for a negotiated connection is the same across states and is summarised in Figure 4.

- The preliminary enquiry provides guidance before proceeding to the detailed enquiry stage. This is a gateway process in which applications are given feedback on whether they would be approved, rejected or require more work.
- If proponents accept the terms and conditions of the connection offer from the DNSP, they can connect to the grid.
- A technical assessment is carried out for most negotiated applications to see how effectively the proposed system works with the network. DNSPs advise on options when applications do not pass their assessment. They range from lowering inverter capacity or curtailing export to paying for an upgrade to the network. Negotiated contracts take up to 65 days.

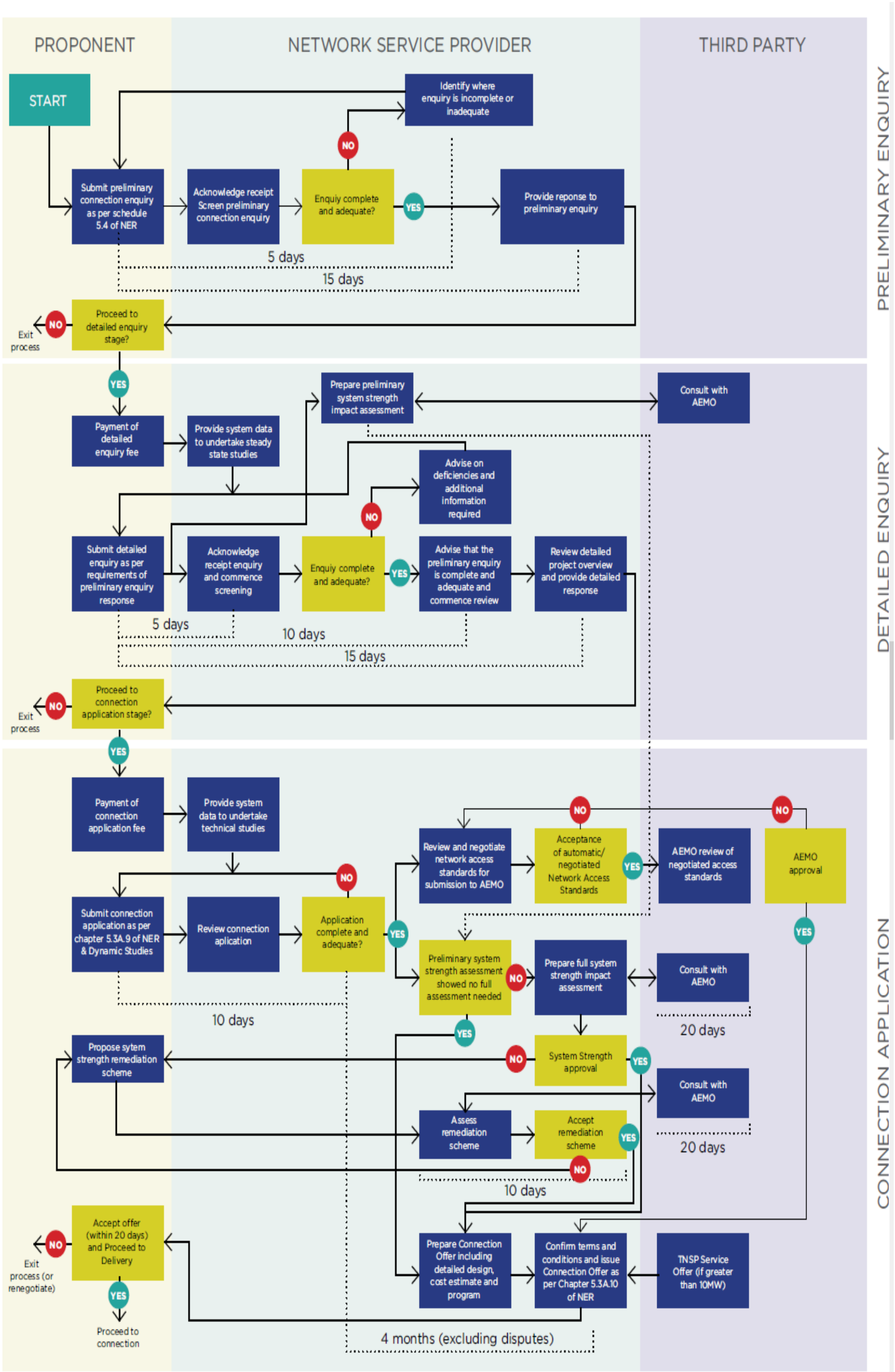

Figure 4: Negotiated Connection Process Source: (ENA, 2018)

2.2.2 NSW and Queensland Connection Processes

There are some variations between NSW and Queensland which reflect differences in state regulations[8], the requirement in NSW for Accredited Service Provides (ASP) to undertake works (the Accredited Service Provider and Contestable Works Scheme, (Department of Planning & Environment, 2017) and differences in approach between the networks. In NSW, the services required to establish a customer's connection to Essential Energy's network are undertaken by Accredited Service Providers (ASP) as contestable services. In Queensland, the DNSP manages the tender process. The ASP is designed to offer the consumer more choice when tendering for connection works.

2.3 Connecting renewable energy to the distribution network: Key challenges

Following the introduction of Chapter 5A, a series of reviews have investigated grid connection processes and highlighted a range of issues for users trying to connect DRE systems (ClimateWorks Australia, Property Council of Australia and Seed Advisory, 2015; Energeia, 2016; ClimateWorks Australia and Seed Advisory, 2017; Climateworks Australia and Seed Advisory, 2018; ENA, 2018). The NSW Government also commissioned a review of NSW transmission and DNSPs with recommendations for improvement (CutlerMerz, 2018).

2.3.1 Reviews of Chapter 5A

There is broad agreement across major reviews of grid connection processes under Chapter 5A that network access arrangements have had negative impacts including:

- Higher costs for RE installations (increased time and connection costs);
- A barrier to entry and the adoption of new decentralised energy technologies (including storage, demand management equipment, charging infrastructure);
- Lower uptake of RE: projects are sometimes abandoned or not proceeded with due to uncertainty, costs, delays or rulings by DNSP's that the network either cannot accommodate more RE or with significant conditions that impact on the viability of the project;
- Under-sizing of RE projects: projects are sized within the peak demand of the site to avoid export.

The specific issues identified in these reviews of Chapter 5A are summarised in Table 2.

[8] Specifically NSW's Code of Practice for Service and Installation Rules & Queensland's Electricity Distribution Network Code

Table 2: Grid Connection Issues under Chapter 5A

Issue	Description
Information	**Inconsistent technical and information requirements between networks:** different standards and processes add to complexity and transaction costs. Equipment that is acceptable to one DNSP is not always accepted by another DNSP. **Ambiguous requirements:** for example, distributor guides can refer to multiple standards which have inconsistencies. Energeia's review found half of the network guides had ambiguous requirements and non-committal language that did not provide certainty. **Information on the reasons for decisions:** information on reasons for unsuccessful applications to provide guidance for future applications is not always provided or communicated.
Connection fees	There is a variety of connection fees that can be levied. Some applicants have found significant variations and unexpected increases in costs. • Enquiry fee; • Connection assessment fee; • Application fee; • Cost of minor deviations from Standard; • Other incidental costs • Investigations • Augmentation (including equipment such as a transformer)
Service standards	Some reviews have found **variable approaches within networks**: In the context of ambiguous requirements, similar requests or issues can be dealt in quite different ways by different personnel depending on their approach, skill and experience.
Queueing	**Processes for 'queueing' of applications:** there is a lack of clarity as to how are applications at the same location processed, especially where there are constraints
Managing network constraints	**Processes for managing impacts on local network hosting capacity**: there are different approaches for determining limits and managing connection applications where limits are identified. Some networks have clear rules whereas others apply a case-by-case approach with little information to guide applicants.
Network augmentation costs	**Equity of process for allocating costs of augmentation:** there is no effective mechanism to address the '"last in, worst dressed" approach to the costs of upgrading a local network' which falls upon a connection proponent after others have used up connection capacity. **Efficiently managing network augmentation costs:** there are a variety of procurement processes for augmentations which are not necessarily competitive and investment in response to specific connections is not necessarily efficient
Islanding	**Islanding is rarely permitted:** a property could continue to self-generate after network failure.
Dispute resolution	**No effective access to dispute resolution:** dispute resolution processes do not apply until a connection agreement is offered and few proponents use dispute resolution processes. The discretion of networks in processing applications and the potential for reputation damage has been offered a reason.

2.3.2 Review of NSW Distribution and Transmission Networks

The NSW Government commissioned a review of grid connection processes for RE to the NSW transmission and distribution networks in 2018. Whilst the study found the complaints about onerous technical requirements were often not valid, six areas for improvement were identified (CutlerMerz, 2018) :

- **Connection documentation**: A common communication platform to provide consistent and clear publicly available documentation to guide proponents through the connection process.
- **Technical requirements**: A consistent set of technical requirements that balance safety, reliability, and ease of connection.
- **Decision making process**: To facilitate consistent and transparent decision-making processes with respect to approving or rejecting applications.

- **Connection processing times**: To improve connection processing times with sufficient regard to NER as well as proponent requirements.
- **Quality of connection applications**: Ensuring that only quality and well advanced connection applications are received.
- **Investment certainty**: Clarity of regulatory and policy mechanisms to invest in network infrastructure to facilitate connections

Five recommendations were made to take up these areas for improvement:

Recommendation 1: Establish a common set of principles and definitions for grid connection to provide greater clarity and transparency.

Recommendation 2: Establish streamlined technical requirements covering the full range of connection types (potentially by engaging with Energy Networks Association).

Recommendation 3: Ensure technical requirements are subject to regular review to reflect changes in technology.

Recommendation 4: Provide proponents and NSPs with clear and transparent information with respect to obligations during the connection process

Recommendation 5: Encourage proponents to connect to locations with available capacity (potentially via linkages to the Network Opportunities Map).

2.4 Voluntary Codes: Networks, Retailers and Installers

Alongside State and Federal regulations, there also voluntary codes which shape the grid connection process. There are two relevant voluntary industry codes overseen by the Clean Energy Council for the parties that manage connections on behalf of growers:

- **Solar Retailer Code of Conduct**: the purpose of the code is to promote best practice amongst suppliers of solar PV systems and improve consumer service. The code covers issues such as misleading claims consistent with consumer law, requires signatories to provide 5-year whole-of-system warrantees and encompasses pre-sale and post-sale service.[9] Only parties that have been operated for at least 12 months can be signatories, there is a complaints process and an audit and compliance program. The code has been authorised by the ACCC.[10]
- **Clean Energy Council Accreditation for solar designers and installers**: to be eligible for incentives under the Small-Scale Renewable Energy Scheme, the installer must hold CEC accreditation. Accreditation requires installers comply with relevant standards and regulations.

Energy Network Australia (ENA), the peak body for transmission and distribution networks is currently overseeing a process to develop standard guidelines for different connection types for each of the different connection types (micro, low-voltage etc.).[11]

9 A list of retailers that comply with the code can be found at: http://www.solaraccreditation.com.au/retailers/approved-solar-retailers. Around 90 retailers are signatories. The section on grid connection responsibilities are reproduced beneath.
10 An updated version of the code is currently being prepared by the Clean Energy Council and will be released for public consultation shortly.

[11] A study by (Energeia, 2016) commissioned by the Clean Energy Council recommended an industry-led approach to develop a national connection guideline. Based on international experience, Energeia recommended a tiered approach with a national standard setting a framework for implementation by DNSPs to reflect local circumstances.

There is agreement between the CEC and the ENA that there is a need for greater clarity and standardisation on connection processes to facilitate RE:

> *Each network has responded to these challenges independently, resulting in a range of technical requirements and connection processes which, although consistent with local regulatory requirements, result in some inconsistencies between networks and a lack of clarity for proponents … This lack of clarity causes confusion with regard to the technical requirements needed for systems to connect to the grid. This has resulted in a large proportion of customer inverters being installed with settings (e.g. frequency trip settings) outside those stipulated in the connection agreement between the customer and the network. This in turn has led to systems not operating to their full potential in integrating with the grid and consequently, full value not attained for the customer* (Johnston, 2018)

In collaboration with the DNSPs and other stakeholders including the Clean Energy Council (CEC) and Energy Consumers Australia, the aim of the model connection guides is to establish clear and consistent guidelines, a level of consistency between technical requirements and balance consumer interests with network security.

The guidelines are voluntary. All networks are participating and will apply them as they consider best for their system. Mandatory guidelines will be considered in reviews of the guidelines which will occur every 2 years and include a range of stakeholders such as the Clean Energy Council. The first overarching framework has been released and other frameworks are scheduled for release 2018/19.

3 Grower Perspectives: Installing On-Farm Renewable Energy

This section summarises the results of the case studies to present the grower perspective on the grid connection process. Four case studies were undertaken across NSW - Bundaberg and the St George basin in Queensland and Narrabri and the Murray/Murrumbidgee valleys in NSW (see Figure 5). The selection of case studies was designed to maximise diversity in terms of geography, crop types, irrigation practices, water availability and constraints and network constraints. The difference in climate zones and agricultural practice have an impact on the electricity demand.

Figure 5: Map showcasing the 4 case study areas

3.1 Canegrowers in Bundaberg, Queensland

Background

Bundaberg is located on the sub-tropical central coast of Queensland. It boasts diverse natural resources and facilities, reflected in its offshore, coastal, riverine, city, rural and protected environments. Primary industries of agriculture, forestry and fishing contribute to over 15% of the gross regional product (Bundaberg Regional Council, 2017b).

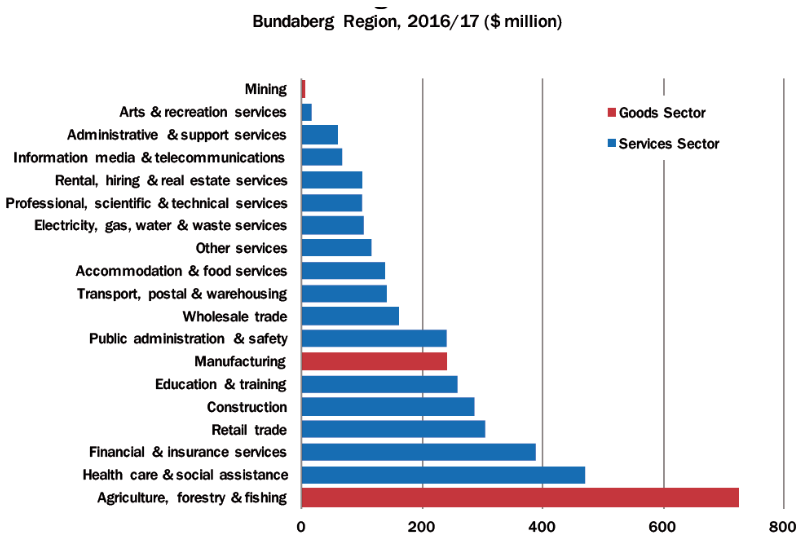

Figure 6: Gross Regional Product, Bundaberg Region 2016/17, (Bundaberg Regional Council, 2017b)

This case study focussed on cane growers in the region. Cane fields represent 20 % of Queensland's total crop area. The Australian sugarcane industry is primarily located along Australia's eastern coastline, from Mossman in far north Queensland to Grafton in northern NSW. Approximately 4400 cane farms grow sugarcane on around 380,000 hectares annually. They supply 24 mills, owned by 8 separate milling companies. The vast majority of cane farms are owned by sole proprietors or family partnerships. The mill ownership structures are a combination of publicly owned entities, privately held companies limited by guarantee, and co-operatives (ASMC, 2018).

Approximately 95% of Australian raw sugar is produced in Queensland (ASMC, 2018). Bundaberg produces one fifth of Queensland's sugar crop (Bundaberg Regional Council, 2017a).The Bundaberg sugar industry is one of the major employers in the region and provides the foundation for the existence of a number of primary, secondary and tertiary industries. It employs 2,500 people and contributes in excess of a billion dollars to the Bundaberg region annually (Bundaberg Canegrowers Ltd, 2017). The major product is raw crystal sugar, which is sold to refineries both domestically and abroad. Approximately 85% of the raw sugar produced in Queensland is exported (ASMC, 2018).

The estimated water requirements for a high yielding sugar cane crop are between 1100-1500 mm/ha over the growing season supplied through natural rainfall and/or irrigation. Under irrigation, water is provided on an as needed basis (AgriFutures Australia, 2017). Sugarcane accounts for over 40 % of agricultural water usage in Queensland. Sixty-six % of cane farms in Queensland have some form of irrigation. Bundaberg particularly is an irrigated district. This has immense energy implications on irrigated fields with water being pumped 24/7. Not all growers have dams on their fields that can be used to store water.

A sugarcane crop will normally grow for around 9-16 months before it is harvested for the first time. Each subsequent crop known as a ratoon crop is harvested annually thereafter until the cane is ploughed out after five or six ratoons and the ground fallowed prior to planting again. The crush or harvesting season for sugar cane is between June and November every year. Heavy-duty machines called cane harvesters cut the cane stalks off the plant at its base. These are then transferred to the sugar mill to produce raw sugar. Cane fields and sugar mills share a complementary energy relationship, with the sugar mills running when farms are not being irrigated.

A 75MW solar farm being developed at Isis River, Childers will include 400,000 solar panels spread over 180 ha to create enough energy to power 65,000 homes. Esco Pacific is also behind the 98 MW solar farm at Susan River, between Maryborough and Hervey Bay (ESCO Pacific, 2018; NewsMail, 2018).

Methodology

The two approaches for data collection for the case study were a focus group discussion and on-farm visits to observe the integration of RE with farm operations.

The focus group discussion was attended by 6 participants. The discussion was hosted by the Bundaberg Canegrower's Association and led by the research team. The aim of the discussion was to capture a broader audience and gather data on opinions, perspectives and reactions to RE connection issues of growers. The guided discussion focused on the approaches adopted by the growers to include RE in their energy mix.

The group included a grower who had a small solar installation, and two growers who were considering the opportunity. It also included a solar irrigation consultant, a solar supplier and an electrical contractor. They were able to provide a broader perspective of the issues faced in the Bundaberg area.

The field visits to different farms highlighted some of the approaches growers have adopted to overcome high energy prices. It included two medium scale installations (30-100 kW) on farms that were using the grid or diesel as a back-up for irrigation. Neither of the systems were exporting electricity to the grid. There was also a visit to a farm that adopted energy efficiency measures to manage cost escalations.

The observations and discussions are summarised below.

Discussion: Key Barriers

Cost as a primary driver for change

Over the past nine years, electricity costs have risen more than 130% (Canegrowers, 2018). The major driver the growers quoted for installing or considering RE was the cost of grid electricity.

"Solar has been tangled in the energy war, and it is not being used for the reasons it should be"

The critical issue with optimising water and electricity use efficiency is mostly around the economics of the system required to deliver the right amount of water at the right time in the right place. The high costs of electricity deter growers from irrigating at all or at the correct times which impacts farm productivity. Water allocation can be left unused till the end of the season, when the benefits of irrigation are smaller or the allocation is sold separately.

Upfront costs of integrating solar power with on farm equipment

The upfront cost of setting up solar to suit farm conditions can also be a major barrier for growers. The main use of on-farm energy consumption in the region is irrigation. Irrigation is either through ground bores or through the canals. Cane farms are large and multiple pump sites are distributed over this area. Growers have been advised that costs and logistics often do not allow each pump site to be powered individually by solar panels, primarily due to the underground infrastructure that is required to connect them to the grid individually. The alternative is for growers in addition to the cost of panels, also incur the cost of the distribution system.

Another concern is that as irrigation for cane grower is a 24/7 requirement, the value of the benefit offered by installing solar is small relative to their load. If not supplemented by a form of storage, growers do not always see the value of installing solar power. The cost of batteries is still economically prohibitive.

Access to finance

Participants were aware of differ financing opportunities available that offered good terms on repayments and interest rates. Off the balance sheet loans were used by some growers for other farming equipment, which can also be adapted for solar panels. However, it was observed, that interest rates for solar power were not very high so there may be much scope for savings.

Assessing the value of solar power

In many irrigation schemes in Queensland, growers have not been using their full water allocation due to the cost of electricity. The use of solar on-farm was allowing growers to maximise productivity of existing crops and also plant additional crops commensurate with their water allocation.

While there is a recognition that solar is one of the cheapest sources of generating energy, the problem faced by cane growers is that they use the asset for only 6 months a year. This will further reduce if it rains a lot in a particular year. An oft raised concern is that the asset sits idle for the other 6 months. Thus without feed in tariffs, growers do not see value in installing solar.

Another challenge discussed was the uncertainty in calculating the value solar brings to the farm. Seasonal variations determine how much energy can be generated but also the energy needed for irrigation. Dry years require more energy to be spent on irrigation compared to rainy years provided there is water allocation available.

Most growers assess the value of solar PV systems on the payback. This depends on the tariffs offered over the assessment period – both feed in tariffs for solar power and the cost of grid electricity. The more the system is used, the better the economics. Another approach proposed was to treat the system as an investment, an integral input, similar to the way a tractor is treated. Another way of looking at it is to understand the rate of return on investment over the 25 years of the panel's life[12].

One point of view expressed was that if the system is saving the grower money, does it matter if the saving is over the entire year or half the year; and then does it matter if the system is idle for half a year if savings are still delivered? This speaks to the lack of information and understanding on the economics of on-farm solar. During the discussion, no consensus was achieved on this issue. However, there is merit in undertaking research to understand the true value of solar for variable irrigation loads and developing business models around the temporal constraint.

Uncertainty about tariffs and energy costs

A big concern shared during the discussion was the uncertainty about changing tariffs. There is a lack of clarity on the interaction between distributed resources and the grid in the future. Growers are hesitant to make a large invest in solar in the face of this uncertainty.

"Biggest impediment for me as a small operator"

[12] There are pros and cons with use of different metrics. In general, rate of return is more accurate as it calculates total costs and benefits. Projects with shorter payback periods do not always deliver the best return over their lifetime. The text notes farmers use rate of return on other investments and use of payback period is a factor in lower take-up.

Another contentious issue was the low feed in tariffs, especially compared to what growers were paying to buy electricity from the grid. The solar PV system sitting idle during the non-irrigating months was seen as lost income and negatively affecting the financial viability of the system. Though this discussion did not get into the actual numbers.

Consolidating multiple irrigation pumps on one meter result in high demand on the connection. The load can push growers over the threshold for large consumers. High fixed charges (i.e. network or connection charges) irrespective of actual usage were another concern mentioned. Further with the new tariffs being introduced as part of the next regulatory period, there is a growing concern that agriculture will become unaffordable. The trial tariffs have already increased costs for growers. This contradiction points to a need to reframe what is happening when growers invest in solar. It's also a risk management tool minimising exposure to grid price movements.

"With the new tariffs, I will not be farming after 2020"

It was also understood that some growers have attempted to contact Ergon to discuss 24/7 irrigation tariffs for growers.

There was also discussion on the principles of costing and valuing network infrastructure by the DNSP. This is not being explored as it does not relate directly to the research questions for this report.

Fit for purpose system

When the irrigation and farm systems were set up, energy costs were not a strong enough driver to invest in efficiency. Equipment is often old and dated and not always fuel and water efficient. Replacing this infrastructure is costly and growers reported that it is often done in an ad-hoc manner. Replacement costs are not planned but related to break downs.

There was also a discussion around appropriate sizing of systems, both irrigation systems and the solar panels. There were contradictory opinions on what the size is fit for purpose. Pumps are sized depending on the irrigation needs, size of the fields and water pressure available. Water pressure particularly, varies with time and location depending on the availability and allotment of water. Some growers recommended getting larger systems, than conventionally used to account for these variations.

Lack of trust in suppliers

There are many suppliers offering solar panels and systems, and we heard complaints installation is often substandard. It is hard for growers to understand the merits of different systems and distinguish between suppliers. There were comments that the lack of anti-dumping legislature allows for panels with all levels of quality entering into the market. There are companies that offer better terms on warrantees and quality. It comes down to growers being better informed about options.

Concerns about companies not lasting the 25 years of the life of the solar panel were also aired. The lack of confidence in these suppliers and the lack of a systemic method to assess them leaves growers at a loss, and disinclined to adopt the systems. Further stories of growers who have been burned by dubious suppliers have turned growers off solar energy. It was highlighted that the Clean Energy Council has an accreditation program for suppliers. There were suggestions for regional agriculture peak bodies to share information about standard criteria to assess / audit solar panels and offer recommendations on suppliers. However there are concerns about peak bodies recommending specific organisations. The best source of disseminating this information needs to be investigated.

The Bundaberg Canegrowers Association interviewed different equipment suppliers with a view to empanelling them, in order to help decision making among members. This is something other regional / local membership organisations can emulate to assist growers.

Location of solar panels

Growers often do not receive appropriate advice on the placement of their solar panels which impacts on productivity. In Bundaberg, new metrological stations have been set up to have a better understanding of local conditions and the impact on the electricity generated. Participants saw merit in sharing guidelines for panel placement with growers through the existing newsletters and communication. Having a quick reference guide that draws on existing case studies, articles, etc. was also seen as being helpful. While there are many guides available online, there still seems to be an information gap. It might be useful to consolidate and publicise existing material.

Grid connection approval

For the larger systems, there are costs associated with getting the approval and grid safety requirements. The process is managed by the principal contractor or supplier, with only a small level of involvement from growers themselves.

Some growers shared that they had received estimates of about $8-10,000 from Ergon to carry out assessments and feasibility studies to understand the export potential for the site. These costs put them off the process and they chose not to export any electricity. Grid electricity or diesel were still used as backup.

There is also not enough understanding for how export thresholds are established for growers. There were a lot of questions around the basis for establishing the 30 kW limit for export and 100 kW threshold for large generators. It was expressed that there was not enough explanation provided from Ergon to growers to understand these constraints and limitations.

Innovation & new technologies

In a trial project using a custom-made variable speed drive, the grower ran into challenges on getting approval from the DNSP. It was suggested that it be sent to China to get tested. The project team refused this course of action and built evidence to support the standardisation. This was done with the help of the in-house technical team and local experts.

Currently, conditional approval has been granted post negotiations, while there is an effort to develop relevant standards to test and validate innovations in this space.

This issue has been raised in literature reviews as a barrier to entry, innovation and competition.

Alternative models

Ideas of local energy trading between different growers and users as well as community energy were discussed. The concept of sharing electricity between sugar mills and canegrowers was explored as their energy usage patterns are very complementary. Micro grids are another potential solution for such load profiles.

However, there are very high charges associated with using the existing electricity distribution infrastructure.

3.2 Cotton growers in Narrabri, NSW

Background

Narrabri is a town located in the northwest of NSW, 521 km from Sydney. The Local Government Area (LGA) has a population of 13,084 people (ABS, 2016). The natural landscape is characterised by floodplains, rivers and creeks and the Pilliga Forest.

The area is considered to have some of the best and most productive agricultural land in the country. With highly fertile soils ideal for cotton growing with black vertosol soils with good water-holding capacity. The local industry is characterised by a diversity of agriculture, energy and education sector. The region is rich in coal and gas resources and is a potential energy storehouse. This case study focuses on the cotton growers in the region.

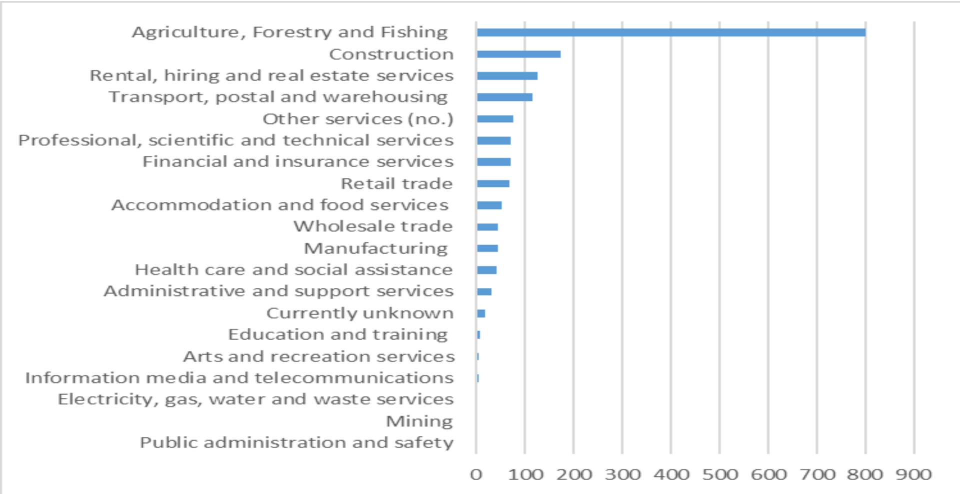

Figure 7: Business by industry in LGA Narrabri June 2015. Source: (ABS, 2017)

Narrabri is located in the north-eastern section of cotton region in Australia. On average cotton represents between 30% and 60% of the gross value of the agricultural production in regions where it is grown. The major production area in NSW stretches south from the Macintyre River on the Queensland border and covers the Gwydir, Namoi and Macquarie valleys. In NSW, cotton is also grown along the Barwon and Darling rivers in the west and the Lachlan and Murrumbidgee rivers in the south. In 2016/17 the industry produced 3.8 million bales on 472,941 ha with an output of 1861 kg lint/ha (Cotton Australia, 2018).

The Australian cotton industry is one of the country's largest rural export earners and helps underpin the viability of more than 152 rural communities. There are more than 1200 cotton farms in Australia, roughly 66% in NSW and 33% Queensland (Cotton Australia & Cotton Research and Development Corporation, 2014), which comprise 14% of the total farm area in the country. The average cotton farm is family owned and operated but there are also large corporately owned properties with international shareholders.

Three solar farms are currently proposed for the Narrabri Shire with a total of 235 MW. Canadian Solar is planning to develop a 60MW solar farm about 5 kilometres south-west of Narrabri in northern NSW. A $100 million Southern Solar Farm is planned on 200 hectares at Vince and Kerrie Haire's property 'Glenville' on Old Gunnedah Road, about 7 km from Narrabri. The 60 megawatt farm - the precise size dependent on negotiations with Essential Energy - would be capable of generating 117 gigawatt hours of electricity a year, enough to power about 18,000 homes (Sonti, 2017; Editorial, 2018).

Methodology

The focus group session in Narrabri was attended by three cotton and grain growers, one representative of Cotton Info and two representatives of Cotton Australia. Interviews were held with two growers who run cotton and grain farms near Narrabri and Moree.

The conversations in both the focus group and the interviews were supported by questionnaire. However, the questions needed to be adapted to the growers experience and their contact with the DNSP.

The Gunnedah growers cultivate cotton and grains which are irrigated by a combination regulated (high or general security), unregulated or aquifer-based water use. The irrigation methods included only pump with diesel, multiple bores – of which majority are electric, and the rest diesel, or just diesel irrigation bores and electric river pumps.

While all of them had considered solar PV, none of the growers had planned for or installed a larger RE system for irrigation purposes yet. Only one person has a very small solar pumping system for spray use around his house. Hence, the following findings are based on the growers' understanding of the perceived opportunities and challenges associated with RE system.

Discussion: Key Barriers

Cost as a primary driver for change

The growers participating in the focus group, showed great interest in RE systems in particular to save on their increasing electricity bills. This is consistent with general observations[13] that cotton growers generally take on new technology quite quickly; facilitating this outlook is grower collaboration with researchers and access to innovations.

The main cropping and irrigation period is approximately four months in this area (for cotton summer months from November/December to February/ March). In this time, growers want to pump 24/7 in order to ensure an effective water use on their fields. Bore water requires a lot of electricity to be lifted and solar solutions could help to reduce electricity bills. Additionally with individual meter charges going up, there appears to be more of an incentive to make the shift to solar.

Integrating energy systems with irrigation systems

Among growers there is a cultural of technical openness and looking for new opportunities to increase efficiency on the farm. When considering solar solutions growers are required to install hybrid systems that would bridge night times, drops in solar radiation and loss of full capacity (e.g. clouds).

But the growers also pointed out that the condition of the irrigation system, which are often old and not at peak efficiency, is not optimum. This has to be factored in while designing the (new/newer) RE systems.

"If you want to be efficient you have to change things over in its outlay."

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[13] As tracked in the annual Grower Survey conducted by the Cotton Research & Development Corporation. The 2017 is available at: https://www.crdc.com.au/sites/default/files/pdf/2017%20CRDC%20Grower%20Survey%20Report.pdf

Growers often have several bores and the pumps can be dispersed across their fields. Further, not every pump is grid connected or has the required infrastructure close by. Thus the grid connection distance to pumps is a challenge for growers designing a system. Another limitation in the availability of land around the pumps to install the panels and the ancillary infrastructure.

An important consideration is the efficiency of a dollars per mega-litre in relation to other cost factors including electricity. Thus the conversation needs to look at water, access to water and irrigation impacts on how growers use energy, not necessarily electricity.

Solar-electric hybrid system are proposed as alternatives to overcome some of these challenges. Another consideration is installing variable speed drives on the electric bore to facilitate the integration of the electrical system with the (often older) pumps.

High upfront system costs and ancillary expenses act as a deterrent

For some growers, upfront costs of a solar PV system are prohibitive. This was specifically expressed by younger growers. Growers reported that the payback period for solar is not favourable. It was somewhat ambiguous where the thresholds for making the system economically viable lies, but mostly a short payback time (4 years) was referred to as a key factor for decision making.

Besides the cost of the system, ancillary costs around the system place a further burden on the growers. These costs include costs for consultants and experts at the design and application stage. There is a need of expertise for integrating the system in farming operations, especially the pumping/irrigation system. The choice of technically compatible equipment that can be integrated with the pump which can be more costly. This increases the overall costs of setting up the system.

There is also the aspect of the cost to connect the infrastructure to the grid. Growers as well as agribusinesses are often asked to pay for technical feasibilities on certain feeders, as well as the cost of augmentation to the grid to support the requested export.

Financial viability of systems

The water allocation for each grower is limited and mostly used up in the main cropping period. That means that growers rarely irrigate beyond the four months of summer. A grower pointed out specifically that,

"*You can't just pump outside the season in a dam or so because you will lose a lot of water through evaporation".*

This brings forth challenges in regard to the economic efficiency of the system in case it is not connected to the grid and can't feed in the excess power back. In case, the system is/ can be connected to the grid, the wholesale price (variable feed in tariff) also impacts whether the growers' investment makes economic sense.

All growers did some preliminary investigations regarding the economics of installing solar on their property. There was a unanimous view;

"Economics don't stack up for installing solar yet".

The solution is seen by some in diesel-solar hybrid system. According to the Cotton Info Energy Lead the costs for diesel are on a 30 year low. Hence some growers have expressed their inclination to explore the more attractive option of diesel over solar PV systems.

Another avenue to be further explored is the small businesses tax break available. Growers could potentially claim immediate tax deductions on all purchases below $20,000. From 1 July 2016, a range of small business tax concessions became available to all businesses with turnover less than $10 million.

Power Quality

Power quality was raised as a concern by some growers. The quality of the grid supply and capability for powering the motor for their pumps (usual size 75 kW) is often limited, especially for SWER (single-wire earth return) lines that generally supply electricity to remote locations. There is a higher power demand when the motor (pump / agribusiness equipment) starts up, which requires a surge i.e. a higher output for a short amount of time. This increases the peak demand of the feeder.

Access to information

An often repeated barrier by growers was the lack of knowledge on the technical specifications of solar PV systems. Growers are busy and already have a lot of responsibilities. They lack the time and capacity to conduct individual research into appropriate solar PV systems. Unfortunately, they also report on the lack of guidance to proceed down this path.

There is merit in engaging consultants to assist in designing and integrating energy systems with farm systems. This requires consultants who have expertise in both these aspects. While some growers have availed these services, it is not very common.

Lack of trust in suppliers

A common theme seen in all the case studies, was the lack of trust displayed by growers in solar suppliers. There are only a few solar suppliers that have an in-depth understanding of the requirements of on farm solar PV systems. This is especially true in the case of integration with the irrigation / pumping system.

Most solar suppliers adopt a one size fits all approach. This however is not suitable to agricultural applications. Individual farms and their energy demand are different and often require customised solutions. There is a dearth of suppliers who can provide this comprehensive service.

Future Opportunities

Growers are excited about the prospects of integrating storage with their RE systems. The current costs of batteries are prohibitive for most growers. However, they see the potential of using storage to extend the use of RE beyond the daylight hours.

“Storage would make things different! When storage costs go down further certainly more growers would look into it”

Lack of communication

A concern expressed by some of the growers who had reached the stage of grid connection was the lack of effective communication with the DNSP. There was a lack of understanding on why limitations had been placed on export thresholds while approving grid connection applications. No details or explanations were shared with the growers to clarify the limited offer. This was also seen in the case, when growers themselves applied for approval without a third party intermediary.

100 kW Grid Connected System in Gunnedah

A successful example of on-farm grid-connected renewable energy systems comes from the Gunnedah Shire region in NSW.

A local cotton grower has 1,750 acres with almost 60% of it irrigated in a combination of flood and overhead irrigation using river and bore water. He already has two small (10 kW) systems supplying electricity to his home and workshop and to a lift pump (meeting 30% of the pump's daytime requirements). He is currently developing a third installation – 100 kW grid connected single axis tracking PV system. The system will power a lift pump with a submersible motor that will run 24/7 during the 3-4 months of the cropping season. A Zener drive system will facilitate optimal integration between the grid and PV systems, with a plan to eventually be off-grid.

The grower is motivated by his interest in renewable energy and environmental consciousness to prove that clean energy can eliminate coal. This is especially relevant with the proposed Shenhua coal mine in the same region. Economic incentives also play an important role. Earlier systems have helped him to significantly save on his electricity costs, especially due to the generous feed in tariff (FiT) scheme in place when he installed the systems. In this instance, the FiT is 9 cents/kWh. He is also receiving SRECs, which also prompted the decision to limit the system to 100 kW.

Enablers

The success of this project can be attributed in part to overcoming some of the barriers discussed above. Being an electrician by training, the grower had the capacity and technical knowledge to design and install the PV system. Further as an accredited solar PV installer, registered with DNSP afforded him a good and detailed understanding of the process requirements and meet them.

Having the grid connection infrastructure close to the pump sites, also reduced any additional expenses he would have to incur. Also he had land available to install the system, keeping in mind safety requirements.

The viability of the system was mainly ensured through his own research, knowledge and understanding of the technical details as well as the in-house installation which allowed him to absorb most of the costs for external consultants/ installers.

Challenges

Despite the in-house expertise and experience, the time required for planning such a complex integrated system was much longer (18 months) than for the usual solar PV rooftop (household/ business) installations This included additional research to select a system that meets the location criteria (flood prone land and high winds, minimise the footprint on valuable agriculture area). He estimated that 70% of the time was spent on design and planning while only 30% on the actual construction of the system.

Financially, the high upfront costs and out of pocket expenses for technical equipment to ensure a quality integration with the pump proved to be a challenge (expensive inverters to protect the submersible electrical motor from high voltage spikes). There were also additional costs to connect to the grid (metering costs). Even though the payback of 4 years, was acceptable, the upfront costs were still a challenge.

The DNSP only approved the export of 50% of the system's capacity back to the grid, which has an impact on the economic viability in the off-peak period. Communication with the DNSP was another barrier. He received no details or explanation for the limited export capacity.

"Economics don't stack up unless you contribute a lot of personal effort…I feels like a pioneer in the industry".

3.3 Cotton growers in St. George and Dirranbandi, Shire of Balonne, Queensland

Background

The Shire of Balonne has a population of 4391 (ABS, 2017) and is about 500 km inland from the Queensland's capital nestled just above the NSW border. The shire encompasses a total land area of more than 31,000 km^2 comprising St George, Thallon, Dirranbandi, Bollon, Nindigully, Mungindi, and Hebel.

Key industries are agriculture with 31.2%, followed by health care and social assistance (10.4%) and retail trade (9.1%) (ABS 2018). The Shire's most important economy is agriculture, in particular the production of cotton, grain, sheep and cattle. In the last decade new economic areas such as tourism, and horticultural crops have been growing. In 2016-2017 the Council registered 14,440 visitors for 2016-17 and increase of 5% to the previous year.

Central to the growth of the agriculture sector has been the development of the St. George irrigation system with channels mainly based on rain and river water sources.

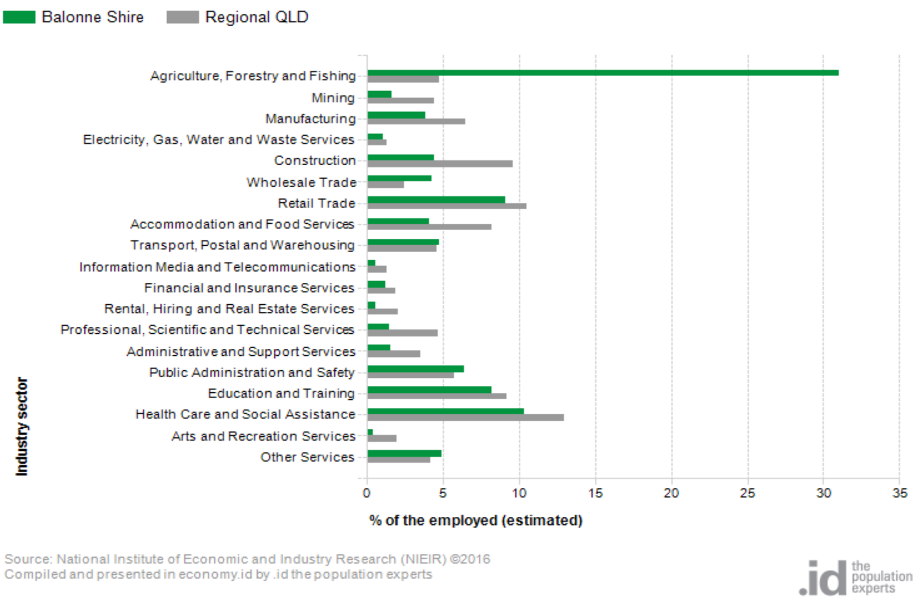

Figure 8: Employment by Industry (total) 2016/17. Source: (.idcommunity, 2017)

Methodology

Two focus group sessions were held in St George and Dirranbandi. They were attended by a total of 12 cotton and grain growers, including two Gin managers and one representative from the Balonne Shire Council. The conversations were held onsite of the Gin and on the property of one grower.

The questionnaire was used to guide the conversations. The questions were adapted to reflect the growers experience or inexperience with the grid connection process.

While bore water is used for drinking supplies, the Balonne Shire Growers rely mainly on surface water pumped into irrigation channels. That means, the growers are more heavily dependent on the availability and the natural cycle of the resource.

Discussion: Key Barriers

Cost as a primary driver for change

As seen in the other case studies, the main motivations for growers in St George to investigate and consider solar PV are increasing electricity costs and the falling price of solar PV systems. Secondary motivations include improving the efficiency of existing irrigation processes. Some growers expressed environmental concerns as part of their motivation to consider solar energy.

However only a few growers have implemented solar projects for their businesses currently. These are mainly stand-alone systems not connected to the grid. They are generally small scale systems installed on farm workshops.

Financial Viability of systems

The variability of energy demand for cotton irrigation, presents the same concerns for growers as seen in Narrabri and Bundaberg (for cane). The season for growing and irrigating cotton and other crops in the Balonne Shire is three to four months over the summer. This short period of pumping has an effect on the economic viability of the (installed) solar PV. This is particularly the case when growers don't receive any additional subsidies or financial support, FiTs are low and export to the gird is limited or not allowed. Further costs are added due to upgrades of lines required to send electricity back to the grid.

The growers highlighted that other agriculture sectors like dairy, horticulture with refrigeration, meat production; that have a constant annual electricity demand are better suited to be integrated with solar PV.

None of the growers stated that the capital costs would pose a major challenge, yet, the payback period is a key determinant if an investment is reasonable. However, there was not enough evidence to determine what the acceptable time period would be.

Uncertainty about tariffs

Consistent with the experience in Bundaberg, growers expressed an uncertainty about tariffs under the new regulation period, starting in 2020. There are change expected in the tariff structures from Ergon in the next two years. Attending growers found that this uncertainty could make RE solutions not worthwhile pursuing. Growers that move now could lose out when Ergon reduces the tariffs.

Power Quality

St George is located at the end of the grid and the reliability of the grid has been stated as an issue since brownouts and fluctuations are regularly noticed (particularly by the Gin).

It is anticipate that, future demand increases, as in the case of the cotton gin would pose a challenge for the supply of electricity (see Box).

Grid Connection Approval

All attending growers reported on the difficulties in connecting proposed solar PV systems to the grid. This was not limited to solar PV for irrigation pumps but included small-scale household systems. They have only been approved as off-grid or behind the meter systems.

One grower was able to install three 10 kW systems on his three phase line during the Solar Bonus Scheme of the Queensland Government in 2011. However, he didn't get approval for grid connection for his additional systems after 2012 (62, 30 and 30 kW).

Half of the attending growers received negative replies on grid connection inquiries. Yet, without grid connection to obtain some return on their investment, it would not make economic sense to install solar PV for the operation of their irrigation systems. One grower notes that a minimum of 4 cent/kWh would make it worthwhile.

Communication with DNSP

The challenges in communicating with the DNSP further add to the discontent of growers.

One grower described that they went through the inquiry process for grid connection thrice. Feedback received for the first enquiry was that the proposed system (250 kW) was too large. However they did not received any guidance on the optimal size. It took them two more tries to downscale the system to 150 kW and 100 kW respective. Continuing to get rejected, the grower finally decide in favour of a diesel system.

"What killed it for us, we could not return it to the grid …. and as soon as we couldn't do that on the three different levels, the return on investment wasn't there …… how can you stump up this high capital expenditures when you don't have a return on investment".

Furthermore it was reported that frequently changing contact persons at Ergon make the interactions with the DNSP difficult when "*you have to talk to a new person all the time*".

3.5 MW Solar Farm powering a Cotton Gin near Dirranbandi

Cubbie Station near Dirranbandi/ Queensland is an 80,000 ha property which uses 19,000 ha for irrigated farming with cotton going to the onsite Gin. Cubbie Station is in the process of installing a 3.5 MW on-site solar farm to meet at least half of the Gin's electricity needs with renewables.

After conducting an energy performance audit and improving the energy efficiency of the Gin, the next logical step for the owners was to consider renewable energy generation for their demand. The main motivation was to hedge against rising electricity prices and reliability issues of the grid that could be managed with solar PV and storage solutions. The costs of solar have come down significantly and made it worthwhile to invest. Moreover, they considered to add another ginning motor to their operations but this would exceed the capacity of the local grid.

However the challenges with the grid connection process have prohibited the project from commencing today. Three years ago the initial project proposal was a 100 MW solar farm out on the farm with the intention to sell electricity back to the grid and help stabilise the electricity supply to the benefit of the local community. Since then the project had to be scaled back three times since Ergon didn't approve the grid connection because it would have required major upgrades of the local grid. In this process Cubbie Station was supported by different consultancies providing technical expertise and fulfil Ergon's request for modelling data of the systems performance. However the inquiry with Ergon took several months without any security or knowledge about the outcome of the process. Despite seeking regular contact to Ergon, it was mentioned that Cubbie Station didn't feel supported in the process to work towards a joint solution.

The final project proposal comprises 10,000 solar panels (3.5 MW) installed on the southern end of the Gin site with the construction beginning in October 2018. The system will operate behind the meter, since no approval was received for feeding access electricity to the grid. The ultimate goal for Cubbie Station is to become an electricity exporter since the ginning period only runs between April and September (usually for four months) and the solar farm could be an additional income source.

3.4 Murray and Murrumbidgee Valley, NSW

Background

This case study focussed on two valleys in Riverina – the Murray and Murrumbidgee valleys. The major towns in the Murray valley are Albury–Wodonga, Yarrawonga, Echuca–Moama, Deniliquin, Swan Hill and Mildura. While these valleys only covers about 3% of the total Murray Darling Basin area, many of the major rivers of the Murray–Darling Basin enter the River Murray in this region. One of the major tributaries is the Murrumbidgee River.

The Murrumbidgee Valley, in southern NSW, stretches from Cooma in the east to Balranald in the west, north to Temora and south to Henty. The Murrumbidgee valley is highly diverse, with the Alpine areas of Kosciuszko National Park and the Monaro plains, the grazing and grain belts of the south west slopes and plains and the shrub lands and grasslands of the semi-arid western Riverina.

Dryland grazing and cereal-based cropping account for more than 75% of land use and 5% is irrigated. Commercial forestry occupies about 3% of the catchment, mainly in the east. Tourism is also an important industry for the region. The region generates about 37% of all RE produced in eastern Australia, through the Snowy Mountains Hydro-electric Scheme (Murray-Darling Basin Authority, no date).

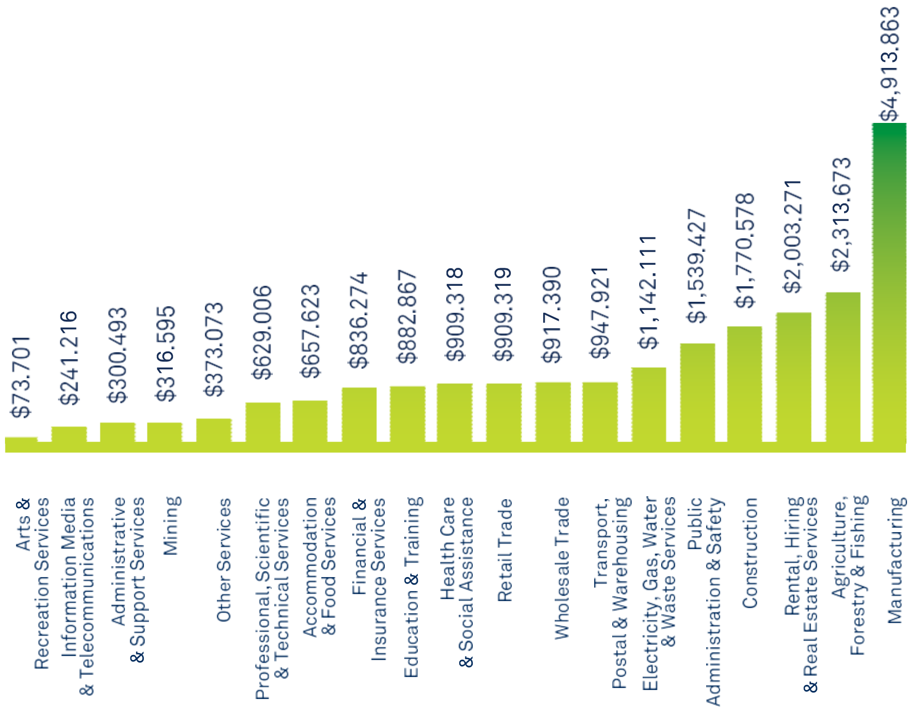

Figure 9: Riverina, output by industry ($M) (Regional Development Austral Riverina NSW, 2018)

Irrigated agriculture is one of the key users of water in both these valleys. Irrigated agriculture in the Murrumbidgee produces 25% of NSW total fruit and vegetables, 90% of NSW potatoes, 80% of NSW carrots, 42% of NSW grapes and 50% of Australia's rice(NSW Irrigators' Council, no date). Thus there is a large variety of crops grown in the region that have an impact on the water and energy demands for irrigation.

The case study included dairy farmers and growers cultivating cotton, grapes, almonds, popcorn, etc. as well as growers involved in large scale solar farm development.

Methodology

The focus group discussion in this case study was attended by 6 participants, all of whom were dairy farmers. The majority of the group already has solar installations, though some were using it to power their home and not the farm. The discussion was held in Deniliquin and lasted two hours, where the growers shared their experiences and interactions with the grid approval process. This group included both early adopters who had gotten their installations a while ago and were in the process of installing or planning upgrades as well as growers who had just started thinking about solar alternatives.

The site visits and individual interviews were with a cotton & vineyard grower, a grower who has leased his land to a solar farm developer and a cotton gin. The range of installations ranged from small to large and the level of involvement also varied with the size of the installation.

The observations and discussions are summarised below.

Discussion: Key Barriers

The push towards solar

Energy costs and environmental concerns were the two main factors that encouraged growers to investigate RE options. Changing energy pricing policies were a key trigger for growers to adopt RE energy. These included initially, the end of the 60 cent/kwh feed in tariff Solar Bonus Scheme and now the projected increase in the demand tariff. However, growers appear to be quite uncertain about when to enter the market given the accelerated development of the technology (increasing efficiencies and decreasing cost).

Due to the rebates available, diesel is seen as a good short term solution by many growers. It was discussed that while the removal of these rebates might encourage growers to adopt RE, it will result in increased fuel costs for tractors. While a rebate removal is not planned, this was discussed by farmers as a potential motivation towards RE.

Economic case for solar

With the large upfront cost of solar panels and the intermittent nature of energy use for irrigation for only a few months, the economics for solar PV systems sometimes do not often stack up for growers. There are growers who are using diesel to power their irrigation pumps as subsidised diesel works out better economically than grid electricity or a new solar PV system. Further the prohibitive costs of batteries that can bring more reliability to the system, also prevents growers from taking the plunge.

"If it couldn't pay for itself in five years, I wasn't even going to think about it."

On the other hand, dairy farmers with a more regular load around the year found solar PV systems to have technical and economic value when integrated with their systems.

There is however, more acceptance of the value solar brings in powering household demand, even on the farm.

Access to finance was not seen as a barrier.

Lack of trust in suppliers

There is a large number of suppliers present in the market. The range of capabilities is vast and difficult to assess for growers. It is a young industry and there is a lot of ignorance in the market, especially on integrating solar PV systems with farm requirements. There is a level of frustration about growers on trying to understand technical specifications of energy systems.

Also, with the solar industry booming, there are unscrupulous suppliers in the market. There is a perception that suppliers are selling solar as a standard product without understanding how the panels integrate with farm energy demands and equipment. Companies go bust and come back in new avatars and there seems to be limited protection for growers against these suppliers. The ombudsman is seen as one of the avenues to deal with these recalcitrant suppliers, however, the costs and time spent on litigation makes this option unattractive. While there is anecdotal evidence on this, the research scope did not cover the extent to which this mechanism has been utilised.

This challenge is not limited to individual growers. Large consumers like gins are also faced with the challenge of finding a trustworthy supplier. There is limited information provided on how to design a system best suited for the purpose.

There was a need expressed by growers to have more agriculture experts on supplier teams selling solar PV systems in regional areas. Ratings for different products or guidelines for choosing specifications would be appreciated by the growers to assist in the decision making.

Need to develop technical skills

There were varying opinions about how much technical expertise growers are keen to develop to design their own systems. Many growers listed the lack of good design and integration of solar PV systems with farm equipment as a major barrier.

"What's it going to take? Does it take me getting up to speed in an industry that no one else knows?"

"The more we understand about the ins and outs of how it works and what it can do, the better value that we can get out of it."

Not all growers have the appetite or time to be able to figure out the best technical configurations of a solar PV system. There is a reliance on engineers and consultants to provide that expertise. However, not all suppliers offer that service, and not all growers are aware of its importance prior to installation. It was mentioned as a key success indicator by growers who had successfully integrated solar power on their farm.

Growers recognised the potential of batteries for storage as well as of thermal storage especially for dairy farmers. Smart shifting of loads like cooling can be used to capitalise on solar power generation. However, growers did not receive adequate technical confidence from suppliers.

Information workshops and sharing stories from other growers who have successfully integrated solar in their farm operations were much appreciated. It was also recognised that there weren't enough of these sessions to reach out to everyone. Consequently, there is still a need for industry bodies educating growers on what's available.

Partnerships between growers and processing plants

Cotton is a popular crop in the Murrumbidgee catchment. Thus, there are a few cotton gins. Cotton gins are energy intensive for 5-6 months in the year. Energy is a big cost in the operations of the gins and there is an interest to look at solar energy as an alternative. However, there is a concern of what will happen to the electricity produced over the other half of the year.

Conversations with the DNSP about exporting the electricity back to the grid have not brought clarity with answers ranging from no export to partial export with inadequate explanations.

An alternative being explored is sharing panels between growers and the gin for 6 months at a time by physically changing the location. The reduced transmission and distribution costs / network charges can go towards the transportation of panels between sites. Local electricity trading using low voltage transmission lines to avoid high transmission cots was also another idea being explored. It is important to get the DNSP involved in these discussions to co-design delivery models to reduce energy costs.

There were also discussions around the power of collective bargaining and negotiating affordable energy deals from retailers for the cohort of growers and cooperatively owned processing units like the gin. However, there is not a lot of confidence in the retailers to be able to offer competitive pricing for export of electricity.

Export thresholds

There is a lack of understanding on export thresholds among the growers. The inconsistency in answers received from the DNSP has contributed to the confusion. This was discussed with the DNSPs who shared that the thresholds were published on their websites. This confusion between the understanding of the growers and the DNSPs speaks to a breakdown in existing communication channels.

Growers are aware of the large numbers of application submitted for connection approval. There is not enough clarity on criteria for selection and approval. Concerns were raised on understating how priority was assigned to applicant if any, including aspects of priority to local consumers or prosumers. The other concern is the available capacity after a large solar developer has established a solar farm. There is a need to provide clarity on these aspects before growers can go ahead.

Communicating with the DNSP

Growers reported inconsistency in the responses received from the DNSP. In one instance, a grower narrated how on trying to get quotes for a solar PV system from different suppliers, he was asked to pay for each of them putting in a submission to the DNSP. When he tried to apply as a grower, the request was denied saying only suppliers could ask for the information about his property. So the message essentially was that whenever somebody provides a quote, they have to pay Essential Energy which increases the cost. In the same area, another grower rang up the energy company and got someone to visit the site and provide an estimate on anticipated costs to augment the network, with no consultation fees. Growers perceived that interpersonal relations play an important role in getting response from the DNSP as compared to following a set procedure.

“You have to pay if you want to get power, and you got to pay when you don't want to.”

Communication challenges with the DNSP were not restricted to the grid connection process. Growers also shared difficulties in reaching to representatives about existing connections and grid infrastructure on their properties. One grower was asked to pay for the removal of lines that were no longer being used, but were running through his property. Later when the DNSP decided they did not want or need to service the line, they came and removed it themselves for no charge. There were also questions around shifting from one phase to three phase connections. There were also concerns around the quality of power supplied to growers.

While these experiences are anecdotal, they reflect the vast range of responses received, contributing to a lack of clarity in the understanding of processes among the growers.

Social license to operate

Large solar farms of state significance require public consultations in NSW (and Victoria). With large solar farms taking up all of the sub-station's capacity, there might be discomfort with the other citizens in the region. There have been instances where these developers then contribute to the community through funds and infrastructure to develop their social license to operate.

There is a feeling of trepidation about developers reaching out to growers to lease their land. Growers often do not have the capacity to undertake a full-fledged due diligence and assess the developer. It helps alleviate some doubts if the company can show a strong investor / ownership base and track record domestically and internationally.

Leasing land for solar farms

An emerging trend is growers leasing their (least productive) land out to companies to develop large scale solar farms. In this case, the growers typically sign over their land for a fixed period and get periodic rent payments. They do not typically access any of the electricity generated on their land.

Farms sites close to sub stations and existing grid infrastructure are preferred and these growers are sought out by solar farm developers. In the case that was visited, it was understood that the farm was sized as per the available capacity on the particular sub-station. In later discussions, this was raised as a concern by other growers on their **ability to export** electricity to the grid.

As seen, in other case studies, the negotiations with the DNSP and the approval process was handed by the developer. It is seen as a passive investment, with no engagement over the technical issues. The grower's only responsibility is the **negotiation of contracts** with the solar farm developer. This most challenges were around understanding the legal requirements to negotiate the best deal possible. The **lack of local legal expertise** / capacity to advise growers on these contracts compounded the difficulties.

One of the barriers raised was around the **valuation of land** to calculate the lease over the extended period of time. With the rapidly changing electricity market, it is difficult to anticipate the value of electricity and other serves both in the short term and the long term. Growers felt there was a dearth of information to be able to take informed decisions. There was also a need expressed in terms of building in the cost of removal and remediation (20-50% of project cost) into the valuation. With many different developers offering varying deals, it is hard to growers to choose and decide the best option for them. The offers range from a firm commitment to build a solar farm to developers testing the waters and offering small payments to assess feasibility with an option for further remuneration in case they would actually build in the future. While it generates incomes for the grower, in case the developer does not go ahead with the project, it could potentially lock up the land and prevent any other use for that duration.

A key concern in around the **end of life issues**, i.e. the removal of the solar panels at the end of the long term solar lease, especially the underground wiring and infrastructure. There are doubts around who would bear the cost and responsibility for this activity, especially since 30 years (general lease duration) is a long time. Larger projects are accorded state significance and this places environmental and rehabilitation obligations on the developer. With large multinational corporations, the foreign investment review board also monitors the company and the project. While the responsibility formally rests with the developer / company, there is uncertainty about the future of the company and farm ownership at that point.

3.5 Survey

The survey received 30 responses (27 complete). The sample is too small to be used for a rigorous statistical analysis, however they provide qualitative information on the growers' situation and confirm the findings of the case studies.

In summary, 14 responses were from growers that already have RE systems installed and 10 growers that are in the process of planning or installing a system. Three responses specified that they do not have or want a RE system. The majority of the first group had small to medium scale solar PV systems (up to 100 kW) installed on their farms (13 respondents), which were mostly financed through their own capital (7 respondents) and bank loans (5 respondents).

Some of the key results included:

- **The majority of growers were content with the systems performance**: savings ranged from 10-30 per cent of electricity cost.
- Most of the growers did their own research (10 respondents) but also relied on suppliers and consultants (7 respondents) to help inform their decision making about the projects. In addition, consulting with other growers (4 respondents) e.g. through field days play a role in information exchange and capacity building about the opportunities and options associated with RE on farm.
- **The main barriers for growers were the DNSP**: various, comments included:

  "The network provider refuses to accept our solar power as the insulators on their poles will not handle the load";

  "We aren't allowed to feed back into the grid, which means when the sheds are empty no one can use the power generated".

  Only 4 growers felt they were able to make an informed decision after receiving the technical assessment from the network service providers. In other words, 10 growers couldn't move on with confidence. This experience is also in line with that the majority didn't receive any advice on location and better placement of the system (12 respondents).

  In addition, it was stated that DNSPs are very slow with their feedback which causes delays in grid connection and loss of money.

Five growers stated that they went through a formal process to resolve the issues with the DNSP with varying degree of satisfaction about the outcomes. Comments were:

"Not satisfied. Limited to the size of arrays allowed. Overvoltage issues with the grid not resolved".

"Yes. Provider sorted the problem".

"We were promised a net meter would be installed for us. It didn't happen. We eventually paid for meter & installation ourselves".

In general, most of the growers assess their engagement with the network service providers as rather poor – eight growers give evidence to this.

A final comment by a grower summarises the overall challenge for growers:

"90% of energy on farm is diesel yet this survey dealt with grid connected systems which are a lot more complicated for farmers to negotiate renewables when they are having to deal with network providers. What helped us was finding a company that understood both water pumping and electricity. They are installing a 500 kW system nearby so we know from the farmer they are trust worthy."

The feedback from the second group of growers, who are in the process of planning or installing a system was very similar to the above responses. The biggest hurdles were seen in understanding the credibility of the supplier, that they are only using the solar panels for a limited amount of time and ultimately making the economics work for that, and lastly a lack of knowledge.

In summary, the results indicate that there is an appetite and existing opportunities for growers to tap into RE deployment, but they face multiple hurdles, including the grid connection process.

Recommendations from Growers to other Growers

Growers who had already invested in on-farm RE were asked to share their top tips with the other growers. There was a lot of synergy in the feedback we received from the growers. The recommendations were around two areas that came up as barriers; designing and sizing the system and the grid connection process.

Design & Planning

- Know your needs
    - Decide what you actually want to achieve. This will determine the design and equipment you have to acquire e.g. electrical, diesel, storage hybrid system.
    - Figure out what do you want before you get in touch with suppliers.
- Be informed
    - Have access to information and success stories from other growers.
    - Buy reliable equipment. Quality is important. Backup services are important when selecting equipment otherwise there is enormous risk of capital loss.
    - Consider technical details e.g. efficiency losses through clouds and how this will impact your systems performance for the pump and the economic return
- Explore all opportunities
    - Start small and look after your own demand first
    - Check if you can reduce your electricity bill through a cheaper deal with the retailer or install more energy efficient equipment.
    - If you already have a pump station, how much can you feed back to the grid in off peak periods? What is the feed in tariff?
    - For large farms, get a clear understanding of legal obligations and contract requirements starting with the Development Approval (DA).

Grid Connection

- Know the process
    - Get more clarity on network connection processes.
    - Prepare for uncertainty and waiting periods in the enquiry process
    - Consider the option of connecting to the grid on a non-export basis
    - Use available / historic data to calculate your demand and export potential. Hypothetical figures create uncertainty.

3.6 Barriers Summary

This section attempts to summarise and categorise the different challenges growers shared over the course of the case studies. It is important to recognise that though the research question was focussed on the grid connection approval process, energy is a complicated issue and many other barriers were brought up by growers. This matrix attempts to report on them across the three key steps, growers undergo to install on-farm RE with the grid connection as the central theme.

1. **Pre Connection:** This is the preliminary phase that includes planning and designing the system. The key stakeholders the growers engage with during this phase are equipment suppliers and / or consultants. On the economic side, this is also the point, when growers assess the economic viability and sources to fund the system. This involves the preliminary enquiry step depicted in Figure 10.
2. **Grid Connection:** This phase comprises of the engagement between the DNSP and the representative of the grower to negotiate a grid connection approval. This is guided by steps laid out by the NER and the DNSPs. This involves the detailed enquiry, application and approval stages depicted in Figure 10.
3. **Post Connection**: This is the final phase in the lifecycle of the process. It includes dispute resolution and redressal if any. Many growers do not actively participate in this phase. This is beyond the process depicted in Figure 10.

Our research found limited direct contact between the DNSPs and growers; grid connections are managed by a range of third-parties for growers (either the solar supplier, an installer or consultant). The third-party that mediates the relationship between the growers and DNSPs is usually selected when growers are purchasing systems. The issues and barriers identified by growers stretch across the process for installing and connecting RE, both before and during the involvement of the network connection process. The lack of independent information or support for growers when they select the supplier - who will also generally manage the grid connection process – and confusion and mistrust was a very strong theme throughout the research. Consequently, solutions need to encompass solar suppliers as well as the networks and grower relationship.

In the supplier-initiated approach, supplier(s) reach out to farmers to sell solar PV systems (often through cold-calling which leads growers confused, mistrustful and many decide it is too difficult or too expensive). A consultant may be engaged to design and integrate the RE system with farm equipment.

There are variations between the approaches of the networks to managing assessment of RE connections but the building blocks of the process are similar with one major difference: in NSW connection works are undertaken by accredited service providers under a contestable works scheme whereas it is managed by the DNSP in Queensland. This offers greater competition but also adds another party that mediates the relationship between networks and growers.

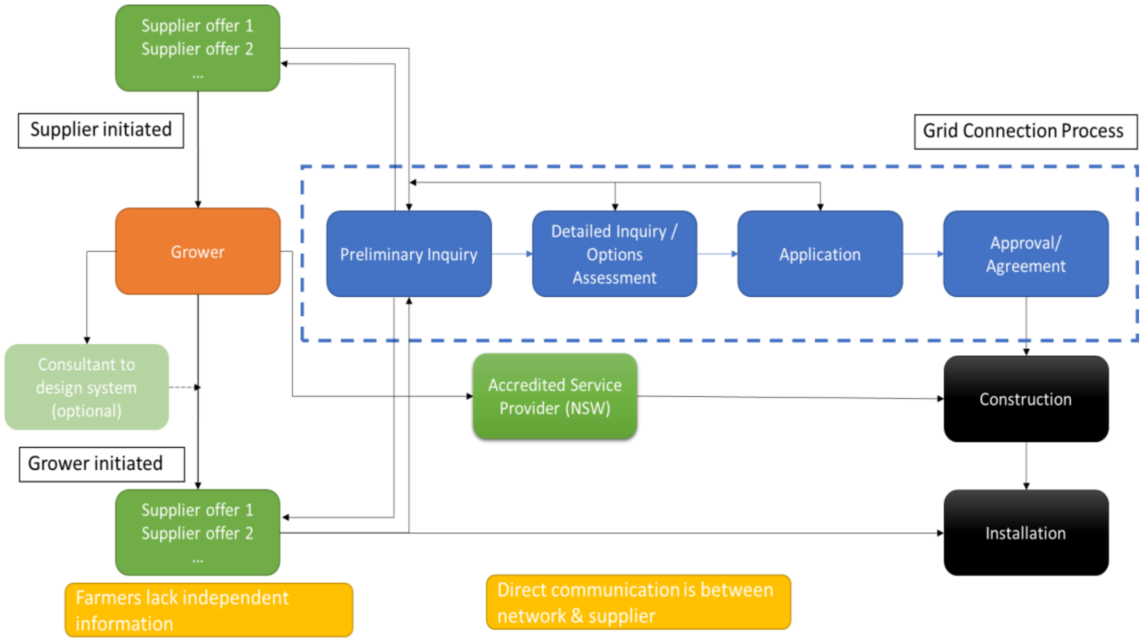

Figure 10: Installing and Connecting On-Farm Renewable Energy

It is important to note **there is effectively no process for network-initiated projects for DERs** (that could potentially lower energy costs) **that could be identified at this stage**. But the emergence of DER technologies creates opportunities for networks to initiate projects with growers that can reduce capital, operating and replacement expenditure. It is generally accepted that DERs will likely deliver network benefits in the future, but the pathway to that future is yet unclear. DNSP's are still in the process of experimenting with and assessing DER based network solutions. Whilst the benefits of these solutions will encourage DNSPs to incentivise consumers to invest in DERs in the future, the infrastructure does not yet exist to support their use as grid assets.

Table 3 summaries these barriers followed by a discussion on the commonalities and differences observed in the two state jurisdictions.

Table 3: Summary of barriers reported by growers and agribusinesses

RE Installation Process	Technical	Economic	Information/ Communication
Pre grid connection (planning & sale)	**System integration and upgrades** Old irrigation equipment can require upgrading for integration with RE adding complexity and cost **Logistics and geography** Bores & pumping station are usually dispersed across the farm – not every site has existing grid infrastructure & difficult to access Suitable land not always available for RE system at the bore sites or pumping stations **Hosting capacity and export thresholds** Limited information/understanding for growers on the hosting capacity and export thresholds for local network when planning RE system	**Financial viability of solar for variable irrigation loads** Biggest issue for cotton and cane growers – irrigation runs for 4 to 6 months so no value for the remainder of the year without grid export Energy storage systems like batteries are too costly Concern about the payback timeframe **Tariffs** Uncertainty about changing tariff structures (time of use, demand driven tariff) in Queensland created uncertainty on the business case for RE. Low feed-in tariff from retailers Rising fixed costs and demand charges for network services **Other financial issues** Younger growers can't afford up-front capital costs of solar (diesel may be more expensive over its lifetime) Higher cost of quality systems and equipment Consolidating pumps on one meter can push growers over the large consumer threshold and lead to higher demand charges	**Information gaps of solar installers** Few growers understand (in detail) solar-pumping integration or agricultural equipment and loads more generally Availability of technology, return on investment **Trust and service issues with solar suppliers** Low trust and reports of malpractice by suppliers **Lack of information on quality of third-parties** Third-parties generally manage process from sale to connection but little information for growers to distinguish good from bad **Grower understanding of solar** Gaps in knowledge about energy systems which is not a core priority for growers **Innovative models** Growers are not sure who to talk to about innovative models for their energy future

Grid Connection **(Preliminary & Detailed inquiry Stages)**	**Hosting capacity of the Network** In some areas (St George and Dirranbandi) there was limited to no capacity for exporting to the grid Export limitations (partial or full) applied in other areas due to network assessment of thermal or voltage/ frequency limits **Decision Making by the DSP** Low visibility and static modelling by the DNSPs on technical limits within local network causes the decision making process to be more opaque and possibly outdated **Queuing of applications** Concerns and lack of understanding on how previous / dormant applications affect approval chances and export limits assigned Similarly, with large solar farms coming up, concerns about hosting capacity left over for small connections	**Process costs** Significant increase in costs for increased export capacity on certain feeders (Augmentation Expenses) The scale of modelling and specialist assessment costs are sometimes considerable	**Limited direct involvement of growers** Connections are usually managed by a third party which adds a further layer to the relationship. Information from the DNSPs is not always being conveyed. **Communication to improve system design** Lack of feedback and recommendations for better placement or scale of the project – which leads to several rounds of application without a guarantee of the success of the next step **Communication on process** Different experiences on responses about who can approach DNSP for initial information – the grower or the supplier Lack of clarity about specific processes within DNSP Frequently changing contact persons within the DNSP **Communication on reasons for decision** Lack of transparency about the decision of the DNSP – the feedback only contains the capacity approved to export without explanations Export capacities seem to be assigned / negotiated arbitrarily
Dispute resolution	No use of dispute resolution processes – either for grid connection or the conduct of solar retailers. No evidence of awareness of codes amongst growers designed to improve service standards.		

4 Network Business Perspective

This chapter presents the DNSP perspective on increasing DRE within their distribution area and the challenges they face in streamlining the system. It also discusses the strategies the DNSP has for allowing for increasing RE in the grid mix as well as exploring their appetite for non-network solutions where RE can help solve some of the power quality issues they are facing or anticipating.

There are two key parties in the grid connection process for the on-farm RE – the DNSP to which the generator will be connected and the RE supplier, consultant or installer that manages the connection application on behalf of the grower. In practice, the DNSP's interviewed for this project both stated they rarely speak directly to growers and that the key interface is the service providers who process the application.

There is an inherent technical complexity to these issues but the key messages are:

- There are technical requirements that need to be satisfied to connect RE to the grid;
- There is low levels of visibility or data on the condition of the network in many farming districts, which leads DNSPs to be conservative in managing connection applications;
- Communications and information flow between networks businesses and growers are not working well at present;
- DER, smart technologies that can address technical challenges, storage and demand management creates opportunities for growers and networks to work together to solve these issues and there are some promising results from pilot projects;
- Newly established schemes, the Demand Management Incentive Scheme and Demand Management Innovation Allowance, have provided up to $1 billion in funding over 5 years for DNSPs to undertake projects that can save money by using these new technologies.

4.1 Challenges

4.1.1 Hosting Capacity, Planning & Data Visibility

DNSPs make decisions about connection applications based on a number of factors, many of which are highly specific to the area of the DNSP in question. Some core issues usually assessed are:

- The need to match supply and demand, considering time-of-use issues.
- Critical safety requirements. In particular, prevention of islanding conditions where a generator exports power during an outage, unbeknownst to the DNSP. Such requirements are standard considerations in any electrical infrastructure, but add to the weight of documentation and certification in the application process.
- Voltage issues. Voltage is typically higher on a feeder during low demand times and vice versa. Injection of power onto the grid also raises the voltage profile of a feeder. Where timing of generation and demand are poorly aligned, the resulting range of voltage on a feeder becomes difficult to manage.

- Harmonics. Depending on generator and storage inverter capabilities, as well as load characteristics, harmonic distortions may affect power quality as a result of DER installation.

Balance of Demand and Supply

The difficulty in aligning distributed generation and demand was specifically identified by DNSPs as an issue. High flows of energy have been consistently observed during the middle of the day on feeders with high RE penetration but evening demand peaks have not reduced. They noted load shifting, by moving the time-of-day operations or through energy storage, could facilitate higher connections of RE.

Potential Benefits of DERs

Whilst DERs may cause issues for grid management, there do exist opportunities for DERs to be utilised as grid assets, whereby they are called upon for demand management and ‘ancillary services’ such as voltage control. This, however, relies on communications infrastructure and standardised command protocols for consumer devices to respond to signals from the DNSP and dispatchability, which is again dependent on availability of energy storage.

This type of DER utilisation fits under a micro grid paradigm that DNSPs are planning towards. At this stage in Australia, however, networks have not developed the infrastructure or capability, with the majority of deployment of micro grid type capabilities only existing in trials.

Grid Visibility

Visibility refers to the ability of a DNSP to monitor network conditions at specific places. The sheer extent of the area covered by regional networks makes grid visibility a challenge. Single zone substations may supply tens of thousands of square kilometres of area and require significant feeder lengths to do so. The logistics in monitoring and maintaining such an extensive network are a key constraint in the ability to plan and facilitate higher levels of RE.

The Network Opportunity Maps (NOM), developed by ISF in collaboration with DNSPs provide good visibility down to the zone substation level. The NOM shows:

- emerging needs for augmentation to meet rising demand (or ‘constraints’);
- the proposed value of the investment (and therefore the value available to a solution that uses distributed energy or demand management to ease the constraints);
- and the hosting capacity for RE

However, as you move from the zone substation towards the fringe of the network, the ability to observe network conditions becomes increasingly difficult.

Analysis of NOM in the four case study regions did not identify network constraints in the regions where growers have reported issues. Figure 11 shows the NOM visualisation of the St George zone substation constraints (remembering there is no visibility of constraints below the zone substation level.

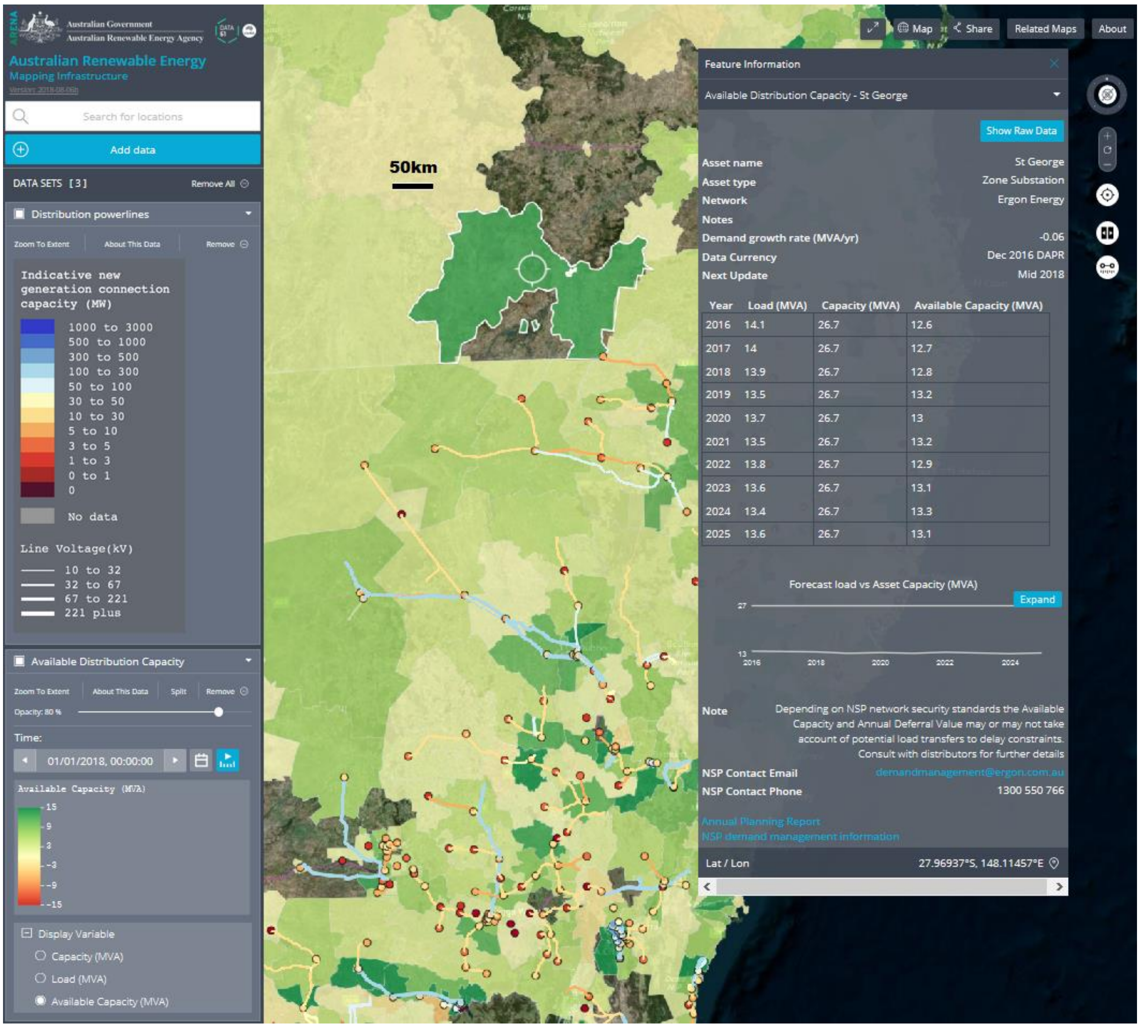

Figure 11. Network Opportunity Map (NOM) highlighting the St George zone Substation

Other than geographical considerations, there are other challenges improving grid visibility and making the information publicly available:

- Grid data is time sensitive. Therefore, the deployment of any data platform is an ongoing commitment that is challenging to maintain.
- As one moves closer to loads on the network, confidentiality issues emerge as individual property loads become easier to identify. DNSPs have an obligation under the privacy act to protect confidential data.
- Making complex technical data available to the public is not always helpful. DNSPs may prefer not to divulge information where there is significant risk that it will be misunderstood by laypeople.
- Several different systems are responsible for measuring and collecting data at different points on the network, so logistically it is more practical to make direct queries about particular areas of the network only when necessary.

Location Specific Issues

DNSPs stated that there is typically a correlation between the location of existing large site loads and higher quality grid connection opportunities. The exact reason for such correlations is often unclear but over several decades strong infrastructure encourages greater demand, and greater demand encourages greater investment in infrastructure.

In some cases, there may be a direct cause where a large farm operation has chosen to invest in network upgrades to facilitate operational growth. Whatever the causes, sites with smaller loads are typically connected to less robust areas of the network. There is a general relationship between farm operation size and capacity to connect to the grid

Planning Approaches

To work effectively with DNSPs to deliver better outcomes for growers, it is important to understand the context in which they operate. DNSPs provide a critical service and are therefore, by necessity, conservative in their assessment of any issues that may affect delivery of that service. However, DNSPs also recognise the need to progress towards a transformed infrastructure that takes advantage of DERs and are, by and large, planning for that outcome. Therefore, a tension exists between maintaining network reliability and progressive innovation on the grid.

In fringe of grid cases, or anywhere in the network where visibility is low, DNSP's will be more conservative. DNSPs noted that connection approvals are typically based on static modelling, that is, modelling that uses set historic or assumed values. This is because of the challenge in monitoring extensive sections of the network to produce data that would enable dynamic modelling capabilities. The distribution grid is the most dynamic element in our electricity infrastructure due to constantly changing loads and continuing DER penetration. Planning windows are therefore short and assessments are necessarily conservative to account for the constraint of low visibility and a lack of real-time data.

"Our connection agreements generally are limited to static modelling of what we see the constraints are on the network, which means… we'll take the conservative number as to whether or not there's capacity available" – DNSP representative

Whilst there is an intention to move to dynamic modelling for such assessments, the appropriate infrastructure to do so does not yet exist. A lack of visibility has therefore been identified as a barrier to RE for growers as it potentially forces networks to limit the options available to a grower.

4.1.2 Application Process

Overview

Under the NER, DNSPs are not obligated to connect generators at the request of customers, but they are obligated to fairly assess applications for connection in good faith. From the networks' perspective, connection application processes are relatively straight forward and clearly defined. DNSPs provide application documents that outline technical requirements for a connection application to be accepted, and generally applications are submitted by consultants on behalf of the famers. The majority of consultants have prior experience with the DNSP and are therefore already familiar with technical requirements. Where applications do not address all requirements, or the specific connection request is deemed unsuitable for the network, DNSPs communicate the issue and provide alternative options for the site where suitable. Depending on the size of the proposed connection, modelling may be required to be submitted as part of the application to demonstrate the generator is appropriate for the network.

Role of Consultants and ASPs

The role of qualified consultants has been identified as essential to the application process in most cases due to the technical aspects of connection, which are generally too technically specialised for growers. Some of the specific benefits, from the networks' perspective, that consultants provide are:

- specific knowledge of a network's processes and requirements, increasing the efficiency of an application
- reduced burden of technical communications with a customer
- certification to complete modelling
- In NSW, there is evidence that whilst consultants typically reduce the complexity of the connection process for growers, the involvement of ASPs may make the process more complex. ASPs, who may work under the umbrella of consultancies, or on their own, are certified professionals who are authorised to undertake contestable work on the DNSP. A service is contestable, under Essential Energy's definition if "the laws of the participating jurisdiction in which the service is to be provided permit the service to be provided by more than one supplier as a contestable service or on a competitive basis." ASPs work are, by necessity, closely aligned with the DNSP, as they work directly on the grid. However, as there are also operating as competitive suppliers of connection services, it may be the case that they have conflicting priorities between advocating for the customer's needs and operating within the context of t DNSP. In Queensland Ergon undertakes the same connections work that ASPs deal with in NSW.
- DNSPs have reported mixed experiences with the quality of consultants, stating that those who correctly adhere to the requirements of their processes rarely encounter issues. However, those who neglect these requirements condemn their customers to an arduous process where information is traded back and forth for long periods of time until issues are resolved. Selection of trustworthy consultants has emerged as a significant issue for growers, with growers expressing that they have difficulty knowing who will best serve their interests. Consultants are key in enabling growers to navigate the technically complex and often laborious process of making a connection request. DNSPs are relatively powerless to facilitate confident selection of reputable providers as it is not in their remit to provide guidance or to rate consultants. In some instances, DNSPs may report installers to the CEC about technical compliance issues, but this only addresses narrow issues.

Information Flows

A scan of publicly available information for those seeking connection approval showed that DNSPs provide a substantial amount of upfront information before the application process begins. Significant effort has been made by DNSPs to streamline the process by guiding consumers to the information they must provide and how they should progress their applications.

Despite these efforts by networks, growers report a lack of clarity with the process. This highlights the fundamental issue that grid connection is complex and communication of complexity to customers is challenging. This challenge is evidently unmet, as yet, and the question that must be answered to do so is: what is the practical threshold of complexity that customers should be exposed to? This must be understood before DNSPs can balance their need to communicate technical specifications and their duty to inform customers against their delivery of processes that are as simple as possible.

As system sizes increase, the information requirement from the applicant become greater and the complexity of the application increases. For example, for greater than 5 kW urban DERs and greater than 3 kW rural DERs, the application must include calculations showing that voltage increases due to the installation will not exceed a maximum limit. For systems above 30 kW, several additional technical specifications must be met, and modelling is required to demonstrate that the system will not create issues for grid management.

Whilst consultants can provide a conduit for communication with the DNSP there is some evidence that important information does not always reach the customer, depending on the consultant involved. For example, some growers have reported that they received advice on how they may alter their connection application to gain approval, whilst others indicated that they simply received a rejection with no further advice. The respective DNSP reported that, as a matter of process, they do not flatly reject applications. This indicates that the flow of information between the customer and the growers, via the consultants, is not always reliable and DNSP's have no way of knowing what information will reach the customer. This has been identified as a potential barrier to the empowerment of growers by DNSPs to identify RE opportunities that suit both the grower and the grid.

Customer equity

Networks expressed that they assess every connection application on its merits and do not seek to treat any customers preferentially over others, in keeping with their obligations under the NER. They do, however, grant connection approval on the basis of when the application was made and when the requirements are met. This means that different customers connected to the same element in the network may incidentally receive different outcomes if the full RE hosting capacity of the network has already been allocated to other customers. Rather than changing the "first in, best dressed" nature of the approval process, it is perhaps more productive to focus on ways to increase the hosting capacity of the network such that access to connection opportunities is available to all electricity consumers.

Connection Fees

Connection fees are reviewed annually and determined based on the average number of hours required to assess connection requests. Whilst the AER has approved fees for 5 kW to 30 kW systems, they are not all charged by not all DNSPs, while larger systems always attract a set fee. Systems that export greater than 30 kW in the Ergon region are classified as generators by the AER and may attract annual fees of around $10,000 to $12,000.

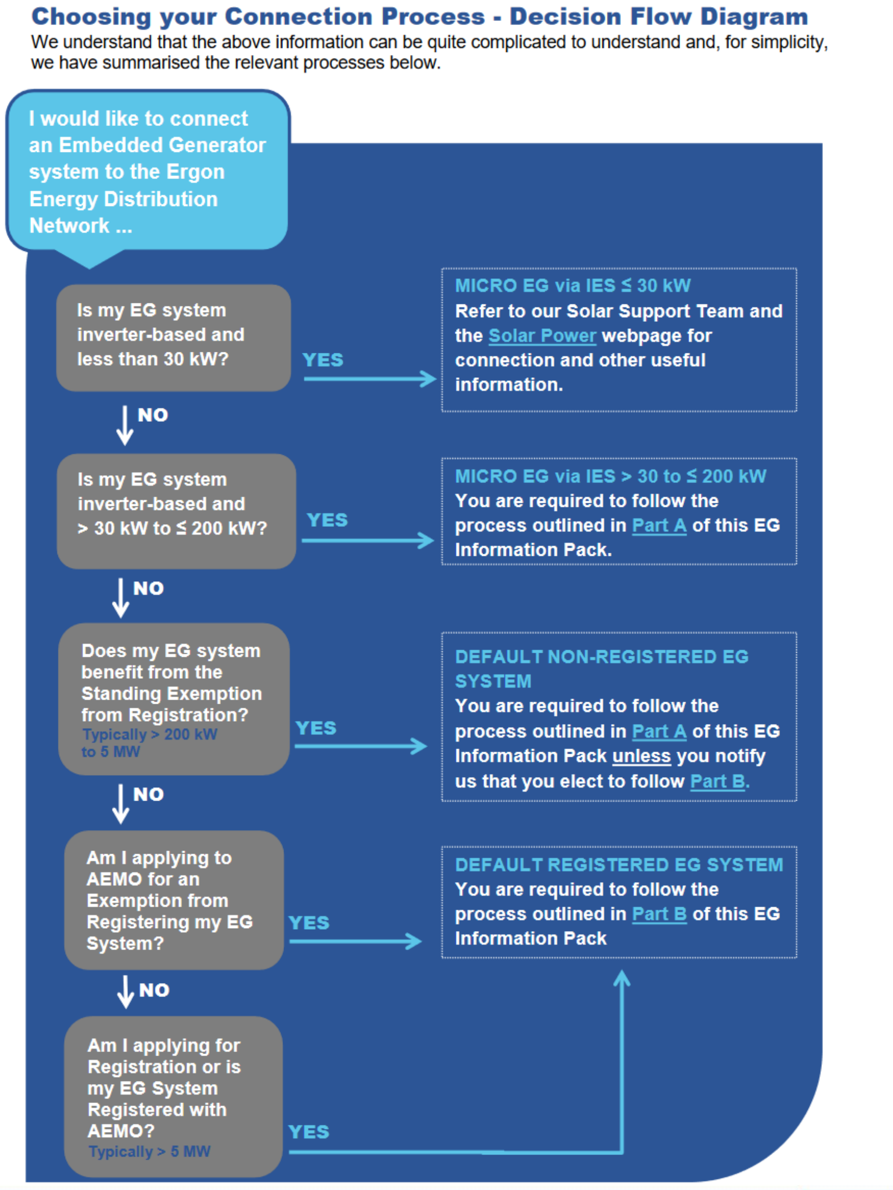

Figure 12. Ergon information provided to connection applicants (Ergon Energy, 2017)

4.1.3 Discussion and Conclusions

Table 4: Key Takeaways on Network Challenges

Challenge	Description of Key Takeaways	Actions
DNSP Context	DNSPs operate in a highly specific context with very particular needs and responsibilities. This fact does not undermine the principle that DNSPs are obligated to deliver effective services to consumers, however, it does highlight the need for a DNSP engagement strategy that allows for this contextual constraint to be managed in a way that benefits both DNSPs and growers.	
Complexity	Connecting to electrical infrastructure is inherently complex. Applications are consequently burdened with highly specific technical and administrative requirements, a fact that is unlikely to change, at least in the near future. Whilst growers are typically more technically proficient than average electricity consumers, they are not necessarily in a position to spend a great deal of time on understanding the connection process, and they often deal in the more complex application types for larger connections. This is a key challenge for the DNSP in keeping the process efficient and effective: how much complexity should growers be exposed to?	Networks need to determine the level at which growers can practically engage with the complexity of the connection process and design their processes accordingly. This should include consideration of the grower/consultant relationship
Potential Benefits of distributed energy resources	It is generally accepted that DERs will likely deliver network benefits in the future, however the pathway to that future is yet unclear. DNSPs are still in the process of experimenting with and assessing DER based network solutions. Whilst the benefits of these solutions will encourage DNSPs to incentivise consumers to invest in DERs in the future, the infrastructure does not yet exist to support their use as grid assets.	Given that DNSPs are risk averse but also engaged in innovation, a productive approach is to target solutions that satisfy both those criteria. That is, solutions that progress DNSPs toward their vision of a transformed network in a low risk way. If growers can present off the rack solutions that entice the network, they are more likely to engage.
Equity	There is limited hosting capacity on the grid, and that which is available is allocated to those who are first to apply and succeed in network connection. The challenge here is best framed as: how can hosting capacity be increased to allow connection access to all growers?	Improve hosting capacity of the network through DER innovation such that access to connection opportunities is available to all electricity consumers

Data	Whilst data is readily available describing the distribution network at higher levels, details of feeder level network assets and below is difficult to obtain. Data at these lower levels, particularly at fringe-of-grid locations, is useful in identifying opportunities where DRE hosting capacity is adequate, or where it may even be beneficial, coupled with appropriate strategies. DNSPs are not naturally orientated towards disseminating such data due to operational constraints and data sensitivity.	DNSPs need to move to more efficient and more effective forms of grid monitoring. This may include utilising customer owned/behind-the-meter assets like smart inverters, smart meters, etc. DNSP databases need to become better integrated to facilitate better data availability for opportunities identification
Information	DNSPs typically provide a large amounts of information at the beginning of the application process. However, the volume and complexity of information is likely overwhelming to growers. DNSPs have attempted to streamline the process by diverting applicants into different streams and categories, however there remains a burdensome level of information to applicants. There appear to be issues with information flow in both directions between DNSPs and growers. DNSPs reported that in all cases they communicate, in detail, issues that prevent application approval and furthermore they provide suggested options that the grower might consider where their original connection application cannot be fulfilled. However, growers report that they have received outright rejections for applications without explanation. DPSPs also reported that they rarely deal directly with growers and do not appear to be aware of the issues growers report. The disconnect between the two stakeholders is a likely contributor to existing inefficacies of the process.	Communicate to growers technical issues that constrain DRE opportunities like hosting capacity so they understand that getting in early may be beneficial If growers understand issues like hosting capacity and how they may be a grid asset, rather than liability, and the networks communicate with them about such things, there are more likely to be a host of solutions for greater access to DRE in the future
Third party roles (Consultants)	Consultants have been identified as key influencers in determining how successful a grower may be in their application. DNSPs report that consultants typically become familiar with application processes, and are typically helpful to the process. However, they did also report cases where consultants had hindered the process by failing to meet basic requirements. Interviews with DNSPs suggest that the issues with information flow described may, in some cases, be directly attributable to consultants who deal with applications on behalf of the grower. The cause of this issue is not necessarily clear, however growers have suggested uncertainty in their ability to choose a trustworthy consultant, which may indicate that there is diversity in the quality of service available, and a need to support growers' decisions.	Accreditation with the CEC may be a useful way for growers to differentiate between good and bad consultants. It may also be useful to produce a guide of what to look for, or what questions to ask, to determine if a consultant is good. It may suit growers to ask for references from previous clients as they may feel they can trust fellow growers

4.2 Network Opportunities

Distributed energy, new smart technologies and storage also provide opportunities to reduce network expenditure and improve network functioning. New schemes have recently been enacted to create an incentive for networks to pursue what are called 'non-network' solutions – the Demand Management Incentive Scheme and Demand Management Innovation Allowance.

4.2.1 Demand Management Incentive Scheme and the Demand Management Innovation Allowance.

In December 2017, the Australian Energy Regulator established the Demand Management Incentive Scheme (DMIS) to enable DNSPs to invest in cost-effective demand management. The DMIS permits DNSPs to recover up to 50 per cent of the cost of demand management projects from consumers where it will lead to lower costs overall. The Demand Management Innovation Allowance (DMIA) is a smaller fund (around $20 million per annum) for innovative projects that are not presently cost-effective.

The scope of eligible activities for the DMIS is broad:

- **Capital Expenditure** e.g. projects that avoid network augmentation by managing peak demand;
- **Operating Expenditure** e.g. cheaper solutions for voltage management. Scope exists for projects that can reduces the costs for integrating variable RE
- **Replacement Expenditure** e.g. deferring or avoids replacement of aging assets such as switchgears. Scope exists for RE projects that reduce the energy throughput on lines with scheduled asset replacements.[14]

Partnerships between growers and the networks that achieve reductions in these types of expenditure could be eligible for funds.

Figure 11 illustrates the volume of funding each network has available annually to spend on projects under the DMIA (striped) and the DMIS (colour block).

[14] For example, Ausgrid project.

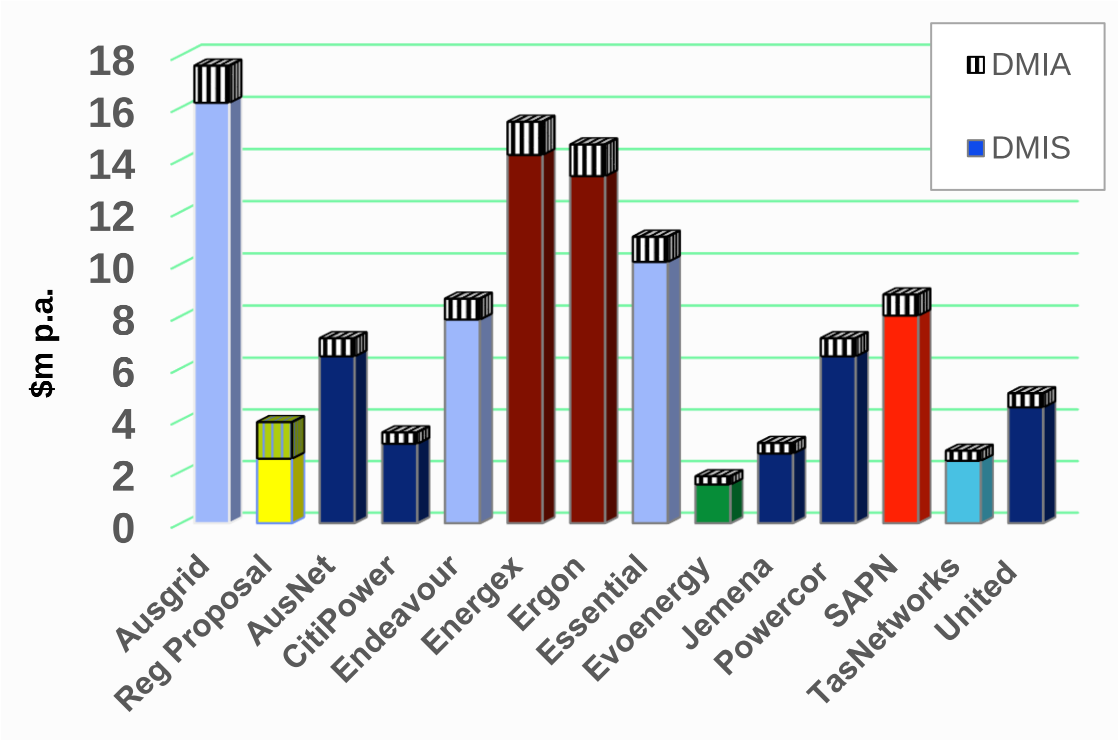

Figure 13: DMIS & DMIA, Additional Revenue for Network ($m, p.a.)

Essential Energy can access around $10 million per annum and Ergon almost $15 million per annum.

4.2.2 Renewable Energy and Load Management

Renewable Energy and Load Management (REALM) could have a significant role in easing the network constraints for on-farm RE in two ways:

- increasing the output of RE that can be consumed on-site in the context of export limitations;
- reducing the need for network augmentation by reliably providing additional energy on-site and providing additional network services.
- Networks have not yet invested in behind-the-meter solutions but there is scope for pilot projects to test the role of REALM through DMIS and DMIA.

4.2.3 Role of solar PV & battery to support power quality

Networks Renewed, an ARENA funded project demonstrates the potential for smart invertors to regulate network voltage. Managing voltage is an important function of the DNSPs, now and into the future, to ensure that Australia's electricity remains reliable. Local power sources like solar and storage may increase the range of voltages seen on the network, potentially leading to more frequent voltage excursions. However, controlling them strategically may actually enhance network power quality.

Solar, batteries and other generators are connected to the grid through inverters. 'Smart' inverters have embedded internet-of-things (IoT) technology and a host of dynamic functions, allowing household generators to 'talk' to the grid, which can request dynamic support for services like voltage regulation. Smart inverters can provide these services to the grid, while managing the energy balance between solar panels, batteries and the household’s energy demands.

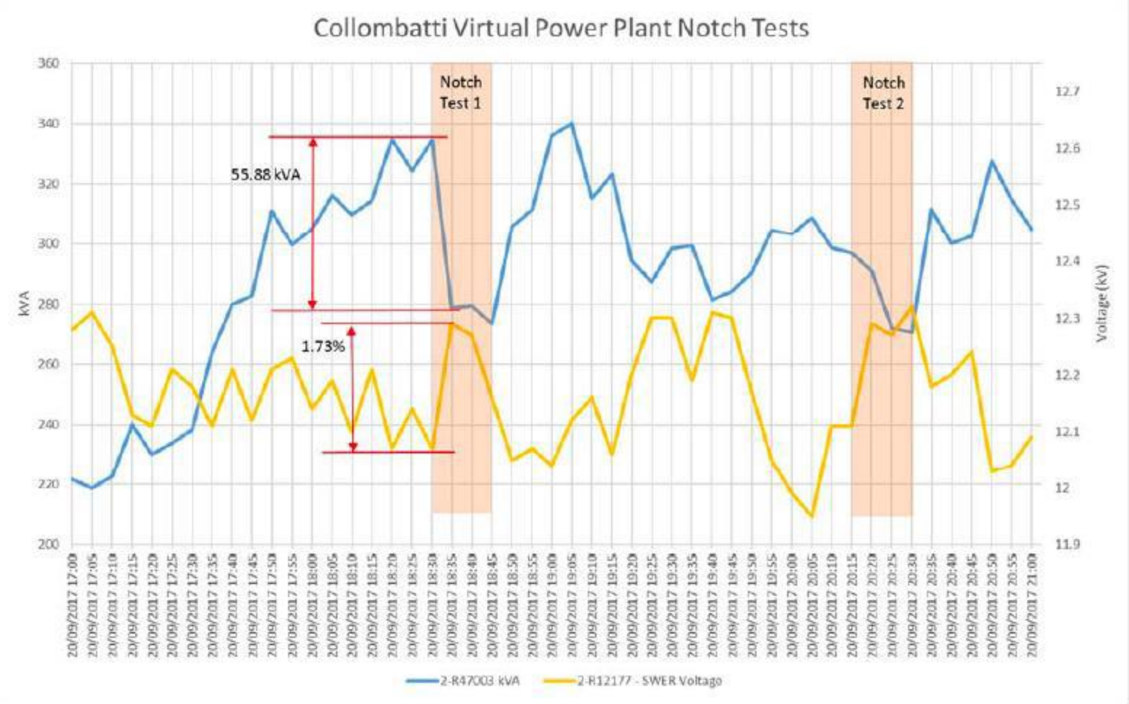

Figure 14: Trial Results

The trial in Collombatti, NSW (Figure 14) showed a clear ability for Essential Energy to quickly deliver real power to the rural network and observe a response in network sensors, allowing them to affect and improve the quality of supply in this part of the network.

While, the trial was run with residential participants in the Essential Energy Network, there is a potential for similar services to be offered to growers through their solar PV (and battery) systems in other areas and networks.

Embedded generation and mini grid trials have been undertaken in many states to demonstrate the technical and commercial feasibility of the support solar PV can provide to the grid. In 2016, AusNet Services started a mini grid trial in Mooroolbark, Victoria to test how mini grids can support the network in peak demand management thus deferring capital expenditure for expansions and densification. United Energy and GreenSync embarked on a demand response and energy storage project on the Mornington Peninsula, Victoria to meet the seasonal increased peak load of 30% over the summer holiday period. The five-year project anticipates to defer the need for around $30 million of investment in new poles and wires. These trials establish that RE can benefit both the network and consumers. Used smartly, these approaches can help in mitigating expensive network augmentation and replacement costs.

5 Conclusion

The purpose of this report was to build an evidence base around the existing challenges and obstacles in the installation of RE systems in rural Australia, particularly NSW and Queensland. It documents the barriers faced by growers across the two states to present a summary of issues reported. The research engaged with a diverse set of stakeholders, including growers and consultants (in Essential Energy's and Energy Queensland's distribution area) and DNSPs (network planning, demand management, executive management, regulatory and generator connections teams).

The report is mapped against the key research objectives beneath:

Objectives	Report
Identify and document the challenges and obstacles experienced by growers who have installed RE generation assets on farm and tried to feed excess energy generated back into the grid (retrospective analysis).	Section 3 presents the growers' perspectives on the issues they faced in the process of installing RE generation assets, particularly with respect to the grid connection process. This is based on the case studies conducted in NSW and Queensland.
Analyse and assess DNSP decision processes and assessing these connection applications with regard to technical/operational and process barriers that limit growers from feeding on-farm generated energy back into the grid.	Section 4 presents the perspective of the DNSP on the grid connection process. It also addresses the constraints and opportunities for growers and networks to work together to address constraints.
Assess the expected implications of new Chapter 5 amendments to the National Electricity Rules to assist embedded generators under 5MW to connect to the electricity distribution network.	Section 2 addresses the current grid connection process. It draws on past reviews and summarises ongoing initiatives to comment on the implications of the rule change on applicants, particularly growers.
Identify and communicate possible future opportunities with the DNSP for RE projects throughout rural Queensland and NSW with the view to better aligning growers and DNSP interests (prospective analysis)	This report builds the evidence for future recommendations. The final report will develop recommendations and identify opportunities for growers and networks to work collaboratively to reduce energy costs.

As the review in this report, specifically Chapter 2 illustrates, grid connection processes are complex. There are Federal and State regulations, voluntary codes and each DNSP has significant discretion to develop and change its own processes and rules. It is not surprising that growers seeking to connect DRE systems find it difficult to navigate.

The reviews of Chapter 5A in operation have concluded grid connection processes have been inhibiting the uptake of RE, identifying issues such as ambiguous and variable information requirements, connection fees, technical standards and service standards. ENA is currently developing voluntary model connection guides to address many of the issues identified in these reviews. The scope of the guide covers all recommendations and areas for improvement in the NSW review, with the exception of regulatory certainty to invest in network infrastructure to facilitate connections and encouraging proponents to connect to locations with available capacity via the Network Opportunities Process.

Our study does not aim to create a model grid connection process which is the focus of stakeholders in the ENA process but instead aims to complement this work by:

- examining the experience of growers in the process of installing and connecting RE to validate and test the findings of these reviews;
- identifying opportunities to improve the understanding and communication with growers on the installation and connection of RE;
- identifying opportunities for collaboration and better ways for growers and networks to engage with each other, notably through new funding vehicles such as the Demand Management Incentive Scheme and using the Network Opportunity Maps.

The experience of growers aligns with the conclusions of a series of reviews into grid connection for RE following the establishment of Chapter 5A in the National Electricity Rules which have concluded the complexity, time and uncertainty of grid connection creates a substantial barrier for DRE.

Some of the key themes to emerge from the research which will be addressed by the recommendations include

There is a need to make independent advice and support on energy technologies and processes available to growers in regional communities.

The issues growers experience with grid connection are strongly intertwined with other barriers to the uptake of RE: grid connections are managed by third-parties (the supplier, installer or consultant) for growers and our research found high levels of distrust, reports of mal-practice and dis-satisfaction with their performance from pre-sale through the connection process to post-sale. Solutions need to therefore encompass suppliers as well as the DNSPs and growers.

There is a need for demonstration projects to develop solutions to the technical constraints to increasing RE in low-voltage areas of the network

There are variations between the approach of the Queensland and NSW DNSPs in managing assessment of RE connections but the building blocks of the process are similar. The main barrier to grid integration of RE are the technical standards that need to be managed by networks to maintain security and reliability, primarily voltage and thermal limits which can be challenged by intermittent RE.

It is important to note there is effectively no process for network-initiated projects for DERs that could be identified at this stage. But the emergence of DER technologies creates opportunities for networks to initiate projects with growers that can reduce capital, operating and replacement expenditure. It is generally accepted that DERs will likely deliver network benefits in the future, but the pathway to that future is yet unclear.

Emerging technologies and pilot projects offer promising opportunities for DNSPs and growers to collaborate on solutions.

Communication processes and information provision between DNSPs and growers is not working well

Another barrier for growers was the lack of clarity and understanding on the processes to connect to the grid. All the DNSPs are currently developing model connection processes through their peak body, ENA, to improve communications and information provision. Engagement with the actual customers (the third-parties that manage connections and end-users like growers) should be a part of this process to ensure it delivers results.

Growers should also explore off-site RE solutions

Improving visibility in regional areas of the network and developing technical solutions will take time. Emerging options such as off-site RE power purchase agreements have the benefit that they are located in areas of the network that can manage power and the developer manages the relationship with the grid. This is another avenue that growers can explore.

As the research reports, there are many initiatives underway to develop model processes and trial innovative ideas. Not many are geared specifically to growers and their unique circumstances. Thus there is a need for **growers to engage with DNSPs** to collaboratively develop processes and projects that are mutually beneficial. The next part of this research, reflects further on these opportunities and offers recommendations to overcome these challenges.

6 References

.idcommunity (2017) *Estimated full time employment | Balonne Shire*. Available at: https://economy.id.com.au/rda-dd-sw/employment-by-industry?WebID=100 (Accessed: 3 September 2018).

ABARES (2017) *Agricultural Commodities: December Quarter 2017*.

ABS (2016) *2016 Census QuickStats*, *Australian Bureau of Statistics*. Available at: http://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/LGA15750?opendocument.

ABS (2017) *Australian Bureau of Statistics web site*, *Australian Bureau of Statistics*. Australian Bureau of Statistics. Available at: http://stat.abs.gov.au/itt/r.jsp?RegionSummary&region=15750&dataset=ABS_REGIONAL_LGA&geoconcept=REGION&datasetASGS=ABS_REGIONAL_ASGS&datasetLGA=ABS_NRP9_LGA&regionLGA=REGION&regionASGS=REGION (Accessed: 3 September 2018).

ACCC (2018) *Restoring electricity affordability and Australia's competitive advantage Retail Electricity Pricing Inquiry-Final Report*. Available at: www.accc.gov.au (Accessed: 10 September 2018).

Agriculture Industries Energy Taskforce (2017) *Agriculture Industries Energy Taskforce Response to COAG Energy Council Consumer participation in revenue determinations Supporting industry and jobs through accessible, reliable and affordable energy*. Available at: https://www.qff.org.au/wp-content/uploads/2017/04/Ag-Industry-Energy-Taskforce-SUB_COAG-Energy-Council_consultation-paper_Nov-2017-FINAL.pdf (Accessed: 30 May 2018).

AgriFutures Australia (2017) *Sugarcane | AgriFutures Australia*, *AgriFutures Australia*. Available at: https://www.agrifutures.com.au/farm-diversity/sugarcane/ (Accessed: 31 August 2018).

ASMC (2018) *Australian Sugarcane Industry Overview*, *Australian Sugar Milling Council*. Available at: https://asmc.com.au/industry-overview/ (Accessed: 31 August 2018).

Bundaberg Canegrowers Ltd (2017) *Annual Report – 2016/17*. Available at: https://www.bdbcanegrowers.com.au/news-media/annual-report/ (Accessed: 31 August 2018).

Bundaberg Regional Council (2017a) *A Welcome to Bundaberg Region | Bundaberg Regional Council*, *Bundaberg Regional Council*. Available at: http://www.bundaberg.qld.gov.au/discover/welcome (Accessed: 31 August 2018).

Bundaberg Regional Council (2017b) *Bundaberg Region Facts & Figures*. Available at: http://www.investbundaberg.com.au/Portals/1/05_Research/Bundaberg Region Facts %26 Figures December 2017.pdf (Accessed: 11 September 2018).

Canegrowers (2018) *Key Issues - Electricity*, *Canegrowers*. Available at: https://www.canegrowers.com.au/page/advocacy/key-issues/electricity (Accessed: 31 August 2018).

CBA (2018) *CommBank Agri Insights. Exploring energy use and investment in the Australian agribusiness sector CommBank Agri Insights Report*. Available at: https://www.commbank.com.au/content/dam/commbank/assets/business/can/agribusiness/agri-insights-9.pdf (Accessed: 2 September 2018).

ClimateWorks Australia, Property Council of Australia and Seed Advisory (2015) *Implementing the Connecting Embedded Generation Rule Project Outcomes Report*. Available at: http://www.seedadvisory.com.au/wp-content/uploads/2015/05/Implementing-the-Connecting-Embedded-Generation-Rule-Report-FINAL-2.pdf (Accessed: 20 September 2018).

Climateworks Australia and Seed Advisory (2018) *Plug & Play 2 Enabling distributed generation through effective grid connection standards*. Available at: https://www.climateworks.com.au/sites/default/files/documents/publications/plugplay_2_report.pdf.

ClimateWorks Australia and Seed Advisory (2017) *Plug & Play: Facilitating grid connection of low emissions technologies*. Available at: https://climateworks.com.au/sites/default/files/documents/publications/plugplay.pdf (Accessed: 20 September 2018).

Cotton Australia (2018) *Statistics*, *Website*. Available at: http://cottonaustralia.com.au/cotton-library/statistics (Accessed: 15 August 2018).

Cotton Australia & Cotton Research and Development Corporation (2014) *Australian Grown Cotton*

Sustainability Report 2014. Available at: https://www.crdc.com.au/sites/default/files/pdf/CCC14003 Sustainability Report_LOW RES_0.PDF (Accessed: 12 September 2018).

CSIRO & Energy Networks Australia (2017) *The Electricity Network Transformation Roadmap*. Available at: www.energynetworks.com.au/roadmap (Accessed: 3 September 2018).

CutlerMerz (2018) *Investigation into NSW regulation, processes, and standards for network connections of advanced energy systems*.

Dairy Australia (2017) *Ease the squeeze on dairy shed power costs*. Available at: https://webcache.googleusercontent.com/search?q=cache:VDwlu_OvYswJ:https://www.dairyaustralia.com.au/-/media/dairyaustralia/documents/farm/environment/energy-costs/ease-the-squeeze-on-dairy-shed-power-costs.ashx+&cd=3&hl=en&ct=clnk&gl=au.

Department of Planning & Environment, N. G. (2017) *Accredited Service Provider (ASP) Scheme and contestable works - NSW Energy*, *Department of Planning & Environment, NSW Government*. Available at: https://www.energy.nsw.gov.au/energy-supply-industry/pipelines-electricity-gas-networks/network-connections/contestable-works (Accessed: 3 September 2018).

Editorial (2018) ‘Three solar farms in the pipeline’, *The Courier*, 7 July.

ENA (2018) *Distributed Energy Resources Grid Connection Guidelines Framework and Principles*. Available at: www.cutlermerz.com (Accessed: 2 September 2018).

Energeia (2016) *EMBEDDED GENERATION GRID CONNECTION STANDARDS SCOPING STUDY*. Available at: http://fpdi.cleanenergycouncil.org.au/reports/grid-connection-standards-scoping-study.html.

Energy NSW (2018) *ASP Scheme and contestable works | Energy NSW*, *NSW Government*. Available at: https://energy.nsw.gov.au/government-and-regulation/legislative-and-regulatory-requirements/asp-scheme-and-contestable-works (Accessed: 18 October 2018).

Ergon Energy (2017) *Ergon Energy Network Embedded Generation Information Pack*. Available at: https://www.ergon.com.au/__data/assets/pdf_file/0007/220939/Embedded-Generation-Info-Pack.pdf (Accessed: 3 September 2018).

ESCO Pacific (2018) *Home | ESCO Pacific*, *ESCO Pacific*. Available at: http://www.escopacific.com.au/ (Accessed: 12 September 2018).

FCA (2016) *Australian Farmer Climate Survey*. Available at: https://d3n8a8pro7vhmx.cloudfront.net/farmersforclimateaction/pages/64/attachments/original/1480387204/FCA_survey_digital.pdf?1480387204 (Accessed: 28 August 2018).

Heath, R., Darragh, L. and Laurie, A. (2018) *The impacts of energy costs on the Australian agriculture sector - Reserach Report*. Available at: http://farminstitute.org.au/publications/research_report/energy.

Johnston, S. (2018) ‘Connecting solar and batteries to the grid | Energy Networks Australia’. Energy Networks Australia. Available at: https://www.energynetworks.com.au/news/energy-insider/connecting-solar-and-batteries-grid (Accessed: 3 September 2018).

Murray-Darling Basin Authority (no date) *Murrumbidgee | Murray-Darling Basin Authority*, *Murray-Darling Basin Authority*. Available at: https://www.mdba.gov.au/discover-basin/catchments/murrumbidgee (Accessed: 13 September 2018).

NewsMail (2018) ‘Childers solar farm begins to recruit workers’, *NewsMail*, 9 March. Available at: https://www.news-mail.com.au/news/childers-solar-farm-begins-to-recruit-workers/3357206/.

NSW Farmers’ Association (2017) *Submission to ACCC’s preliminary report on the Retail Electricity Pricing Inquiry*. Available at: https://www.accc.gov.au/system/files/NSW Farmers .pdf (Accessed: 10 September 2018).

NSW Farmers and GSES (2015) *Solar-powered pumping in agriculture: A guide to system selection and design*, *NSW Farmers*. Available at: http://www.aginnovators.org.au/agiprojects/OEH-Solar-PV-Pumping-Guide/ (Accessed: 2 September 2018).

NSW Irrigators’ Council (no date) *Murrumbidgee Valley Fact Sheet*. Available at: www.mirrigation.com.au (Accessed: 13 September 2018).

Prendergast, J. *et al.* (2018) *Best of Both Worlds: Renewable Energy and Load Flexibility for Australian Business Customers*. Available at: www.isf.uts.edu.au (Accessed: 19 August 2018).

Regional Development Austral Riverina NSW (2018) *Riverina Regional Profile*. Available at: https://static1.squarespace.com/static/59ae4a2a6f4ca38d47990cd8/t/5a794441419202954df358c1/1517896799100/RDA001-Riverina-Profile-S3V1-DIGITAL.pdf (Accessed: 13 September 2018).

Sapere Research Group (2017) *ACCC 2017 inquiry into electricity prices*. Available at:

https://www.accc.gov.au/system/files/Agricultural Industries Energy Task Force %28Attachment%29.pdf (Accessed: 30 May 2018).

Sonti, C. (2017) *$100 million solar farm planned for Narrabri*, *The Courier Website*. Available at: http://www.thecourier.net.au/news/100-million-solar-farm-planned-for-narrabri/ (Accessed: 25 August 2017).

7 Appendices

7.1 Research Methodology

7.2 Grower Questionnaires

7.3 DNSP Questionnaires

7.4 National Electricity Rules and State regulation

There is a set of basic obligations in relation to grid connection:

- Unlike new sources of load, DNSP's do not have an obligation to connect new generation or provide a guaranteed level of access to the network for generation once they are connected;
- Both DNSPs and proponents have an obligation to negotiate in good faith, the DNSP must consider applications in a timely fashion and applicants must provide the information reasonably required to assess the application;
- An obligation to maintain network security, safety and reliability consistent with the NER and state legislation;
- The applicant has an obligation to comply with reasonable requirements of the DNSP;
- DNSP's are required to publish an information pack on their website outlining the technical requirements for grid connection and a public register of connections.

DNSP's are required to 'review and process applications to connect' which are submitted but not to provide access to the network. There are two pathways for connection:

- Chapter 5: originally applied to generators with capacity greater than the standing exemption to register (5 MW), generators under 5 MW can also elect to use Chapter 5.
- Chapter 5A: a shorter, more flexible process designed to apply to generators under 5MW that was introduced in 2014.

Under Chapter 5A, there are three connection processes:

- Basic connection: micro-generation where there is minimal or no network augmentation;
- Standard connection: non-micro generators for which there is an Australian Energy Regulator (AER) model standing offer (30 kw – 5 MW);
- Negotiated connection: all other distributed generation applications.

In practice, almost all connection applications for on-farm RE generators are assessed as negotiated connections under Chapter 5A. The Clean Energy Council proposed to introduce further regulation of various aspects of the connection process in the 2014 rule change application that were rejected by AEMC. These included:

- standard connection agreements for mid-sized technologies (solar, co-generation, hydro);
- firmer rules on process timeframes for networks;
- information provision;
- connection fees;
- technical performance standards to find alternatives to export limitations and dispute resolution

Consequently, the grid connection process is lightly regulated with significant discretion for DNSPs:

- Technical standards for grid connection are developed and implemented by DNSP's in a largely self-regulated framework, resulting in inconsistencies between DNSP's in terms of structure, clarity, coverage and onerousness of technical requirements … there is still no prescribed overarching governance framework or agreed structure for the DNSP's guidelines nor any guidance as to how the technical requirements should be set as to adequately balance network risks of safety, voltage, stability and capacity issues with connection efficiency (Energeia, 2016).
- Climateworks & Seed Advisory (2018) have also noted there is no body or mechanism with oversight of grid connection processes to ensure the balance is being struck between network security, consumer interests and fair competition. There is also no requirement for consultation or external input into the development of grid connection guidelines.

Obligations of customers

a. Each Customer must plan and design its facilities and ensure that its facilities are operated to comply with:

   1. its connection agreement with a Network Service Provider;
   2. subject to clause 5.2.4(a)(1), all applicable performance standards; and
   3. subject to clause 5.2.4(a)(2), the system standards.

Note
This clause is classified as a civil penalty provision under the National Electricity (South Australia) Regulations. (See clause 6(1) and Schedule 1 of the National Electricity (South Australia) Regulations.)

b. A Customer must:

   1. submit an application to connect in respect of new or altered equipment owned, operated or controlled by the Customer and enter into a connection agreement with a Network Service Provider in accordance with rule 5.3 prior to that equipment being connected to the network of that Network Service Provider or altered (as the case may be);
   2. comply with the reasonable requirements of the relevant Network Service Provider in respect of design requirements of equipment proposed to be connected to the network of that Network Service Provider in accordance with rule 5.6 and schedule 5.3;

3. provide load forecast information to the relevant Network Service Provider in accordance with Part D of Chapter 5;
4. permit and participate in inspection and testing of facilities and equipment in accordance with rule 5.7;
5. permit and participate in commissioning of facilities and equipment which are to be connected to a network for the first time in accordance with rule 5.8; and
6. give notice of any intended voluntary permanent disconnection in accordance with rule 5.9.

c. If in AEMO's reasonable opinion, there is a risk that a Customer's plant will:

1. adversely affect network capability, power system security, quality or reliability of supply, inter-regional power transfer capability;
2. adversely affect the use of a network by a Network User; or
3. have an adverse system strength impact, AEMO may request a Customer to which Schedule 5.3 applies to provide information of the type described in clause S5.3.1(a1), and following such a request, the Customer must provide the information to AEMO and the relevant Network Service Provider(s) in accordance with the requirements and circumstances specified in the Power System Model Guidelines, the Power System Design Data Sheet and the Power System Setting Data Sheet.

Note
This clause is classified as a civil penalty provision under the National Electricity (South Australia) Regulations. (See clause 6(1) and Schedule 1 of the National Electricity (South Australia) Regulations.)

d. If in AEMO's reasonable opinion, information of the type described in clause S5.3.1(a1) is required to enable a Network Service Provider to conduct the assessment required by clause 5.3.4B, AEMO may request a Customer to which Schedule 5.3 applies, to provide the information, and following such a request, the Customer must provide the information to AEMO and the relevant Network Service Provider.

Note
This clause is classified as a civil penalty provision under the National Electricity (South Australia) Regulations. (See clause 6(1) and Schedule 1 of the National Electricity (South Australia) Regulations.)

e. All information provided to AEMO and the relevant Network Service Provider(s) under paragraphs (c) and (d) must be treated as confidential information by those recipients.