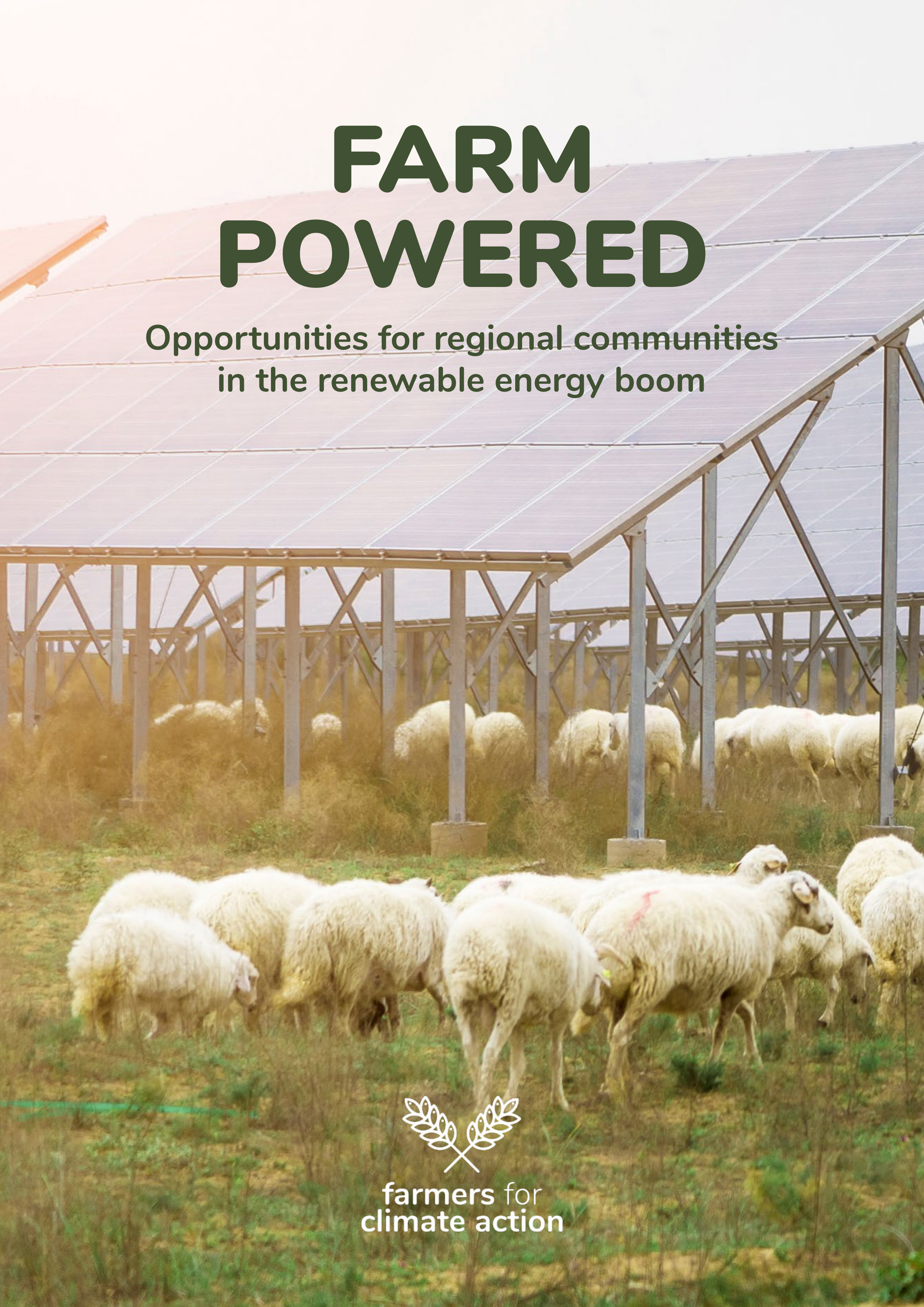
FARM POWERED

Opportunities for regional communities in the renewable energy boom



farmers for climate action

Contents

TITLE PHOTO: ARNPRIOR SOLAR, EDF RENEWABLES

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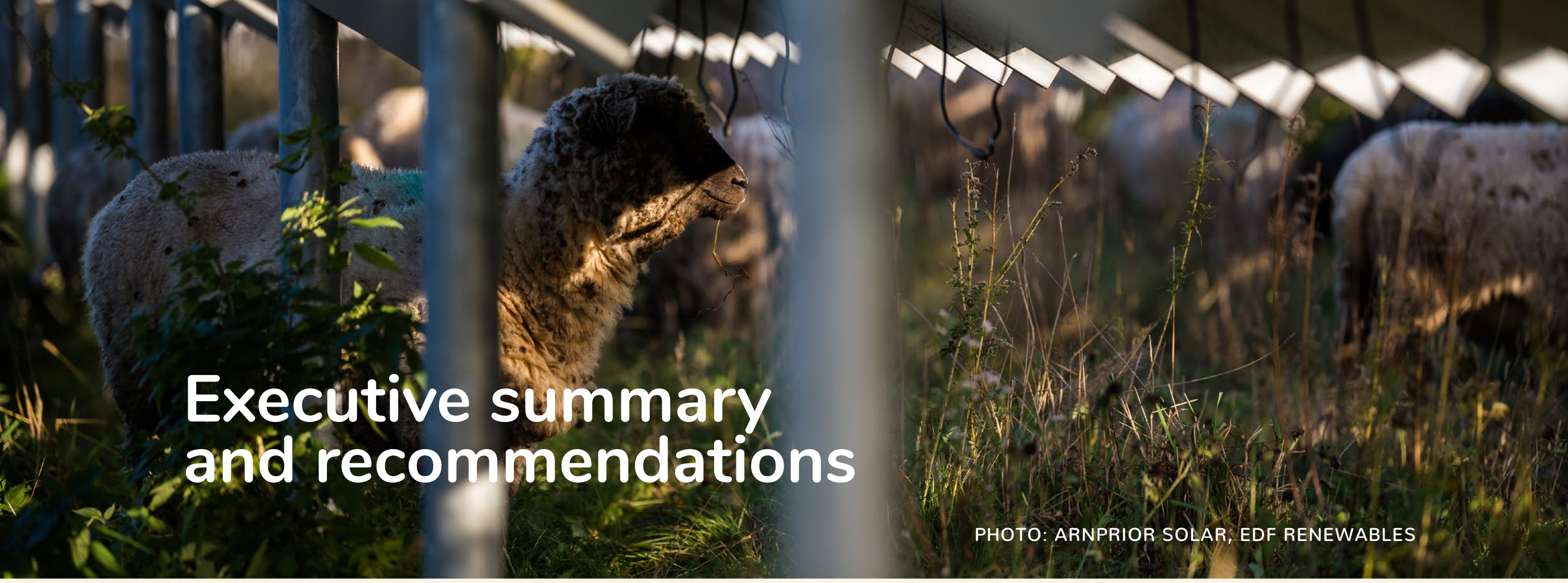
GLOSSARY AND ACRONYMS

ABS	Australian Bureau of Statistics
AD	Anaerobic Digestion
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ARENA	Australian Renewable Energy Agency
CAPs	Covered Anaerobic Ponds
CEFC	Clean Energy Finance Corporation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAPRs	Distributed Annual Planning Reviews
DER	Distributed Energy Resources such as rooftop solar PV units, battery storage, thermal energy storage, electric vehicles and chargers, smart meters, and home energy management technologies
DSNPs	Distributed Network Service Providers, such as Essential Energy in NSW
DPI	Department of Primary Industries, NSW
EV	Electric Vehicles
GDP	Gross Domestic Product
HVCs	High Voltage Customers
ISP	Integrated System Plan 2022, Australian Energy Market Operators
Large-scale renewables	Refers to corporate energy business owned and operated solar and wind developments
LGV	Local Government Area
LOUS	Local Use of System
LPG	Liquid Petroleum Gas
NEM	National Electricity Market
NGO	Non-Government Organisation
NMI	National Meter Identifier
MW	Megawatt of electricity
On-farm renewables	Refers to the use of solar, bioenergy, and storage that replaces a farmer's use of electricity and diesel for producing fuel and fibre. This is called 'behind the meter' and does not attract network charges, but excess can be exported to the grid for a feed-in-tariff
REZ	Renewable Energy Zone
RIT-T	Regulatory Investment Test for Transmission, the Federal process to deliver financial sign-off for new transmission projects
SAPS	Stand Alone Power Systems
Small to mid-scale	Refers to 1-5MW solar plants that connect to the medium voltage distribution network and are for export only - for the purposes of this report, they would be farmer/community driven
SWER	Single Wire Earth Return (thin lines that connect most farming properties to the grid)
TNSP	Transmission Network Service Provider
V2G	Vehicle to grid



Executive summary and recommendations

PHOTO: ARNPRIOR SOLAR, EDF RENEWABLES

Australia's public and private sectors are making much-needed investments as we shift from an energy system powered by coal, oil and gas to one powered by renewables and storage. These critical investments will power more industries and communities, creating hundreds of thousands of jobs in rural and regional areas as Australia significantly reduces emissions over coming decades.

Nationally, the imperative to rapidly deploy renewables is clear. This is key to achieving the deep emissions reductions we need to limit climate change impacts, protecting the future of farms and food security. It is crucial we capitalise on the huge opportunities at farm and regional level.

On a farm level, renewable energy paired with storage can provide cheaper and more reliable energy to replace diesel and grid electricity, while improving productivity, boosting resilience and diversifying income for farmers. Farmers' leadership in this shift also benefits consumers and Australia's global economic interests. As Farmers for Climate Action's recent Fork in the Road report found, reduced costs for farmers mean lower food prices for consumers. Adoption of renewable energy on farms will also serve current trading partners and supply new international markets that increasingly demand low-carbon food and fibre.

It is also becoming apparent that farming and renewable energy - when done right - are complementary. For example, 'agrivoltaics' involves combining energy generation with food and fibre production on the same land, grazing sheep or growing crops under solar panels. In addition to a new income stream, it can deliver a range of productivity benefits, including protection for sheep from heat and wind and in horticultural systems, higher soil moisture and reduced need for irrigation.

At a regional level, renewable energy generation through wind and solar in particular comes with massive regional opportunities through industrial revitalisation and employments.[1] In addition to new job opportunities, increased local use of energy - facilitated by on-farm storage - can also increase the efficiency of the entire electricity network by reducing the need for new long-distance transmission. Renewables paired with storage are increasingly becoming a viable option to reduce costs, improve financial sustainability and replace gas use in industry, including food manufacturing. More sustainable food manufacturers mean a more stable farm sector.

Though critical to renewable energy's success, current energy regulations, policies and programs have not sufficiently engaged nor accounted for farmers or regional communities. There is a focus on large-scale renewable energy developments, often delivered without adequate consultation or benefit sharing with the farmers and regional communities affected.

We need a plan to make sure farmers and farming communities can benefit from the roll-out of renewable energy at all levels. This plan needs to tackle a range of key challenges, including high capital costs for behind the meter on-farm renewables and battery storage; lack of agriculture-specific skills and knowledge in the renewables sector; distribution network constraints and rules and Renewable Energy Zone (REZ) and transmission planning and consultation issues.

[1] Australia's Long-Term Emissions Reduction Plan, Powering Australia

Recommendations

The following key recommendations are proposed to ensure the benefits of renewables to the agricultural sector and regional Australia are fully realised.

Introduce a plan

1. Include in a national climate change and agriculture policy a plan to deliver on-farm renewables, including:

- Setting a target for agricultural renewable energy use.
- Implementing the recommendations identified throughout this report.

Provide Incentives

2. The Federal Government address the high capital costs of on-farm renewables and increase knowledge sharing by:

- Introducing renewable energy incentives for farmers, supported by a national energy audit program, to increase rapid uptake on farms and reduce input costs.
- Subsidising on-farm batteries, funded from the National Reconstruction Fund within the Powering Australia policy, making them financially viable by reducing payback periods.
- Establishing an agricultural program within the Australian Renewable Energy Agency (ARENA) to fund demonstration and knowledge sharing projects for renewable energy and battery solutions on farm.

Reform regional distribution networks

3. Ensure the distribution network is a valuable asset for regional people:

- Establish mid-scale community and farmer 'informal REZs' (outside of declared REZs) which identify under-utilised hosting capacity in the network and encourage dispersed 1-5MW solar developments.
- Trial the carving out of a community energy component within a large scale REZ helping to develop and sustain social license for large scale investments. Some design accommodation within the transmission infrastructure is needed to enable a small collection of 1-5MW projects to tie into the otherwise dedicated REZ infrastructure.
- Eliminate export limits which prevent farmers from exporting more renewable energy to the grid.
- Broaden the Australian Energy Regulator's framework beyond a population density calculation, in determining infrastructure upgrades for the distribution network.
- Develop a plan that identifies areas to prioritise upgrades from Single Wire Earth Return (SWER) to three-phase across regional Australia.


PHOTO: KARIN STARK

4. Prioritise and fund localised, regional renewables-based initiatives that contribute to economic development in rural Australia:

- The Federal Government fund pilot small-scale renewable powered hubs that share infrastructure and supply a local region with products and services such as green ammonia to urea processing.

Ensure large-scale renewables benefit regional communities

5. Improve accessibility and fairness for farmers and regional communities in transmission and REZ planning, including:

- State and Federal Governments provide a mechanism for improved benefit sharing arrangements for transmission hosts and communities, including higher annual payments to hosts, payments to impacted neighbours, and funding for community benefit programs.
- REZ's currently being rolled out should have support available for farmers and communities with independent advice provided in the contract negotiation stage of renewable energy developments.

6. Community ownership / equity shares in large-scale renewables:

- The Federal Government should introduce additional measures to those set out in the Powering Australia policy to support community renewable energy by adopting programs similar to those suggested by the Local Power Plan. These could be implemented by ARENA and Clean Energy Finance Corporation (CEFC).

Combine energy and farming through agrivoltaics

7. Demonstrate that agriculture and renewables can complement one another:

- The Federal Government allocate funding to establish an agrivoltaics research and knowledge sharing program to boost farm profitability and show communities that agriculture and energy production can co-exist.

Introduction: A vision for future farming

In Australia, and globally, food and energy systems have reached a turning point. Growing populations and demand for clean, green energy and food is placing pressure on systems to decarbonise. These food and energy systems can take advantage of the changes ahead if the right decisions are made today. As the International Renewable Energy Agency stated in its report *Renewable energy for agri-food systems*[2], the opportunities for these two systems lie in their pathways to transformation being deeply entwined.

This report outlines a vision for the future of farming, should farmers be supported to embrace these opportunities. This vision sees most of agriculture's energy coming from renewable sources at minimal operational cost, encouraging new ways of operating farming businesses and producing food, with lower costs. Possible examples include areas where current high energy costs limit growth, such as in vertical farming, or desalination processes that provide water security. Technological advances that are energy intensive and costly now could see wide adoption in the future, with more robotic dairies and self-driving electric tractors charged through on-farm energy sources.

Farmers could become traders of energy, reshaping their role in rural areas and supporting their communities to access local, renewable energy. Enabled by a modernised and participatory distribution network, the farm enterprise of tomorrow could be a multi-income stream proposition. As the energy grid continues to modernise, broadening beyond centralised sources of generation, farmers and communities will be able to trade energy with each other, rather than relying solely on energy sources hundreds, or thousands, of kilometres away.

Individuals will be able to source their energy from local generators, be it other residents with solar and batteries, or mid-scale generators on farms. With the ability for more farmers and regional people to produce and sell electricity, the benefits and influence are spread more widely than just a few centralised corporate players.

At the local level, towns could be powered by regionally based mid-scale solar developments, reducing the need to import power from energy producing regions thousands of kilometres away. Regionally, farmers could sell their waste to power bioenergy hubs, supplying towns and industries and providing on-demand energy. Again retailers could aid these developments, financially rewarding farmers for the creation of low-carbon energy and a modernised distribution network can ensure that power is circulated locally to where it is needed the most, whether within a physical microgrid or a local energy market.

Small and large-scale hydrogen hubs could produce green ammonia and urea, supporting agricultural regions with locally produced fertiliser from renewable energy sources, increasing security of supply, and reducing cost volatility. Food processing facilities could run on cheap green energy in regional areas where food is grown, reducing the need for transport within the supply chain.

Large-scale wind and solar farms and transmission lines, delivered with active involvement from the agricultural sector, could bring new sources of income to rural economies and provide employment and demand for services that contribute to the prosperity of regional centres.

[2] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Nov/IRENA_FAO_Renewables_Agrifood_2021.pdf

BENEFITS OF RENEWABLES FOR FARMERS AND THE REGIONS

Perhaps the greatest opportunity for Australian agriculture is the building of farm resilience as an outcome of this symbiotic relationship with renewable energy production. Australian farmers manage significant variability, such as an increasingly unpredictable climate and volatile commodity prices. These factors generate substantial variation in farm output and incomes, more than experienced by farmers overseas and more potent than those experienced by business owners in other sectors of the Australian economy.

Resilience is crucial for farmers in an increasingly unpredictable climate, so electrification and adopting renewables can help build this: reducing costs (and their volatility) and supply chain risks, creating redundancies, and generating income streams.

REDUCING COSTS

Renewable energy can dramatically reduce costs for farmers by up to 85%, as demonstrated by the case studies in this report.

To illustrate the impact rising electricity costs are already having on agriculture's productivity, in Queensland many primary producers have switched to dryland farming as electricity prices become unaffordable. Alarmingly, the number of irrigating farm businesses in Queensland fell by more than 42% between 2009/10 and 2015/16, resulting in a substantial loss of productivity in the sector.[3]

> "The cost and affordability of electricity from the grid is an issue for our members. Around renewables, they are worried about diminishing feed-in-tariffs. We recently conducted a survey of our members and the high priority issues included transparency of tariff pricing, the need for a tariff that reflects and enables agricultural productivity, energy bill transparency, data access, smart meter upgrades and affordability, energy sharing/Virtual Power Plants and meter consolidation.
>
> **MADISON STURGESS,**
> **Queensland Farmers Federation**

[3] https://www.smh.com.au/business/the-economy/we-re-in-trouble-australia-risks-food-insecurity-expert-warns-20220803-p5b6u3.html

Reliability is the number one issue for dairy farmers around energy. If they lose power and milk spoils, there's the lost income from losing that milk but they also need to dispose of milk which requires an Environmental Protection Agency permit. Some farmers have resorted to diesel generators for backup because supply of power is so important, and many are on SWER lines or on the edge of the grid so reliability isn't guaranteed.

DAIRY AUSTRALIA

RELIABILITY

Some farm businesses more than others are dependent on a reliable supply of energy. Backup power for when the grid fails, either due to natural disasters, maintenance or due to ageing poles and wires, helps buffer businesses against costly losses. Dairies and wineries in particular require consistent power, to prevent operational issues or spoiling resulting in significant loss of income. Battery storage will play a progressively more important role in providing back-up power to farming operations, control over when and how excess energy is used, and reduced need to export of excess power to already constrained networks.

Australia only has about five days worth of perishable food in the supply chain, according to a report from the Australian Security Leaders Climate Group.[4] Access to cheap and reliable renewable energy sources could attract new food processing plants to the regions, which in turn will strengthen food security. Thermal energy storage such as being used by pet food processor Mars Petcare in Wodonga will be the first of its kind, displacing some of the factory's use of gas.[5]

DIVERSIFYING INCOME STREAMS

The opportunity to grow clean, green, low emission agricultural produce for export will position Australian farmers well to attract premiums on their products and enable continued and potentially new access to global markets. Building mid-scale solar developments with storage on the distribution network to export to the grid could also provide a secondary income to primary producers. Australia could also be a major exporter of clean energy with farmers positioned well to host solar and wind developments and supply the power needed to realise this potential.

[4] https://www.smh.com.au/business/the-economy/we-re-in-trouble-australia-risks-food-insecurity-expert-warns-20220803-p5b6u3.html

[5] https://www.abc.net.au/news/2022-08-04/graphite-battery-will-be-first-commercial-thermal-energy-storage/101295350

A plan to make renewables work for farming communities

This report identifies a range of opportunities to make the shift to a renewable energy system work for farming communities. We need a plan to ensure these opportunities are captured.

The interconnected nature of food and energy systems requires greater collaboration between farmers, researchers, governments and industry. A coordinated and long term regulatory and policy framework that is farmer focused, is essential to position Australian agriculture to grasp the opportunities ahead.

RECOMMENDATION:

1. Include in a national climate change and agriculture policy a plan to deliver on-farm renewables, including:

- Setting a target for agricultural renewable energy use.
- Implementing the recommendations identified throughout this report.

Powering the farm - behind the meter renewables

Opportunities by agriculture sector

Renewable energy presents immense opportunities for agriculture and can play a critical role in meeting the sector's needs for electricity, heating, cooling and transport - while also exporting energy for use in other sectors. Early adopters are already reducing costs, increasing energy security and reducing carbon emissions.

An Australian Farm Institute report from 2018 estimated that the agriculture sector spends $5.85 billion on energy annually across the entire supply chain (inputs, production, transport and post-farm processing). Fuel costs agriculture $2.5 billion annually, and electricity costs $2.4 billion. Direct energy costs are estimated at $1.4 billion on fuels and $1.2 billion on electricity annually.[6] Energy prices have spiked since then so the sector's energy spend is likely to be significantly higher.

Intensive industries such as piggeries, poultry, and dairies tend to use higher volumes of energy and hence offer particular renewable energy opportunities such as converting manure waste to energy. Horticulture that requires year-round irrigation can suit solar water pumping, whereas the seasonality of irrigation for cotton heavily relies on a grid that allows the exporting of excess solar in the winter months for the business case to stack up. Other industries such as beef and sheep production, which are more extensive in nature, tend to have low on-farm energy use but higher energy use in the processing part of the value chain. There are options for this sub-sector in hosting mid- to large-scale solar and wind, depending on their location and hosting capacity of the grid, which offers important and substantial income diversification. This section outlines the energy demands for key sub-sectors of agriculture, touches on what the renewable energy opportunities could be and provides illustrative case studies.[7]

[6] https://www.farminstitute.org.au/product/the-impacts-of-energy-costs-on-the-australian-agriculture-sector/

[7] Broadly speaking, a lack of energy data exists for the agricultural sector. Older figures and reports have been used for this report and it is important to recognise the need for more up to date figures. The below information may not reflect the dramatic reductions in the prices of renewable energy technology, in particular solar over the last five years, while in parallel the price of fuels and electricity have risen significantly. This leaves farmers exposed to international markets that can be extremely volatile.

Irrigated agriculture has a crucial role to play in feeding the nation, but relies on cheap, reliable power for pumping and hence this sub-sector benefits greatly from renewable energy. According to the National Irrigators Council, 93% of fruits, nuts and grapes, 83% vegetables, 100% of rice, 53% of sugar, 85% of cotton, and 48% of dairy is produced from irrigation.[8]

Fruits, nuts and grapes
93%

Rice
100%

Sugar
53%

Vegetables
83%

Dairy
48%

Cotton
85%

PORK

Energy is a significant and growing cost for pork producers with most energy used in feed production(46.8%), piggery energy use such as heating and lighting (23%), feed milling (16.2%) and meat processing (14%).[9] Piggeries tend to have high energy use if using intensive indoor setups. Energy use can also be high if feed is grown on site.

Specific to piggeries, there are bioenergy opportunities which convert high levels of manure to energy while addressing odour emissions. Solar is also an option due to the constant energy demand throughout the year.

[8] https://www.irrigators.org.au/
[7] https://www.farminstitute.org.au/product/the-impacts-of-energy-costs-on-the-australian-agriculture-sector/

PHOTO: THE FARMER MAGAZINE, NSW FARMERS.

CASE STUDY: PIG POO POWER

Edwina Beveridge and her family run Blantyre Farms, a piggery in Young, NSW. They have 2,000 sows and up to 20,000 pigs at any one time. The farm is split into breeder and grower sites.

In 2010 energy was their fourth largest cost, spurring them to invest in a methane digestion system that captures gas from manure, and generates enough power to run their farm operation and export excess to the grid. At the piggery, pigs are housed on top of slats so manure can be flushed out from sheds and be captured. Once the manure drops into the pit, it is flushed into covered anaerobic ponds (CAPs). These hold 15 million litres of pig poo, with gas collected to convert to power. The system has been successfully producing renewable electricity from the poo for 10 years and the manure that comes out of the effluent system is dried out, and used on paddocks to grow grain to feed pigs.

> **"It's almost a closed loop system. We produce pigs that create electricity and manure, which in turn is used to power the site and grow crops to feed the pigs. We produce enough power to supply the whole farm and some is exported to the grid. We've been able to generate and sell carbon credits from not releasing methane into the atmosphere, for the last 10 years. We were the first farming project in the Emission Reduction Fund, so I call us the first carbon farm in Australia, Our biggest saving comes from not buying power from the grid. I think we save about $250,000 in electricity costs each year.**
>
> **EDWINA BEVERIDGE**
> Blantyre Farms

POULTRY

Approximately 70% of operating costs at a broiler poultry operation fall into four key areas; labour, electricity, gas and bedding.[10] Poultry farms can be large users of energy when hens are housed in climate-controlled sheds due to ventilation fans, lighting, feed and water lines. Feed production for layer hens and pullets also uses high amounts of energy. Solar can be an effective solution, as the timings of solar generation mirror peak energy use because sheds are often required to be cooled in the middle of the day.

As a variant of solar panels, solar thermal technology also sees applicability for poultry through energy intensive heating/ cooling processes. This technology transforms solar energy into thermal energy (heat) that is stored in liquid or gas form and is more efficient that solar panels. Although not common in Australia, poultry sheds and horticultural greenhouses requiring temperature regulation are prime candidates for this technology.[11]

Similar to piggeries, Anaerobic Digestion (AD) converts biodegradable organic matter to energy.[12] The resulting biogas from this process is made up of methane and carbon dioxide and could be used as a fuel for heating and electricity. The residue left behind, known as digestate, is semi-solid and could be repurposed as a liquid or solid fertiliser. The high upfront capital costs of AD systems however limits their use to larger operations that benefit from economies of scale.[13]

CASE STUDY: RIVERLANDS FREE RANGE CHICKEN FARM, SLASHING ELECTRICITY BILLS WITH AGRICULTURE'S MOST EXTENSIVE SOLAR AND BATTERY SYSTEM

One of Australia's largest free-range chicken-meat farms has reduced its reliance on the grid by 70% through the adoption of renewables and storage. Riverlands Free Range chicken farm in South Australia raises 10 million birds a year in 42 sheds. The farm's energy bills were nearing $1 million before the renewable energy system was installed. This expense plus the volatility of electricity prices were starting to impact profits, which drove the business to invest in 1.4MWs of solar, installed on the farm sheds, as well as five large batteries. The $5 million investment has seen the farm slash its costs and reduce emissions by 1,500 tonnes per year.[14]

[10] https://www.nuffieldscholar.org/sites/default/files/reports/2016_AU_Ben-Edser_Renewable-Energy-Technologies-And-The-Broiler-Poultry-Industry-Cost-Reduction-And-Income-Diversification.pdf

[11] https://www.pwc.com.au/infrastructure/powering-the-global-food-bowl-july-2019.pdf

[12] https://www.nuffieldscholar.org/sites/default/files/reports/2016_AU_Ben-Edser_Renewable-Energy-Technologies-And-The-Broiler-Poultry-Industry-Cost-Reduction-And-Income-Diversification.pdf

[13] https://www.nuffieldscholar.org/sites/default/files/reports/2016_AU_Ben-Edser_Renewable-Energy-Technologies-And-The-Broiler-Poultry-Industry-Cost-Reduction-And-Income-Diversification.pdf

[14] https://www.poultryworld.net/poultry/clean-energy-slashes-costs-at-australian-poultry-farm/

"We are Australia's first registered uncooked, raw cheese producer, so product quality and safety are vital. With the renewable energy system that's been installed, we're no longer using LPG. It's amazing to be electrified. The upgraded power system safeguards our production and lets us sleep well on stormy nights,"

MICHAEL CRESSIDA
Pecora Dairy

DAIRY

The dairy industry in Australia contributes $4.4 billion in farm gate value and is the fourth largest rural industry in Australia.[15] Dairy farmers are high users of energy, due to electricity needed for milking, pumping, cooling, heat for pasteurising, irrigation, and lighting. Robotic dairies can use 50% more energy than traditional operations.

Milking shed effluent and concentrated manure scrapings could be used to create biogas through AD, common overseas but not yet in Australia, largely because most dairies use pasture-fed systems making collection of high amounts of manure difficult. CAPs would be the most economical AD system for dairies, with the biogas used to fuel a generator producing electricity, the most common use for the gas.[16] The capital cost of a biogas-fuelled generator large enough to power a milking shed (50kW) ranges from $30,000 to $120,000. In addition, several thousand litres of hot water (90°C) per day could be recovered from the biogas generator engine coolant and exhaust gases.[17]

Unless paired with a battery, the opportunities for solar can be limited due to milking generally having to be done twice, 10 to 12 hours apart, often not in daylight hours. Other renewable energy options include waste heat from milk cooling, solar pumping for irrigation of pastures, solar plus batteries or solar hot water units. Microgrids such as that being undertaken at Nowra with 18 participating dairy farms will create biogas for the farm's use and to export to the grid. Hydrogen could be a potential future energy source well suited to dairy's energy profile.[18]

CASE STUDY: SOLAR AND BATTERIES AT PECORA DAIRY

Michael and Cressida Cains run Pecora Dairy, a sheep dairy and boutique cheese producing business in Robertson, NSW. Unreliable energy supply and an insecure supply of LPG threatened processing operations leading to the installation of 28kW of solar, a 40kWh flow battery system and a new heat pump to replace the LPG boiler. The solar and battery will also form part of a peer-to-peer trading market so the couple can sell their excess power and buy from others on the platform.[19] The solar and batteries are saving them approximately 82% on energy costs.

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[15] https://www.agriculture.gov.au/agriculture-land/farm-food-drought/meat-wool-dairy/dairy
[16] https://www.dairyingfortomorrow.com.au/wp-content/uploads/0781_Biogas-technology-A4-report-summary_160726.pdf
[17] https://www.dairyingfortomorrow.com.au/wp-content/uploads/0781_Biogas-technology-A4-report-summary_160726.pdf
[18] https://www.nowrabioenergy.com.au/
[19] https://extensionaus.com.au/energysmartfarming/pecora-dairy-energy-efficiency-solutions-pilot-project/

PHOTO: SUNFARMING

HORTICULTURE

Horticulture is an extremely diverse sector, covering everything from nuts and potatoes, to flowers, fruits and vegetables. Horticulture's energy demand can be relatively consistent as fruits and vegetables are irrigated and cooled in storage ready for transport, all year round.

Limited energy-use data is available for the overall industry. However some work for orchards has been undertaken, where energy has been found to account for a large proportion of production costs and is a major financial burden for fruit businesses.[21] Apple and Pear Australia Limited conducted a 'Watts in your Business' program which audited 30 representative packhouses and orchards across Australia. It found 64% of energy was used for refrigeration, 18% in irrigation, 8% on grading equipment, 6% on controlled atmosphere, and 3% on lighting.[22]

Protected cropping is one of the fastest-growing areas of food production in the country, with almost 30% of all Australian farmers growing produce in some form of a soil-less culture system, according to peak vegetable industry body Ausveg.[23] The impacts of natural disasters like flooding can be minimised with use of indoor growing environments such as greenhouses. But these systems tend to use more energy, with an energy intensity 10 – 20 times higher per kilogram of product than that of the same crops grown in open fields.[24]

Typically, solar for irrigation and for running refrigeration can be beneficial. Battery storage can further optimise excess solar enabling use behind the meter in non-daylight hours rather than exporting power for a very low feed-in-tariff or to an already saturated grid. Biogas produced by breaking down horticultural waste through AD also presents an opportunity, however additional data is required to understand the business case more thoroughly.

Agrivoltaics, where panels are placed over protected horticultural crops such as berries and fruit trees can result in increased yields, and in fact studies have shown these crops benefit from up to 30% shade.[25] See section on Agrivoltaics below for more detail.

Renewable energy business Akuo Energy provides greenhouses with solar roofs, at no cost to farmers, helping them manage their production cycles, control yields, and limit the use of chemicals.[26] These dual use systems generate clean energy and produce food, and could reduce land use conflicts and increase community support for regional renewables.

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[21] https://www.energy.gov.au/business/industry-sector-guides/agriculture#:~:text=Energy%20use%20in%20Australian%20orchards,second%20largest%20cost%20after%20labour
[22] https://apal.org.au/watts-in-your-business/
[23] https://www.abc.net.au/news/rural/2017-07-13/farmers-turn-to-greenhouses-meet-growing-demand/8702386
[24] https://www.agrifutures.com.au/product/benchmarking-energy-use-on-farm/
[25] https://link.springer.com/epdf/10.1007/s13593-022-00783-7?sharing_token=jtnO0pm7RyKWz896JpNZHPe4RwIQNchNByi7wbcMAY6te6X-eQr46Rhcrn6FfBnn5qwJvPy4RyEMktGoo8tz38TCr6VCCwP6nkwytdkbh1uPSCxhdBjelJgJRKmjxMmq7xFRE2VWgNaS87LrcQOKjXqknJf1ByuFpDo_ywBPIX-tY%3D
[26] https://www.akuoenergy.com/en/agrinergie

CASE STUDY: USING SOLAR IRRIGATION TO REDUCE COSTS AND IMPROVE SLEEP

Organic vegetable grower Wayne Shields runs Peninsula Fresh Organics on the Mornington Peninsula, Victoria. He also runs a second site on the Murray River in Barham, NSW.

Wayne produces organic broccoli, broccolini, lettuce, kale, leeks, silverbeet, and Asian greens all year round, on a total of 140 acres (40 acres Mornington Peninsula and 100 acres in Barham).

Before investing in renewables, Wayne would irrigate and pump water at night to use the cheaper off-peak tariffs from the grid. This watering schedule was not optimal for the vegetables, as it increased the risk of mildews and rots; organic farms can't use fungicides due to certification.

The farm installed a 40kW solar system to run the pumps and a 30kW solar system to run the cool room on the Murray River property, and a 30kW solar system to run the pumps and cool room on the Mornington Peninsula property. These enabled Wayne to start irrigating during daylight, which was much better for vegetables and for his sleep.

"By using solar, we have seen our pumping and cooling costs reduce significantly. Now we feel the biggest payback will be in the future once our loan is paid back. There's also the social licence to consider, from using renewables. We supply to Coles, Woolworths, and numerous others, and they're wanting to know how we're reducing emissions as a business."
Wayne explains.

"The margins in producing vegetables are thin, so if you get a large power bill, it wipes out your profits for the month."

CASE STUDY: SUNDROP FARMS - NATURE AS A PARTNER NOT A SUPPLIER[27]

Sundrop Farm, in South Australia's semi-arid zone, uses the sun's energy to desalinate water from the nearby Spencer Gulf, producing fresh water to irrigate truss tomato crops, and to produce electricity to heat and cool the growing environments within their greenhouses.[28]

The farm's greenhouses act as a natural barrier to pests and diseases more prevalent in open field farming, and protect against excessive heat, hail, and frost. This method of sustainable, closed-loop horticulture utilises energy created through concentrated solar thermal technology and has allowed Sundrop to achieve energy security, at the same time as reducing running costs by displacing over two million litres of diesel annually.[29]

[27] https://www.sundropfarms.com/our-difference/
[28] https://www.sundropfarms.com/our-technology/
[29] https://www.pwc.com.au/infrastructure/powering-the-global-food-bowl-july-2019.pdf

CASE STUDY: COTTON GROWER USING SOLAR TO CUT COSTS

The property 'Burgorah', owned by Anne and Ian Brimblecombe, is located just outside St George, 500km west of Brisbane, Queensland. When water is available, the couple grow and irrigate 320 hectares of cotton.

Local network constraints, a non-competitive energy market, and unsuitable tariff schemes have meant Ian has had to install numerous meters and solar installations to keep energy for irrigation affordable. They invested significantly in nine solar installations totalling approximately 344kW with an average payback of three to four years. Ian estimates he saves about $60,000 a year because of his solar ($30,000 income from feed in tariffs and $30,000 savings on not buying electricity from the grid).

Ian says "We know that burning fossil fuels is heating the planet and each of us has to stop that as quickly as we can and come up with other ways for getting power for what we need."

"My dream is to run my whole operation with renewables as I only pump for one month a year so for the other 11 months, my solar is not doing anything. In that time, I'd like to be making hydrogen or ammonia and be using that ammonia to run tractors and as fertiliser. That is my goal."

Ian's operation is constrained by the inability to share solar energy between various pumps and other loads on his property, which is not permitted under current distribution network rules. He's keen to see changes in some of the network rules around the sharing of energy on farms.

COTTON

Due to irrigation pumping requirements, the cotton industry can be large users of energy. For river irrigators, pumping accounts for 45% of all energy that is directly used on-farm while it can be as high as 75% for farmers using bore irrigation. Diesel use in tractors and machinery is the next largest energy use on cotton farms.[30]

Using solar to partly power irrigation pumps is the main renewable energy opportunity for irrigators. However, one of the difficulties is the industry's seasonality of energy use, with high demand over summer and very low demand in the remaining months. If grid connected, some solar can be exported to receive a feed-in tariff depending on network capacity in the local area, but for off-grid, solar power could effectively be sitting idle when the pump is off. The sharing of energy across properties with energy requirements at different times via microgrids could help with creating more viable solar pumping scenarios in the future.

[30] https://cottoninfo.com.au/energy-use-efficiency
[31] https://www.youtube.com/watch?v=9GloGliMVQ4

CASE STUDY: TECHNICAL CHALLENGES FOR BLENDING SOLAR AND DIESEL AT A NARROMINE COTTON FARM

Jon Elder grows cotton, barley and wheat on his farm in Narromine in Central NSW. Prior to 2018, Jon and his family were spending over $300,000 a year on diesel to pump their bore water licence. Keen to look for alternatives, Jon along with ReAqua, a solar pumping business, decided to install the country's largest solar diesel hybrid pump. The business case was strong with a payback of five years. The existing diesel-powered CAT C-9 engine was replaced with a WEG 250kW electric motor and a 500KVA CAT diesel-powered generator was installed along with 500kW of solar on one hectare of land with associated inverters, variable speed drives and control systems.

The promise had been to seamlessly blend diesel with the available solar power, enabling the pump to run on overcast days when the solar arrays were unable to maintain their maximum power. The first year saw the family reduce their diesel costs by 40% and emissions by 500 tonnes a year. However, the system exposed two persistent problems.

Firstly, the challenge of blending solar and diesel is revealed where sudden reductions in solar power occur; typically during intermittently cloudy days. In these instances the generator fails to 'ramp up' quickly enough to supply the power shortfall and power to the electric motor sometimes falls below a level that triggers a shutdown of the bore.

The second problem relates to the sizing of the diesel-powered generator. During cloudy days, or, during the mornings or evenings, the shortfall in solar energy often requires only small inputs of power from the diesel generator, and as such it spends an amount of time working at capacities below that specified by the manufacturer. In effect the generator is 'glazing', or not working hard enough, causing damage to the engine itself.

"While we can see the potential for solar to help irrigators like ourselves reduce reliance on diesel, we don't believe the technology is quite there yet. A battery could be the ideal solution but the costs are prohibitive so we are continuing to seek solutions and hope to have this resolved soon."

JON ELDER

WINERIES

Wineries have been estimated to spend approximately 40% of their total expenditure on electricity.[32] Of that 40%, refrigeration and tank storage in particular can be responsible for the vast majority of the energy consumption at a winery.

Solar and battery technology have the potential to reduce costs and emissions at wineries in Australia. Microgrids that share solar energy around the farm, for example between the cellar, pumps, homestead, cool rooms and processing sheds, holds promise for reducing costs and emissions in the future, but there are still obstacles to be overcome in this area (see Microgrids section below).

CASE STUDY: A CARBON NEUTRAL WINERY IN THE HUNTER VALLEY

Alisdair Tulloch is a fifth generation winemaker, and runs Keith Tulloch Wines with his family. Their 20 hectare property includes 10 hectares of vineyards and was the first carbon neutral winery in the Hunter Valley.

With an understanding of climate change and its impact on viticulture, Alisdair worked out the farm's carbon footprint in 2017/18 to be 660 tonnes of CO2 equivalent. They then looked at where those carbon emissions were coming from and identified 145 tonnes were from electricity use. They were spending $30,000 on electricity a year for processing, picking and harvesting, heavy machinery,
and refrigeration.

In 2018, they spent $100,000 to construct a 65kW solar array which met 72% of the farm's power needs and had a four year payback. They saved $25,000 a year and reduced their emissions by 100 tonnes of CO2 equivalent.

Alisdair explains "We've tried to electrify as many processes as possible. We purchased a new refrigeration system which was more efficient and we tried to use more energy during daylight hours. If the sun is hitting your property, you may as well capture it and use it."

"Electricity is one of the major assets you have on your farm. When the electricity goes out, you're pretty hamstrung. We have so much going on in the food processing side of our business, that if we lose electricity, our products could spoil within days or hours if we're within the vintage period."

"Having a carbon neutral product we sell direct to the public, we also noticed a strong increase in sales as customers look for more sustainable products. If your product has a low carbon foot-print, it also has a competitive advantage."

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[32] https://aemo.com.au/en/newsroom/energy-live/wineries-electricity-management

GRAINS

The majority of grain produced in Australia is grown using a rainfed production system. The energy use of this sector is relatively low, with direct energy used in tractor fuel, electricity for pumping if irrigated, and heat for drying (LPG and gas).

Interest is building around the value and use of residual straw stubble to create biofuels, biogas, hydrogen, and renewable fertilisers. There are ongoing studies in Victoria around the use of pelletised straw to generate energy.

BEEF

The beef industry contributes $18 billion annually to Australia's Gross Domestic Product through production, processing and sales, according to a report by the Australian Farm Institute in 2018.[33] The same report found that the combined cost of energy along the red meat industries value chain was approximately $1.58 billion annually.

The highest users of energy tended to be diesel use on-farm, red meat processing and on-farm embodied energy (energy associated with producing a product).

Energy costs are significant for abattoirs and meat processors, ranging from $100,000 to more than $10 million a year. Up to 90% of the energy used comes from steam and hot water production as well as refrigeration.[34] Solar livestock pumps are increasingly being used to replace diesel pumps for remote watering stations, improving water security for cattle and sheep and cutting costs and time for farmers.

Beef farmers are not large users of energy on farm, however opportunities exist for cattle farmers located close to transmission in windy areas to host wind turbines to earn a secondary guaranteed income. In areas of the distribution network able to host more solar generation, small 1-5MW solar plants could be initiated on 10 hectares of land, primarily for export.

[33] https://www.farminstitute.org.au/product/the-impacts-of-energy-costs-on-the-australian-agriculture-sector/
[34] https://www.victorianenergysaver.vic.gov.au/energy-advice-for-business/managing-your-energy-consumption/farms-and-business-case-studies-and-guides/abattoirs-and-meat-processing

Challenges for on-farm renewables

HIGH UPFRONT CAPITAL COSTS

High upfront capital costs continue to impede adoption of on-farm renewables, especially for technologies like storage batteries and infrastructure to raise solar panels to allow production below. In the three years leading up to 2020, the CEFC provided low interest loans to the farming sector of over $100 million for 417 grid-connected and 20 off-grid solar power projects, more than any other single sector. These projects were also on average larger than other sectors, with loans averaging $250,000, almost seven times more than the average across all sectors.[35] These figures demonstrate the high capital costs faced by farmers.

Battery storage costs in particular are prohibitive for most farmers, with the payback period being much longer than for installing solar PV panels. Storage provides multiple benefits for farmers, consumers and the grid including:

- enabling better use of renewable energy by storing power and hence extending daylight hours (for solar)
- reducing input costs for food production
- reducing emissions
- reducing the need to export to the grid
- increasing business resilience by providing back up power during outages
- providing potential future income streams from providing grid firming services.

The seasonal variation in farm profits as well as droughts and floods risks mean many farmers are reluctant to take on more debt. Other than farms taking on commercial loans to adopt on-farm renewables, there are few grants or subsidies available to help manage the costs and risks. Where such programs do exist, consultations suggest that funding criteria may not be adequately targeted towards the agricultural sector. For example, pre-commercial renewable on-farm projects have struggled to attract investment from existing government renewable energy funding bodies such as ARENA.

> "I've looked into renewables in the past, we all want to do the right thing by the environment but it comes down to what you can afford at the time. The dairy industry has had a tough time over the last few years, with price pressures and fluctuations. It can make it hard to plan."
>
> **PETER MULHERON**
> **Dairy Farmer, Swan Marsh, Western Victoria.**

[35] https://www.qff.org.au/projects/renewable-energy-on-farm/

LACK OF AGRICULTURE-SPECIFIC SKILLS AND KNOWLEDGE IN THE RENEWABLES SECTOR

The business case for many on-farm renewable energy solutions is poorly understood, and there is a lack of regional expertise to assist a farmer's decision making. While farmers are increasingly looking to adopt renewable solutions, a lack of working examples reduces visibility and peer-to-peer knowledge sharing.

While many renewable energy solutions are well known, their application to farming may be highly specific. For example, energy use by irrigators is often seasonal in nature, causing peaks in energy demand at certain times of the year and at other times very low demand. On the other hand, the dairy industry typically uses the most power before sunrise and after sunset. Technology suppliers and installers need to understand the operations of farming better, as well as how behaviour and operations changes could influence the design of smart systems that integrate the needs of the farm with the various energy management and renewables components. We will require a highly skilled workforce if agriculture is to decarbonise.

"We have made calls that ARENA and CEFC have a focus on implementation of renewable technologies in regional and rural areas, as the problem is no longer the lack of viable technologies, the problem is adoption."

ASH SALARDINI,
National Farmers Federation

RECOMMENDATIONS:

2. Federal Government to address the high capital costs of on-farm renewables and increase knowledge sharing:

- Introduce renewable energy incentives for farmers, supported by a national energy audit program, to increase rapid uptake on farms and reduce input costs.
- Subsidise on-farm batteries, funded from the Powering Australia policy, making them financially viable by reducing the payback period.
- Establish an agricultural program within ARENA to fund demonstration and knowledge sharing projects for renewable energy and battery solutions on farm.

Other farm opportunities
LOW EMISSION FARM VEHICLES

Agriculture relies heavily on diesel, for farm vehicles and plant and equipment such as irrigation pumps, depending on the operation. The Australian Bureau of Statistics (ABS) in 2017- 18 found that more than 80% of energy consumption in Australian agriculture was diesel.[36] This level of reliance leaves farmers exposed to fuel price hikes like those experienced this year due to supply chain issues and global upheaval in energy markets following the invasion of Ukraine.

In the first six months of 2022, more than 100,000 new utes were bought in Australia, none of which were electric.[37] Companies such as General Motors and Ford are making electric utes (the Hummer EV, the Silverado EV pickup and the F-150 Lightning), as is Tesla (the Cybertruck – production expected to start in 2023) but they are yet to make it to Australia's shores.[38] EVs can be considered large flexible loads that are intermittently connected to the grid. As with behind-the-meter batteries, a properly managed EV or farm vehicle fleet could provide low voltage (LV) management services to the grid.

There is growing interest from farmers in alternative vehicles and low emission tractors. Manufacturers are starting to respond to this interest. The Polaris electric side-by-side is already available in Australia and has sold out in some branches. The battery powered, electric Fendt e100 will begin series production in 2024 and John Deere plan to bring electric tractors to Australia in 2026. A US based start-up, Monarch Tractors had planned to have their autonomous e-tractors in Australia shortly but this has been postponed.

New Holland has a hydrogen prototype tractor, the NH2 tractor but this is yet to be released in Australia. The company has also developed the first 100% biomethane powered tractor which can be powered by agricultural and animal waste. The tractors are promoted to have the same power as their diesel equivalent but with a 30% lower running cost and a reduction in CO2 of 10% and overall emissions of 80%.[39] A prototype is expected in Australia in early 2023.

Hydrogen has been suggested by some in the industry as more technically capable for the high horsepower requirements of agriculture when compared to their electric counterparts, however

[36] Australian Bureau of Statistics, 46040DO0006 Energy Account, Australia, 2017-18
[37] https://thedriven.io/2022/07/29/football-meat-pies-efficiency-standards-and-electric-utes-can-we-have-it-all/
[38] https://thedriven.io/2022/07/29/football-meat-pies-efficiency-standards-and-electric-utes-can-we-have-it-all/
[39] https://agriculture.newholland.com/eu/en-uk/equipment/products/agricultural-tractors/t6-methane-power
[40] Discussion with Nathan Gore Brown, Mov3ment Jul 22

the current price of producing and transporting hydrogen means it could be years before this becomes a feasible option.[40] The running cost of hydrogen tractors is also likely to be higher than for electrified farm vehicles.

Low emission farm vehicles are still a few years off supplying the Australian market. This possibly presents an opportunity domestically for development of a low emission, bridging fuel industry such as renewable diesel, if the right policy settings are in place.

A number of challenges will need to be overcome before Australia can embrace low emission farm vehicles and tractors. These predominantly relate to high potential purchase costs, technical capability and knowledge, confidence, and policy settings. Australia currently lacks fuel emission standards meaning there are no incentives for manufacturers to send their low emission vehicles to Australia adding to the supply chain issues already being experienced.

CASE STUDY: GRID INTEGRATION WITH EVS AT A WINERY

Joseph and Sue Evans run Ballycroft Vineyard and Cellars, north-east of Adelaide. The couple will use their new electric Nissan Leaf vehicle as a mobile battery, after their vehicle-to-grid and vehicle-to-home converter is installed. The two-way charging capability of their Nissan Leaf will save the vineyard $1,700 in power costs a year. The car will be charged by solar panels on the cellar door roof during the day, and 'plugged' into the house at night so power can be drawn from the vehicle rather than the grid.[41]

[40] Discussion with Nathan Gore Brown, Mov3ment Jul 22
[41] https://thedriven.io/2022/07/26/australian-winery-readies-to-power-cellar-door-with-nissan-leaf-and-v2h/

> "On a farm scale, there could be great benefits if farmers were able to share power across meters on their property, or net their power off (without paying the standard transmission and network charges)."
>
> **ANDREW CHAMBERLIN,**
> Queensland Farmers

Powering the community: regional scale initiatives

In the future, rural and regional communities could become energy 'prosumers', producing energy and trading their excess in local energy markets facilitated by the distribution network service providers (DNSPs). In this future vision, DNSPs have also evolved to provide services to farmer-owned microgrids, maintaining poles and wires specifically to meet reliability and safety obligations. The cost of energy is lower for regional people given that energy is produced and consumed locally, and so is not subject to the same network charges.

This vision could be supported by retailers providing a higher feed-in tariff that rewards small-scale generators. More batteries in the network help shift exports to parts of the day when demand is high and hence attracts a higher value for feed-in-tariffs. With lower connection costs and quicker processing times, mid-scale renewables in the regions will flourish.

In this future vision, smart grids are commonplace, enabling two-way communication between the network and customers. Controllers, automation, and new technologies working together enable the grid, customers, and renewable energy sources to respond quickly to changes in demand and supply of power. For example, where areas of the distribution network are constrained, demand response programs pay farmers to reduce their use of power at peak times, all automated using artificial intelligence (AI) and smart controls. Sophisticated Frequency Control Ancillary Services (FCAS) markets are creating lucrative secondary revenue streams for farmers.

In this vision, DNSPs have upgraded lines and transformers in physically constrained areas, where population growth is predicted or intensive agriculture is clustered, enabling the continued uptake of renewables and export to the grid and to trade with others in the locality.

DNSPs have progressively identified areas of under-utilisation, and nominated several community and farmer REZs across the Eastern Seaboard. Farmers have responded, initiating hundreds of mid-scale (1-5MW) solar developments in response, on marginal parts of their land, and partnering with developers to secure a guaranteed income not dependent on the weather. New land for consideration has been opened up over high-value crops like vineyards and berries as agrivoltaic systems become more commonplace, demonstrating that energy generation and farming can successfully co-exist. Mid-scale renewables enjoy a higher degree of community acceptance because locals have greater ownership and share of profits over energy production.

Enabling regional power through distribution network reform

Transmission networks are high voltage networks consisting of towers and wires that transport the majority of energy, produced by large generators, to major demand centres like cities or industries. Transmission network service providers (TNSPs) own, build, maintain, and operate networks in Queensland (Powerlink), NSW (Transgrid), Victoria (Ausnet), South Australia (ElectraNet), and Tasmania (TasNetworks). These interconnected networks form the National Electricity Market (NEM), the longest interconnected power system in the world, with a distance of around 5,000km. Western Australia is not connected to the NEM.

It is through this network that large-scale solar and wind developments connect to send their energy back into the grid. The high voltage electricity from the transmission network is converted to lower voltage at substations where it is then transported to businesses, farms, and homes via the distribution network — the poles and wires beside local roads.

It is through the distribution network that excess power from small and mid-scale on-farm renewables (installed for the primary purpose of reducing a farmer's diesel or electricity use) can be exported to the grid. This is also the network that farmers could connect mid-scale solar farms (1-5MW) to, solely for export purposes.

STATE OF PLAY OF THE DISTRIBUTION NETWORK

The way energy is produced and transported in Australia is changing. The rapid uptake of rooftop solar in Australia, assisted by various incentives, has resulted in many Distributed Energy Resources (DER) being connected to the electricity network by energy consumers. In the future, this trend will be accelerated by people buying and installing batteries, whether installed in the home or alternatively in an EV.
EVs are, in time, expected to have vehicle-to-grid (V2G) capability, greatly increasing the potential for energy exports to the grid. The distribution networks must therefore now cater for 'reverse flows' of energy, particularly during the middle of the day.

When 'penetration' of solar and other DERs was low, the impacts on the grid were minor. However, as deployment costs of solar and other DERs have reduced, many parts of the electricity network have reached their hosting capacity and are now called 'constrained', meaning that consumers installing DERs are being limited in their energy exports. Many prospective owners of small to mid-scale solar farms are also finding it increasingly likely that the distribution network they wish to connect to will limit their energy exports to the grid, either to a set maximum, or to a flexible maximum controlled by the network. The significant reduction in the costs of DERs has seen many electricity customers installing and using their own energy on site, becoming more active participants in the

PHOTO: ARNPRIOR SOLAR, EDF RENEWABLES

"It would be great to see networks provide discounts for local energy sharing."

MADISON STURGESS, Queensland Farmers Federation

energy market. There's a growing desire to trade and sell excess energy back to the grid, as well as to others ('peers') in the local network

However DERs, mostly solar, are causing issues for a grid designed to send electricity one way. Customers are continuing to install solar for the first time and add to their existing solar installations. They then export excess power, often during low demand periods such as in the middle of the day (the so-called 'Duck Curve') when large-scale solar farms are also generating at maximum capacity. This can cause issues such as voltage rise on the network, causing power quality issues for all consumers. This excess can result in concerns with thermal and stability limits for assets in the distribution and transmission network. The 'legacy' voltage regulation and protection schemes on the electricity network were not designed for two-way flows, and hence must be upgraded or replaced.

Cumulatively, these issues have started to cause reduced power quality, involuntary reduced solar generation (curtailment), and DNSPs such as Essential Energy in regional NSW or PowerCor in Victoria refusing, delaying, or limiting exports from prospective solar or other DER connections.

Limited visibility of distribution network hosting capacity and static export limits is preventing uptake of small- to mid-scale renewables in regional areas. The annual reports prepared by the various DNSPs contain the details of any planned investment to address these concerns; these Distribution Annual Planning Reviews (DAPRs) are large and complex documents.

Rules effectively prevent the sharing of energy between customers in close proximity as all energy which flows through a national meter indicator (NMI) (customer meter) incurs the full transmission and network costs. There is no broad provision for peer-to-peer trading even within the same property, using a Local Use of System (LUOS) mechanism

"

There are no definitive solutions that address equitable price tariffs across NSW. From a pricing scheme point of view, there are three options that need to be worked through. Firstly, where the rules could be changed so that the overall network (and hence all customers) pays for certain areas to be upgraded if we can show this is beneficial for all customers (i.e. there is not a limited benefit gained by one or group of customers). Secondly, if moving to LUOS, those in REZs could benefit, but this could inadvertently result in other rural customers, further from large renewable generators, paying more in network charges as cross-subsidisation is removed. Thirdly, the current system, 'customer pays,' means if the customer wants to increase the capacity to export energy, they pay to upgrade the system. A working group between networks, communities and Governments could be established to work through the principles of equity and decisions that drive the best outcome.

JOSH HARVEY,
Essential Energy

DISTRIBUTION NETWORK CHALLENGES

Energy development and investment in Australia is largely driven by corporate entities. There is limited opportunity for communities to play a role. The current distribution network was designed for large centralised facilities. A distribution network built for DERs will unlock many opportunities for agriculture and regional communities.

Currently, there are limited opportunities for installation of small to mid-scale dispersed solar, and therefore this limits the numbers of farmers benefiting from the energy transition and secondary incomes these developments secure. Only those farms with existing access to large size 11kV and 22kV three-phase lines are likely to host a 1-5MW Solar Farm (e.g. Grong Grong Community Solar Farm).

Farmers are at times unable to build or host 1-5MW solar farms because of a culmination of factors including:

- the area is constrained by existing DER
- high connection costs
- upgrades to existing lines needed
- export limits
- complex connection application processes with unclear wait times
- uncertainty connection will be granted.

For example, pumping for irrigation is often seasonal, so pumps are often only used for a few months of the year. This makes the use of solar financially unviable unless energy can be exported or sold to neighbours (or local processing plants) at non-pumping times. Irrigators also have peaky energy use which sometimes creates high demand charges that are applied across the entire month.

> "DNSPs could undertake the business case for the role of small and mid-scale renewables as an alternative to infrastructure upgrades and then share any cost savings with the farmer.
>
> **ASH SALARDINI**
>
> **National Farmers Federation**

UNDER-UTILISATION OF SOME PARTS OF THE GRID

The electricity network is designed to cater for 'peak' demand times – be that mid-winter evening peak (heating and cooking) or mid-summer afternoon peak (air conditioning) – that may only occur on 6-10 days per year for a few hours at a time. At all other times the network is operating below its maximum capacity – typically 40% to 60%. In the case of rural networks and transformer utilisation this can be as low as 20%. Whilst there is ample current capacity in the existing network, rural networks are generally 'voltage constrained', particularly the high voltage single phase and SWER networks (widespread across Victorian and Queensland farming areas and in western NSW) due to the long distances involved. Managing DER connected to these 'thin' networks is particularly challenging for DNSPs. In NSW, up to one quarter of electricity costs now comes from infrastructure that sits around waiting for demand spikes that occur for less than 40 hours a year.[43]

> "Just in NSW there are approximately 140,000 substations. If just 10% of these were available to connect 5MW solar developments to the distribution network, there would be enough power to power the Eastern seaboard. These enormous assets are already there, but they are failing to be seen by governments. The medium voltage network isn't just about electricity, it's about continued economic and regional development and sustainability. We need to stop the huge cash exodus from regional areas into the cities and use mid-scale renewables owned by locals to keep the profits local.
>
> **METHUEN MORGAN,**
> co-founder Meralli Solar

[43] https://d3n8a8pro7vhmx.cloudfront.net/solarcitizens/pages/1202/attachments/original/1461023115/Homegrown_Power_Plan_Full_Report.pdf?1461023115

CASE STUDY: CHALLENGES IN CONNECTING A 4.99MW SOLAR DEVELOPMENT IN DUBBO

Tom Warren, a farmer in Dubbo NSW who also hosts an 18MW solar development on his property, recently partnered with a developer to propose a second development of 4.99MW on 15 hectares of his land. This would connect and export to the distribution network, earning him an income from the lease of his land. Initial investigations identified the line had a hosting capacity of 7 or 8MW. Unfortunately for Tom, another 4.99MW project was approved first by Council, impacting the viability of Tom's project. They were asked to re-assess the line capacity and if needed, put in mitigation measures to deal with congestion, including monitoring and measuring power flow on the network. If the project had gone ahead, they could have faced curtailment depending on congestion and whether power flows were exceeded. The developer was also responsible for the cost of upgrading the line to accommodate the new project, with no buy-in from the DNSP.

Essentially the asset would be developer/customer funded, and gifted back to the DNSP. The issue in Tom's case is the cost of the upgrade for the distance of 2-3 kilometres from the zone substation, estimated at $1 million would include capacity beyond what was needed for their specific project. If the upgrade had taken place, other customers, loads or generators could also use this increased capacity. The DSNP, Essential Energy, however do have a Pioneer Scheme so that the proponent who upgraded the network can be reimbursed for a period of time if others make use of the new works.

> **I'm a huge supporter of the need for renewable energy, but unless these sorts of smaller devel-opments can be enabled in a Renewable Energy Zone, where demand for power is increasing locally, I don't see much advantage for regional people living in a REZ.**
>
> TOM WARREN

PHOTO: DESTINATION NSW

CASE STUDY: UPGRADING LINES AND TRANSFORMERS TO ENABLE A VIABLE RENEWABLES SYSTEM

Fig, olive, and wine producer Sam Statham of Rosnay Organic, partnered with QuantumNRG project management services to design and implement a renewable energy system. The property, on the 'edge of the grid', was grid power-connected through old SWER lines that suffered from occasional power outages and impacted operations. Rosnay received matched funding from the NSW Department of Primary Industries (DPI) which helped pay for solar and batteries and, importantly, helped to move them from a thin single line to a new 3 phase connection and newly installed underground cables. This moved the farm from a maximum of 3kW to unlimited export and allowed increased production capacity while reducing overall energy costs. The final benefit was replacement of an ageing diesel-powered generator source that did not fit with the company's green philosophy.

The new transformer and three-phase cabling upgrade was costly, at approximately $60,000. There were also delays to the project, with the DNSP changing internal protocols at the last minute which, if implemented, would have added significant project design and implementation costs. The upgrades have allowed the sharing of energy from the new 30kW of solar to multiple outbuildings and in the future will allow sharing to an existing community bore.

"Putting in solar and batteries and upgrading our transformer helped with some of the limitations of our ageing infrastructure and power supplies. If it weren't for DPI's funding, the project would have had a 20 year payback, and wouldn't have been something we would have undertaken ourselves. With the grant, it's a 10 year payback, but not everyone will have access to the funding we did," says Sam.

Aidan Moore, Founding Director at QuantumNRG commented: "This was a really interesting project, needing careful coordination of multiple contractors. Rosnay now has a modular, resilient green power source that can meet current and forecast growth plans."

CONNECTION APPLICATION UNCERTAINTY

The report *Irrigators – The flow on benefits of regionally embedded generation*, completed by the Institute for Sustainable Futures, indicated that farmers had grid connection applications for solar returned from DNSPs, where export limitations were rescaled several times without explanation or the provision of alternatives. In some other instances, applications were only approved after lengthy assessment and subject to costly upgrades.[44]

"When we first started building mid-scale solar plants (under 5MW), the slowest part was the construction phase. Now the slowest part by far is negotiating the connection agreements with the network and dealing with Councils. The lack of visibility around who else is applying for a connection can be frustrating and as it's a first come, best dressed situation you can spend tens of thousands if not hundreds of thousands on assessments and then your project is knocked back. The secrecy is difficult to manage.

PETER MAILLER,
cattle and grains farmer in NSW and contractor for Meralli Solar

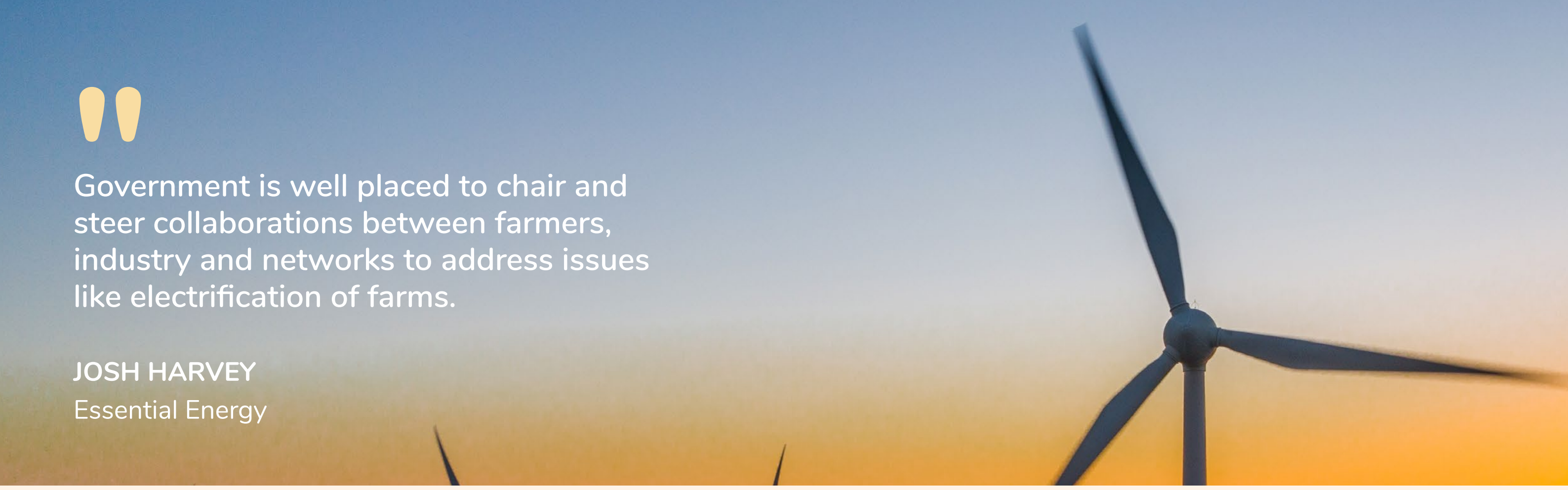
INCOMPATIBLE POLES AND WIRES

Single phase and SWER lines physically cannot accept higher levels of solar energy into the grid from farmers' properties. The largest single-phase and SWER distribution transfers in common use are 50kVA each. These rural lines have long spans of high-resistance steel conductors and increasing their capacity requires additional poles and new conductors – effectively a complete rebuild.

"A key contributor to energy infrastructure regional disadvantage is the outdated approach of the Australian Energy Regulator which uses population density metrics as the sole consideration of value in its consideration of infrastructure upgrades on the distribution network. This creates a strong bias to serving metropolitan communities.

NATALIE COLLARD,
Food and Fibre Great South Coast

[44] https://www.qff.org.au/wp-content/uploads/2019/03/Barriers-Final-Report.pdf



> Government is well placed to chair and steer collaborations between farmers, industry and networks to address issues like electrification of farms.
>
> **JOSH HARVEY**
> Essential Energy

EXPORT LIMITS

Blanket export limits imposed across areas prevent excess power being sold to the grid when not being used on-farm, extending out the return on investment for on-farm solar. Batteries that store excess power to dispatch behind the meter, during non-daylight hours, could reduce export to an already saturated grid, however current storage costs mean most systems are financially unviable.

ELECTRICIFICATION

Future electric tractors will have large power requirements and big batteries. There is a lack of clarity and discussion on how to enable electrification with most farmers on SWERs. There could be a role for powering tractors and farm equipment by solar, hydrogen, and bioelectricity, but work needs to start now to address these future issues. Future agtech could require high volumes of energy and rely on a grid that can deliver the electricity needs of farmers.

MICROGRIDS

Microgrids often don't stack up financially due to the inability to share energy without having standard network and transmission charges apply; there are also complex technical and social issues to be overcome in the operation of microgrids. Current network rules don't support brownfield microgrids – with the exception of remote towns and villages where reliability imperatives make them viable. If farmers take over their high voltage network and become High Voltage Customers, this is seen as problematic due to insurance concerns and access to Authorized Contractors to perform switching and maintenance on the HV assets.

STAND ALONE POWER SYSTEMS

For farmers located on the 'edge of the grid', reliability of electricity can be an ongoing issue. Stand Alone Power systems (SAPs), off-grid systems operating independently from the main network, can increase farm energy resilience. SAPs consist of a renewable energy supply such as solar panels, battery storage and a backup generator, making them completely self-sufficient power units.[45] They reduce outages, which are extremely detrimental during harvest and vintage periods for climate controlled environments like poultry sheds, or for dairy farm's daily milking, heating, and cooling requirements.

A study by Energy Networks Australia suggests SAPs could be beneficial and economic to reduce the impacts from natural hazards and disasters. The study suggests a rule change request should consider broadening the considerations that a DNSP is able to use in determining whether to transition existing customers to a SAP to include improved resilience.[46]

According to another report by Energy Networks Australia and CSIRO, new regulatory arrangements will be required to allow innovative service delivery for up to 27,000 new rural connections expected to occur by 2050.[47] Almost $700 million could be saved by supplying these connections, usually farms, with a SAP system, yet current regulations would mandate a conventional 'grid connected' service.[48]

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[45] https://www.westernpower.com.au/our-energy-evolution/grid-technology/stand-alone-power-system/
[46] https://www.energynetworks.com.au/resources/reports/2020-reports-and-publications/opportunities-for-saps-to-enhance-network-resilience/
[47] https://www.energynetworks.com.au/resources/reports/unlocking-value-microgrids-and-stand-alone-systems/
[48] Ibid

RECOMMENDATION:

3. Enable on-farm and mid-scale renewables through distribution network reform.

- Establish mid-scale community and farmer ‘informal REZs’ (outside of declared REZs) which identify under-utilised hosting capacity in the network and encourage dispersed 1-5MW solar developments.
- Trial the carving out of a community energy component within a large scale REZ helping to develop and sustain social license for large scale investments. Some design accommodation within the transmission infrastructure is needed to enable a small collection of 1-5MW projects to tie into the otherwise dedicated REZ infrastructure.
- Eliminate export limits which prevent farmers from exporting more renewable energy to the grid.
- Broaden the Australian Energy Regulator’s framework beyond a population density calculation, in determining infrastructure upgrades for the distribution network.
- Develop a plan that identifies areas to prioritise upgrades from SWER to three-phase across regional Australia.

Attracting energy-intensive industry to the regions

The decentralisation of energy is characterised by the production of energy close to where it will be used, such as on farms ‘behind the meter’, allowing for more optimal use of renewables and new business opportunities. For the purposes of this report, decentralisation also refers to the development of emerging small-scale industries and manufacturing, powered by locally generated renewables that supply a local region, increasing economic development and prosperity for rural people.

The tariffs for power produced under this decentralised model are expected to be cheaper because the power doesn’t have to travel so far. Therefore, these cheaper tariffs should attract manufacturers and new industries to locate in the regions to take advantage of cheap, renewable energy sources.

The technology suited to produce decentralised renewables depends on a region’s competitive advantage. For example regional liquid biofuel hubs may work where abundant waste feedstocks from farms can be transported short distances to a central point and the biofuel sold back to local farmers. Alternatively in areas with high solar resources, industries such as green hydrogen or ammonia to urea processing may be established to supply the region's agricultural communities.

Producing ammonia is a highly energy intensive process, contributing to 1.8% of global carbon dioxide emissions, similar in scale to the aviation industry. [50]

These new industries can provide regional development through long term employment opportunities and could increase fuel and fertiliser security while decarbonising agriculture’s supply chains.

As an organisation, Riverine Plains recognises we don’t want to be reliant on international inputs such as urea and prices have also been only going up. Being a not for profit, we also want to provide value to our members so investigating a renewables-powered ammonia urea plant could be a fantastic start. Our average member would spend $500,000 on fertiliser a year and given we’re in one of the sunniest spots in Australia it just makes sense to be looking at these sorts of opportunities. We just have no idea where to start.

CATHERINE MARRIOTT,
CEO, Riverine Plains

[50] Pilbara to get Australia’s first large-scale hydrogen plant - Energy Source & Distribution (esdnews.com.au)

CASE STUDY: HYDROGEN FROM WHEAT STRAW IN CENTRALISED REGIONAL HUBS

HydGene Renewables has developed a process that uses the sugars from waste biomass sources (such as barley and wheat straw) and converts these to hydrogen using an engineered biocatalyst technology.

It's the transport and storing of hydrogen that drives up its costs, but HydGene believes it will be possible to make hydrogen on-site and on-demand. They are currently also investigating centralised processing facilities. Working with the Grains Research and Development Corporation they identify that globally there is enough wheat straw stubble available which could be used to replace up to half of today's fossil fuel derived hydrogen.

"Today, if you took 100 tonnes of straw stubble, you can extract nearly 40 tonnes of sugars which can produce about 1 tonne of hydrogen. That's nearly enough energy to power 1,000 houses for a day," explains Louise Brown from HydGene.

"We want to work towards larger regional plant systems in the future. We modelled there is about 100kt of straw stubble available annually from approximately 20 average grain farms that can be used to produce up to 10 tonnes of hydrogen each day in a regional centralised plant with our biocatalyst technology."

"A regional plant making up to 10 tonnes of hydrogen per day could be used to power up to 10,000 homes or provide fuel for nearly 10 refuelling stations."

HydGene recognises the benefits of leaving straw in the paddock for soil carbon and moisture needs, so plan to leave up to 15 centimetres of stubble behind, depending on what individual growers need.

On a regional scale, technology to create green ammonia and urea for local farmers' use from renewable energy sources such as hydrogen has not been demonstrated and there is little understanding of the opportunity, costs (local small scale production compared to industrial scale production), and benefits (job creation, transport cost reductions, and security of supply).

RECOMMENDATION:

4. Prioritise and fund decentralised, regional renewables-based initiatives that contribute to economic development in rural Australia.

- Fund pilot small-scale renewable powered hubs that share infrastructure and supply a local region with products and services such as ammonia to urea processing.

Other regional opportunities

WASTE TO ENERGY OPPORTUNITIES FOR AUSTRALIAN AGRICULTURE

Agriculture creates millions of tonnes of waste a year and can form a fundamental building block for a viable bioenergy sector in the future as well as be a key end user. Bioenergy is a form of energy generated from the conversion of biomass into heat, electricity, biogas and liquid fuels. Biomass includes organic waste products from poultry, dairy and piggeries, cereal straw crop stubble, crops grown specifically to produce biofuels, and horticultural waste like tomato vine residue. There are some industries like food manufacturing or brick works that require high volumes of heat, which currently cannot be met by commercially available electrictrification options. Bioenergy can fulfil this role.

> "Secure energy sources underpin regional economic growth and the security and sustainability of the existing industries we have here in Shepparton. We remain the second largest dairy production region in Australia, we are home to almost a quarter of Australia's milk processing capacity, and we produce almost half of Victoria's fruit. What we want to understand is how we can use the waste from these industries and convert it to energy to strengthen our region as we have never had secure energy given we're on the edge of the grid."
>
> **LINDA NIEUWENHUIZEN**
> CEO Committee for Greater Shepparton

According to ARENA, bioenergy currently provides only 3% of Australia's total energy consumption but has the potential to provide up to 20% by 2050 and up to 26,000 new jobs.[51]

Biogas technologies produce methane by AD of animal and crop waste presenting an opportunity for better waste management, reduced emissions and improved regulatory compliance for agriculture. The outputs are biogas and digestates (soil products in liquids and solid form). The biogas can produce on-demand heat and electricity for use in engines, microturbines or fuel cells.

> Goulburn Valley Water is in a strong position because we are co-located with a high concentration of manufacturers and food processors and we have significant wastewater resources from those industries. We also have a lot of agriculture nearby producing thousands of tonnes of wastes and residuals a year. We are still understanding what those waste profiles are and what the best technology in the bioenergy industry is for producing the biogas to supply our processing and manufacturers. We're keen to understand what a direct supply arrangement could look like from the wastewater treatment plant to the manufacturers and processes and want to secure these industries long term commitment to staying in the Shepparton region.
>
> **SARAH THOMSON**
> Goulburn Valley Water

Waste from Australia's livestock, biosolids, food, and water processes, used to generate biogas, has the potential to become a $2.24 billion per year industry.[52] The country's livestock population of 29 million cattle, over 2 million pigs, and 101 million poultry in addition to about 24 million people generating biosolids and 290 kilograms of food waste per year, the potential for biogas is approximately 7.5 million m3. This could significantly contribute to achieving a cleaner on-demand electricity supply.[53]

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[51] https://www.sustainability.vic.gov.au/news/news-articles/record-breaking-bioenergy-investment-in-victoria
[52] http://www.worldbiogasassociation.org/wp-content/uploads/2018/07/Australia-International-Market-Report.pdf
[53] http://www.worldbiogasassociation.org/wp-content/uploads/2018/07/Australia-International-Market-Report.pdf

CASE STUDY: SOUTHERN MEATS ABATTOIR (SHEEP)

Southern Meats, an abattoir in Goulburn, NSW were facing power bills of $100,000 a month for their operations slaughtering 4,000 sheep a day. The abattoir also produces a lot of effluent creating an environmental challenge for the business.

Southern Meats installed a bioenergy system, supported by ARENA, at a cost of $5.75 million. Effluent is piped into covered anaerobic lagoons, where biogas is produced. This gas is transported through an underground pipeline to a gas fired generator where it's converted to electricity. The system produces approximately 4,000 MWh of electricity a year, about half of what the abattoir consumes.[54]

[54] https://arena.gov.au/blog/goulburn-bioenergy-project/

Powering the country: large-scale renewables

THE DEMAND AND THE OPPORTUNITY

Energy generation has historically been a major economic opportunity for regions such as the Latrobe Valley and Hunter Valley. The future energy system will continue to see these regions deliver renewable energy, capitalising on existing transmission infrastructure. At the same time, energy generation opportunities will open up for other regional communities around the country, which have some of the world's best solar and wind resources. Rural and regional Australia will be at the heart of this development boom and with appropriate planning and policy support, it has the opportunity to reap significant rewards.

As fossil fuel power plants reach the end of their lives and Australia moves towards a net zero emissions electricity sector the urgency of this shift is accelerating. Across the eastern seaboard the Australian Energy Market Operator's (AEMO) Integrated System Plan (ISP) models huge growth in electricity generation infrastructure by 2050:

- An almost doubling of the electricity delivered to homes and businesses every year, facilitating the electrification of our transport, industry, office and homes.
- Coal-fired generation withdrawing faster than announced, with 60% of capacity withdrawn by 2030.
- The need for 9 times the utility-scale wind and solar developments.
- The need for nearly 5 times the solar PV capacity, and substantial growth in battery storage.
- The need to treble firming capacity to support variable renewables.[55]

The ISP's optimal development path also identifies 10,000 kilometres of new transmission lines to connect these developments and efficiently deliver firmed renewable energy to eastern seaboard consumers.

[55] https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp https://www.abc.net.au/

To increase the efficiency of this investment, the ISP envisages a series of REZs, where new renewable energy generation projects are clustered together to fully utilise existing and new transmission links. The majority of investment will be in rural and regional Australia.

This should not be simply an opportunity for the electricity industry. An actively involved rural sector can see new diversity of income for farmers who host large-scale infrastructure, increasing resilience to seasonal variations. Energy generation facilities bring new jobs and throw an economic lifeline to regional towns, especially smaller towns that are seeing population decreases. Community funding can be provided from energy projects, and this can make a material contribution to the fabric of rural and regional towns. Community ownership of energy infrastructure could see profits stay in regional areas. As regional Australia becomes a more attractive place to site large-scale electricity generation, new energy-intensive industries can establish themselves in regional centres, bringing new job opportunities.

The key to securing these opportunities is ensuring that regional communities are well informed, and can be active participants in the renewable energy boom. While some of these opportunities are already being delivered throughout regional Australia, widespread community ownership and new energy-intensive industries will require new government frameworks to support their development.

If we do this well, large-scale renewables can support the growth of our agriculture sector. As long as rural Australia has access to cheap and reliable sources of energy, agriculture can confidently progress on its way to the National Farmer Federation's goal of becoming a $100 billion industry by 2030.[56] The renewables build-out can allow agriculture to grow and open new opportunities, ensure a cheap, reliable and clean electricity grid for the farm sector into the future, and deliver additional benefits that strengthen the long term prosperity of rural and regional Australia.

SECONDARY INCOMES FOR RURAL LANDHOLDERS

For over 20 years, landholders in rural and regional Australia have been diversifying their farming income with lease payments from hosting wind turbines and, later, solar panels. The quantity of these payments has grown steadily as the proportion of wind and solar power has climbed to contribute 16% (wind) and 10% (solar) respectively of the generation capacity in the NEM.

Wind turbines take up only around 3% of leased land allowing farmers to derive additional income as they continue their core business of producing food and fibre.[57] In many cases, farmers have been able to accommodate wind turbines on less productive hill country, increasing the overall productivity of their land.

[56] https://nff.org.au/policies/roadmap/
[57] https://ldcinfrastructure.com.au/wind-energy-lease-explained/

Payments to those who host wind turbines are typically made through annual lease payments that are made for the life of the wind farm. Across Australia's windiest regions, a new, reliable, long term source of income now helps to support farming communities.

In 2019, it was estimated wind farms were paying an estimated $17.5 - $20 million to host landowners each year.[58] This figure has increased significantly to around $50 million in 2022.[59] These payments have been critical for many families, delivering year-in, year-out on-farm income and helping them ride out extreme weather and commodity prices. These income streams also help families with the tricky problem of succession, making the farm business more attractive to the next generation and providing extra breathing space to make the right decision for those involved.

There are several hundred farmers across Australia who now enjoy annual payments over a 25-year life span of a typical wind farm. When farmers hire staff, purchase supplies, repair equipment and invest in new machinery this pumps money into local businesses to the benefit of the whole town. That's a big boost to the resilience of a lot of rural towns and businesses who have to struggle year to year with the ups and downs of agriculture.

Across all 41 NSW REZs, EnergyCo estimates that "landholders hosting renewable energy generation projects could be expected to receive an estimated $1.5 billion in lease payments by 2042."[60]

It should be noted that the above payments are for host landholders. Neighbours are often impacted by changing visual amenity and construction phases of projects but often aren't included in sharing the wealth these solar and wind projects create. There have been instances where erosion has occurred on neighbouring properties to solar developments during construction due to changes to the layout and hydrology of the land.

Best practice renewable energy development includes providing payments to neighbours who are impacted by renewables developments whether visually or otherwise. These payments are not mandatory however and are far from uniform across different projects.

CASE STUDY: WIND TURBINES PROVIDE SECONDARY INCOME FOR BEEF AND SHEEP FARMER

Simon Barton is a sheep and cattle farmer, running a property on the Mudgee Road near Wellington, NSW. He is one of a number of hosts for the Bodangora Wind Farm, earning a secondary income through leasing his land. Simon explains how their family were forced to cut back on production during the drought in 2018-2020. He says the conditions were some of the hardest they've ever struggled through.

"We had to de-stock quite a lot. I went from 220 cows down to about 80 during the drought. Sheep numbers were also down, not as much as the cattle, but one of our first cross-breeding enterprises was halved."

"The wind turbines have been a huge help. It's rained a lot since but we're in a financial drought now and it's taking a while to re-stock so the income from the wind turbines is helping drought proof us and keep us viable for the future."[61]

[58] Building Stronger Communities-Wind's growing role in regional Australia
[59] Re-Alliance internal figures based on on Building Stronger Communities, 2019.
[60] https://www.energyco.nsw.gov.au/renewable-energy-zones/what%E2%80%99s-involved-in-a-renewable-energy-zone
[61] https://www.wellingtontimes.com.au/story/5939334/wellington-farm-turns-to-wind-turbines-to-stave-off-effects-of-drought/

LEVELLING THE PLAYING FIELD

Farmers living and working in areas that have seen renewable energy development in the last two decades know that the process is far from straightforward. Often out of the blue, project developers get in contact to offer contracts to lease land. If the land is in a highly sought after position with, for instance, high winds or close proximity to a transmission line, a farmer might be approached by multiple developers. Contracts are complicated, requiring knowledge and experience that farmers may not have. Access to professionals with these skills is often hard to find in regional areas, where the local solicitors and accountants are likely to have limited experience in these kinds of developments. While developers are experts in all the financial, technical and planning details of these negotiations, in most cases, farmers are coming off a standing start.

The end result is that, without asking for any of it, landholders have to make complex decisions that will have long-standing implications for the future of their farm business.

Because farming communities are close-knit, with neighbours who are often relatives or family friends over generations, these decisions have impacts that extend well into the surrounding community. These situations are potentially very stressful and differences within families and between neighbours can arise. While large projects inevitably bring some disruption, poor behaviour from some project developers in the past[62] has put many communities on high alert.

There are also obstacles for landholders and communities living in a REZ that need to - and can be -addressed by State Governments. These can be around housing shortages, shortages of skilled tradies, increased trucks and road usage, and visual impacts. It is important that these challenges are acknowledged and the right mechanisms put in place.

The starting point is access to information. Guides like NSW Farmers Landholder Guide[63] are an excellent resource for landholders who need to understand the development process.

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[62] https://www.abc.net.au/news/2018-03-18/controversial-wind-farm-application-withdrawn/9560698
[63] https://www.nswfarmers.org.au/NSWFA/Content/IndustryPolicy/Resource/Renewable_Energy_Landholder_Guide.aspx

A FAIRER DEAL FOR FARMERS AND COMMUNITY AROUND NEW TRANSMISSION LINES

> "The biggest concern we're hearing about from farmers around energy and renewable energy is around large-scale renewables and associated infrastructure (transmission lines)."
>
> **ASH SALARDINI**
> National Farmers Federation

Much of the new transmission infrastructure needed to meet the ISP will be developed on new easements over land that may be owned by farmers. There will also likely be impacts on publicly owned land and land owned by Traditional Owners.

Local regions along planned transmission routes must be respected in the development of the lines and not be expected to simply tolerate the impacts without benefit. Landholders and neighbours must be treated as key stakeholders for deep consultation on social, cultural and environmental impacts around transmission route location.

There are ways to improve the transmission development process for the immediate benefit of the local region, including the following:

- Investment in high-quality engagement that results in better local social, cultural and environmental outcomes as locals holding knowledge about their region are treated as primary stakeholders.
- Higher annual payments for host landholders to ensure they benefit as though they were hosting a wind or solar farm.
- Payments for impacted neighbouring landholders based on proximity to the line, such as is practice in the wind industry.
- Payments for landholders in study corridors for proposed lines, to cover time that may be taken away from farming businesses to understand and provide feedback on the potential placement of the line.
- Community benefit programs, co-designed with local communities to support local projects, such as access to cheaper local electricity. [64]

Transmission companies could contribute to the reasonable costs of community benefit sharing and community partnerships, with only a modest impost either recovered from electricity consumers or potentially contributed by Government. Transmission companies can recover benefit sharing related costs from electricity consumers through existing market mechanisms.

There is a lot that can be done by transmission companies and by state governments. However, the new Federal Rewiring the Nation policy, and review of the Regulatory Investment Test for Transmission which have been promised by the Federal Minister for Energy presents even greater opportunities for more equitable sharing of costs and benefits in the development of our grid.

[64] https://d3n8a8pro7vhmx.cloudfront.net/vicwind/pages/2616/attachments/original/1628044697/RE-Alliance_July_21_Building_Trust_for_Transmission_Earning_the_social_licence_needed_to_plug_in_Australia's_Renewable_Energy_Zones-compressed.pdf?1628044697

Landholders affected by new transmission lines often call for the undergrounding of some or all of the new transmission infrastructure. Undergrounding is appropriate in some circumstances, for instance two of Australia's largest interconnectors Murraylink and Basslink have been built underground. It is important to remember however that the costs of undergrounding transmission lines are much greater than above ground options. Transgrid recently released a study into the costs of undergrounding the new Humelink transmission line between Wagga Wagga, Bannaby and Maragle. It will connect the pumped hydro project Snowy 2.0 to Sydney, Newcastle and Wollongong, where the power is most needed.

The report found that the cost of undergrounding the HumeLink transmission lines is estimated to be $11.5 billion (for Option 2A-1, high voltage direct current lines), which is at least three times more than the entire project's current cost of $3.3 billion. In addition, this option is expected to take seven years to build, compared to four to five years for the overhead option. It is also the case that there are significant environmental impacts associated with trenching for underground projects.[65]

The current regulatory arrangements overseen by the AER only allow for the recovery of efficient costs from consumers. Options costing significantly more will not be approved by the AER.

RECOMMENDATIONS:

5. Improve accessibility and fairness for farmers and regional communities in transmission and REZ planning, including:

- State Governments provide a mechanism for improved benefit sharing arrangements for transmission hosts and communities, including higher annual payments to hosts, payments to impacted neighbours, and funding for community benefit programs.
- REZ's currently being rolled out should have support available for farmers and communities with independent advice provided in the contract negotiation stage of renewable energy developments.

CONSULTATION WITH FIRST NATIONS COMMUNITIES

Appropriate consultation must be undertaken with impacted First Nations communities on all projects. This is explored in greater depth by other organisations more appropriately placed to address these issues. For example, guidance on working with Aboriginal Communities is provided in the *NSW Government's First Nations Guidelines*[66] and in the *Australian National University's Clean Energy Agreement Making on First Nations Land: What do strong agreements contain?*[67]

[65] Undergrounding Humelink would triple the cost, Transgrid report finds available at: https://www.re-alliance.org.au/undergrounding_humelink_report

[66] NSW Government 2022, First Nations Guidelines available at: https://www.energy.nsw.gov.au/sites/default/files/2022-08/first-nations-guidelines-increasing-income-and-employment-opportunities-from-electricity-infrastructure-projects.pdf

[67] O'Neill, L., Riley, B., Hunt, J., & Maynard, G. (2021). Clean energy agreement making on First Nations land: What do strong agreements contain?, Centre for Aboriginal Economic Policy Research, Australian National University. https://doi.org/10.25911/ VHH3-F498

> Our business sees massive potential from community driven mid-scale renewables to deliver long term economic development for regional Australia. Approximately $12 million flows out of the Uralla Local Government Area, to the city each year in electricity costs (into the hands of Origin, AGL, Essential Energy etc). If the community owned a renewable energy generator, this could shift this economic dynamic with power produced and used locally, resulting in that money being retained in the Local Government Area itself.
>
> **METHUEN MORGAN**
> co-founder Meralli Solar

COMMUNITY OWNERSHIP OR CO-INVESTMENT

The most direct way for regional communities to gain a sense of ownership over renewable developments is by becoming co-owners or co-investors in the project. Under a co-investment model, the community owns some part of the profit associated with the renewable energy development, but does not have any decision-making power or control over the operation of the asset. Co-ownership involves more direct control as the community ownership allows an active role in decision making.[68] Co-ownership allows participants to generate income from the asset, develop skills and capacity locally and build long-term trust with the community.[69]

In Europe, co-ownership and community co-investment are much more common than they are in Australia. In Denmark in 2011, the Danish government mandated new wind farms must be at least 20% community-owned.[70] In parts of Europe this model has proved very successful and popular with local communities. For example, in 2013, 46% of Germany's 63 GW of renewable energy was locally owned.[71]

There are many benefits of co-ownership, including:

- allowing generation of income that can be re-invested locally;
- providing jobs, training and business opportunities;
- reversing economic decline of an area by attracting investment;
- allowing better stewardship of local assets because the community owns and uses them;
- instilling a renewed sense of pride and confidence in the community; and
- providing local people with a meaningful stake in the future development of the place in which they live and / or work.

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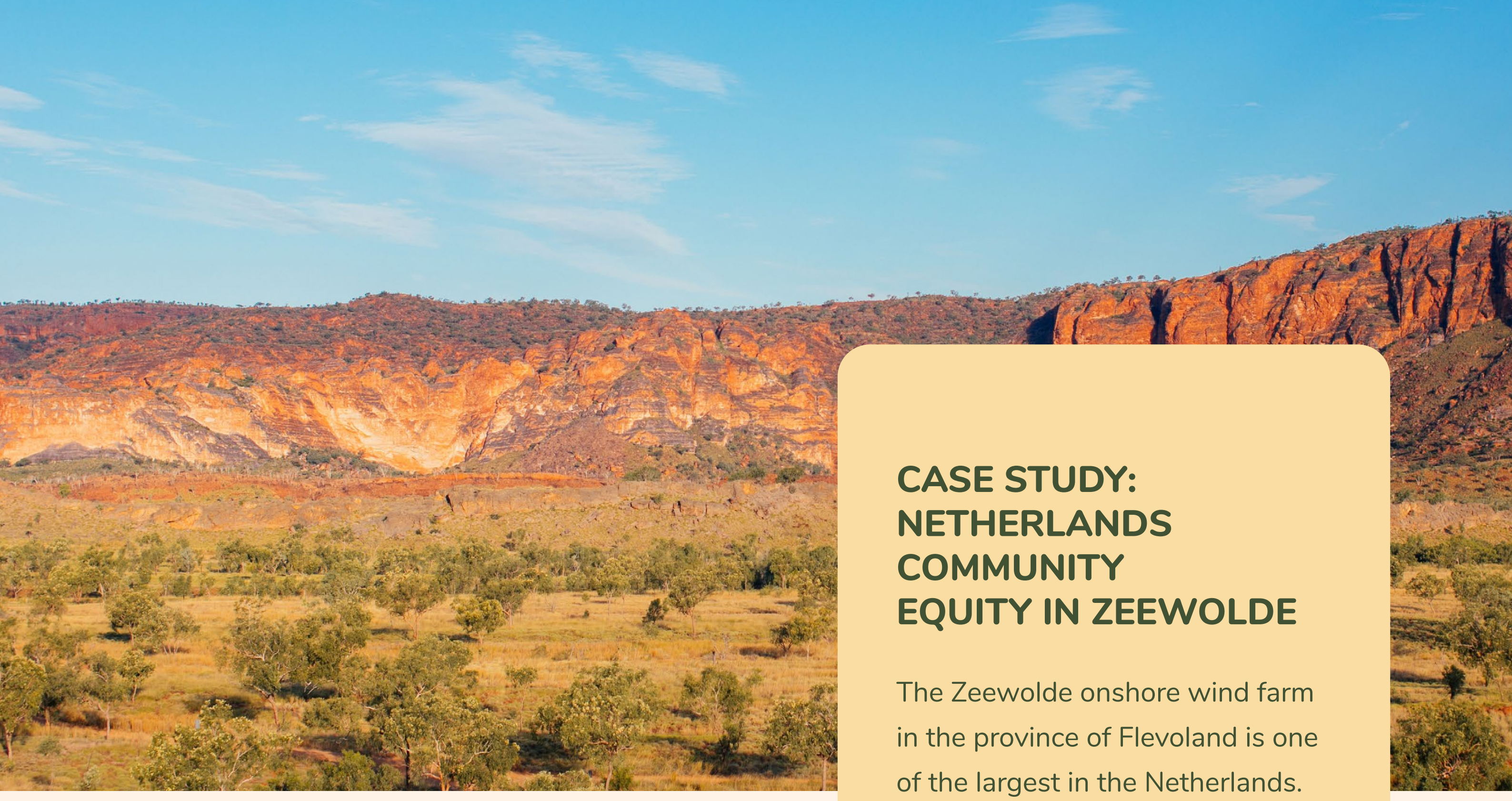
[68] Lane, T. and Hicks, J. (2017) Community Engagement and Benefit Sharing in Renewable Energy Development: A Guide for Applicants to the Victorian Renewable Energy Target Auction. p 26. Available at: https://www.energy.vic.gov.au/__data/assets/pdf_file/0027/91377/Community-Engagement-and-Benefit-Sharing-in-Renewable-Energy-Development.pdf and Community Benefits Handbook: How Regional Australia can Prosper from the Clean Energy Boom p. 25 available at: https://assets.nationbuilder.com/vicwind/pages/2631/attachments/original/1630471142/RE-Alliance_Community_Benefits_Handbook_WEB_01v1_%281%29.pdf?1630471142

[69] Benefits of community ownership available at: https://dtascommunityownership.org.uk/community/community-asset-transfer/getting-ready-asset-transfer/benefits-community-ownership

[70] Communal ownership drives Denmark's wind revolution available at: https://www.greeneconomycoalition.org/news-and-resources/people-power-denmarks-energy-cooperatives

[71] Farrell, J. (2013) Half of Germany's 63,000 megawatts of renewable energy is locally owned. Available at: https://ilsr.org/germanys-63000-megawatts-renewable-energylocally-owned/ and Community Benefits Handbook: How Regional Australia can Prosper from the Clean Energy Boom p. 25 available at: https://assets.nationbuilder.com/vicwind/pages/2631/attachments/original/1630471142/RE-Alliance_Community_Benefits_Handbook_WEB_01v1_%281%29.pdf?1630471142



Local communities may also partner with Traditional Owners. For example Canada has developed the Locally Owned Renewable Energy Projects that are Small Scale renewable energy procurement program, which has driven partnerships with First Nations peoples.

Australia's biggest community-owned renewables project comprises two turbines in Hepburn, which took a huge effort over many years by the Hepburn community. There have also been a number of projects on First Nations land – such as Ramahyuck Solar Farm,[72] which is currently in development and will be Victoria's first Aboriginal owned and operated solar farm – but Canadian examples show that there is a lot of room for improvement.

Many community groups lack the expertise to develop a renewable energy project. The cost to engage a consultant to assist with feasibility studies and connection applications can be extremely high before a project is known to be viable. Added to this are legal costs in developing the right structures to finance a community owned energy project and the time commitment from volunteers to run meetings, assess contracts and engage others in the community. Programs like those set out in the Local Power Plan (see below) would empower communities to engage in the process of developing local energy with confidence.

CASE STUDY: NETHERLANDS COMMUNITY EQUITY IN ZEEWOLDE

The Zeewolde onshore wind farm in the province of Flevoland is one of the largest in the Netherlands. Despite the opposition of some of the inhabitants, the authorities of Zeewolde proceeded to its inauguration. Other residents in the community could see the benefits of the project, as they could obtain equity in the project and receive a portion of the revenues.

The onshore wind farm of "Windpark Zeewolde BV" has a capacity of 320 MW. In addition, this allows it to supply electricity to approximately 300,000 homes. Its construction is part of the Dutch energy strategy to increase its share of renewable sources. Regina de Groot, owner of an organic farming business in the vicinity of the wind farm, said:

"People are sometimes not happy about wind turbines. But if wind turbines are owned by everyone and everyone can benefit from them, then I think people will look at them in a more positive light".[73]

[72] https://theconversation.com/how-can-aboriginal-communities-be-part-of-the-nsw-renewable-energy-transition-181171
[73] Energy News - Zeewolde Wind Farm inaugurated, available at: https://energynews.pro/en/zeewolde-wind-farm-inaugurated/?utm_source=facebook&utm_medium=social&utm_campaign=ReviveOldPost

THE LOCAL POWER PLAN

The Local Power Plan (LPP) was developed in consultation with regional communities and aims to capture opportunities for local ownership of renewable energy assets, so that these benefits can be shared with the community locally.[74] This includes programs to install solar PV on community buildings and locals getting together to fund community batteries. The LPP was costed by the Parliamentary Budget Office at $483 million over 10 years to 2030-31.

The LPP is comprised of three schemes:

1. The **Local Power Scheme**, to support local power hubs which would assist communities to develop their own energy projects;
2. The **Underwriting New Community Investment scheme**, which would underwrite locally-owned mid-scale projects;
3. The **Community Renewable Investment Scheme**, which would enable local communities to co-invest in large-scale projects.

The **Local Power Scheme** would establish 50 local power hubs to support renewable energy projects in regional communities. Each Hub would provide technical and project support to community energy groups, and work with them to access a new $310 million Local Power Fund to provide strategic development capital. Over 10 years, the Local Power Scheme was intended to catalyse thousands of small-scale projects across Australia. Each hub would be provided $500,000 a year for 5 years for establishment and administration costs. These hubs would also receive administered funding each year, for 10 years.

The **Underwriting New Community Investment Scheme** (UNCI Scheme) would have guaranteed a minimum return for eligible community-owned renewable energy generation and storage projects for up to 10,000 gigawatt hours each year for 10 years.

The eligible energy projects for this scheme are those that: can generate or store from 1 to 10MW of electricity, are at least 51% community-owned through local individuals, organisations or councils, are community-driven, have broad local support, and deliver tangible benefits to the region and which demonstrate technical benefits to the grid consistent with the ISP.

The **Community Renewable Investment Scheme** (CRIS) would require any new large-scale renewable development to offer 20% of the project equity to local communities within 30 kilometres of the project. To administer this scheme, the Australian Local Power Agency would be provided ongoing funding to develop guidelines for the scheme, assess whether developers meet those guidelines and award approvals once developers have completed co-investment funding rounds.

The Australian Local Power Agency Bill 2021 and Australian Local Power Agency (Consequential Amendments) Bill 2021 were introduced to the Federal Parliament in 2021 to begin implementing the LPP. They were referred to the House of Representatives Standing Committee on the Environment and Energy, who considered that the creation of another new agency, with all the costs and administration that entails, would not be of benefit to Australians. The Committee considered that the ARENA and the CEFC are appropriate agencies to undertake the work of providing support to renewable energy projects in Australia.

[74] Local Power Plan, available at: https://www.localpowerplan.com/_files/ugd/c2035c_89f382e44d71418f85683cea9bcfaa89.pdf

RECOMMENDATION:

6. The Federal Government should introduce additional measures to those set out in the Powering Australia policy to support community renewable energy by adopting programs similar to those suggested by the Local Power Plan. These should be implemented by ARENA and CEFC.

CASE STUDY: SAPPHIRE WIND FARM COMMUNITY CO-INVESTMENT FUND

In 2019, after a two year co-design process with the local community[75], the 270MW Sapphire Wind Farm, 18 km west of Glen Innes, opened a co-investment fund.[76] The Fund allows local community members to invest directly and share in the profits of a large-scale operational renewable energy asset. Shareholders committed $1.8 million of their own funds for a fixed 6% annual return payable across the fund life of 9.5 years. Based on community feedback, a low minimum investment amount of $1,250 made the Fund a realistic option for anyone who was interested.

The impetus for the fund came from the ACT Government's 100% Renewables program, which awarded Sapphire Wind Farm a long term power purchase agreement. Bidders in the tender process were assessed on community engagement and local investment benefits[77]

While other wind farm projects are planning similar programs,[78] clearer expectations around the need to offer them, such as those envisaged by the Local Power Plan may be necessary to see them become more widespread.

[75] https://assets.cleanenergycouncil.org.au/documents/events/Benefit-Sharing/CEC-Benefit-Sharing-Andrew-Dickson-CWP-Renewables.pdf
[76] https://cwprenewables.com/assets/main/PDFs/Bango/Minutes/Sapphire-Wind-Farm-Community-Co-Investment-Fund-booklet.pdf
[77] https://www.environment.act.gov.au/__data/assets/pdf_file/0007/987991/100-Renewal-Energy-Tri-fold-ACCESS.pdf
[78] https://goldenplainswindfarm.com.au/community-investment/

PHOTO: ARNPRIOR SOLAR, EDF RENEWABLES

COMBINING SOLAR AND AGRICULTURE WITH AGRIVOLTAICS

Renewable energy developments have undergone massive expansion over the last five years and this expansion will continue as we decarbonise our electricity supplies. Renewable energy developments are now being planned to be predominantly in new REZs. These REZs are located in regional communities, many of which support high levels of agricultural production.

Farmers are uniquely positioned to make the most of the roll-out of large-scale renewables being developed in the regions, while continuing to produce food and fibre on the same parcel of land.

Agrivoltaics (or agri-solar) forms part of this opportunity and refers to co-locating agricultural activities with large-scale solar developments. In practice, this could be activities under or between panels such as grazing sheep or cattle, cropping, horticultural crops, creating pollinator habitat or establishing free range chicken farming. Combining farming and solar in agrivoltaics presents a powerful path forward, increasing social licence for renewable energy developments and allowing ongoing agricultural use of productive land. Examples of co-location of agriculture and solar generation in Australia are identified in the Clean Energy Council's Agrisolar Guide.[79]

[79] Clean Energy Council: Australian Guide to Agrisolar for Large-Scale Solar - For proponents and farmers, March 2021 available at: https://assets.cleanenergycouncil.org.au/documents/resources/reports/agrisolar-guide/Australian-guide-to-agrisolar-for-large-scale-solar.pdf

PHOTO: SUNFARMING

BENEFITS FOR FARMERS OF AGRIVOLTAICS INCLUDE:

- Ability to continue to graze animals beneath panels; increasing the productivity of the land Studies have indicated less water consumption for sheep and lambs under solar panels than in exposed sites.
- Secondary income from leasing their land.
- For solar grazing, higher 2 metre cyclone wire fences provide protection against wild dogs and foxes.
- For cropping and horticulture, panels can offer protection from hail and sun.
- Reduced irrigation requirements by up to 20%.[80]
- Increase in some crop yields such as tomatoes as shown by a study in Arizona in the US.
- Certain crops such as berries and fruit trees, increase yield with up to 30% of shading.[81]
- Temperatures up to 5 degrees lower during heat waves.[82]
- Reduced risk from spring frosts as night time temperatures under solar can be between 1 degree and 4 degrees higher.
- Reduction of water use/stress under solar of between 12% and 50% reducing the need for irrigation.
- Reduced loss of productive land.
- For vineyards, improved aromatic and phenolic quality. Up to 2% less acidity and increases of between 9% and 14% anthocyanin.[83]

BENEFITS FOR SOLAR DEVELOPERS INCLUDE:

- Demonstrate commitment to valuing agricultural land.
- More options to site projects.
- Reduced costs for mowing and chemical input to keep weeds down when grazing continues under panels.
- Higher panel efficiency through better convective cooling.

BENEFITS FOR GOVERNMENTS INCLUDE:

- Ability to achieve net zero targets with increased support from regional communities and farming groups.
- Smaller more dispersed new land-siting opportunities for solar.

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[80] Elamri, Y. & Cheviron, B. & Lopez, J.-M. & Dejean, C. & Belaud, G., 2018. "Water budget and crop modelling for agrivoltaic systems: Application to irrigated lettuces," Agricultural Water Management, Elsevier, vol. 208(C), pages 440-453.available at: https://ideas.repec.org/a/eee/agiwat/v208y2018icp440-453.html
[81] Laub, M. & Pataczek, L. & Feuerbacher, A. & Zikeli, S. & Högy, P. Contrasting yield responses at varying levels of shade suggest different suitability of crops for dual land-use systems: a meta-analysis. Agronomy for Sustainable Development (2022) 42:51 https://link.springer.com/epdf/10.1007/s13593-022-00783-7?sharing_token=jtnO0pm7RyKWz896JpNZHPe4RwIQNchNByi7wbcMAY6te6XeQr46Rhcrn6FfB-nn5qwJvPy4RyEMktGoo8tz38TCr6VCCwP6nkwytdkbh1uPSCxhdBjelJgJRKmjxMmq7xFRE2VWgNaS87LrcQOKjXqknJf1ByuFpDo_ywBPIXtY%3D)
[82] Sun'Agri website available at: https://sunagri.fr/en/farmer-project/
[83] *Ibid*

CASE STUDY: SOLAR AND SHEEP

A farmer in the Central West, NSW Tom Warren hosts an 18MW solar farm and runs about 250 merino ewes and wethers on 54 hectares of land. Tom believes that as well as earning a secondary income from leasing his land, the solar panels have increased the carrying capacity of the block by about 25%. This was important during the drought in 2018, as water condensed on the solar panels in the mornings and trickled down below to keep strips of pasture green for his sheep to feed on. This resulted in him only needing to buy feed for them for three months of the two year drought.

"Hosting an 18MW solar farm was a great opportunity for me to supplement my agricultural income. I was very keen from the outset that I would get the opportunity to graze my merino sheep beneath the panels. The company agreed and it's been a win-win ever since. I've noticed the sheep's wool is relatively clean, without burrs, without dust. There's very, very little contamination of the wool and they're protected from the sun as well."

Adoption of agrivoltaics in Australia has been slow. Knowledge gaps, technical and economic impediments, poor planning and a lack of clear policy guidance at the development stage have hindered uptake.

While there are no current legislative barriers to agrivoltaics in Australia, the set up costs, particularly for cropping and horticulture projects, is higher than for conventional solar developments. This is due to the additional materials needed to increase the height of the structures and the increased land that can be needed.

RECOMMENDATIONS:

7. Support the combining of energy and farming through agrivoltaics by demonstrating that agriculture and renewables can complement one another.

- The Federal Government allocate funding to establish an agrivoltaics research and knowledge sharing program to boost farm profitability and show communities that agriculture and energy production can co-exist.

Conclusion

We are living in extraordinary times and with this comes extraordinary opportunities. We have the opportunity to revitalise the regions and embed sustainable farming into our society. Not getting this right means a huge missed opportunity for long term regional economic development.

The adoption of on-farm renewables means reducing emissions, reducing input costs and building business resilience, just some of the many benefits to be grasped. A sustainable farming sector benefits all Australians; keeping food affordable and allowing agriculture to continue to access export markets overseas.

Importantly communities need to be empowered and involved in the energy shift that is occurring. Australia has some of the best renewable resources in the world. Instead of power being held by a handful of entities, dispersed mid-scale renewable energy developments owned by farmers and communities could mean building a generation of shared prosperity. But we need to create supportive policies and programs for this to happen.

Australia's energy and food systems have reached a critical moment in time where every step we take now as a society will either set us up to succeed or to fail. New ways of thinking and operating are needed to foster meaningful and lasting benefits for regional communities and our farmers.

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