Energy infrastructure for future farming

Phase 1 – 3 Presentation

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NSW GOVERNMENT

CutlerMerz

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- DPI has engaged CutlerMerz to estimate the scope and cost for transitioning on-farm energy infrastructure to more electrified, lower carbon sources
- The core objective is to identify areas where investment is required to support the transition and the likely cost of such investments
- The engagement was undertaken as part of the NSW Primary Industries Climate Change Research Strategy funded by the NSW Climate Change Fund
- This engagement flows on directly from CutlerMerz's previous work for DPI (CMPJ0471) to identify the data sets available to support this assessment, and set out the scope, approach and intended objectives of the assessment.
- The scope of work comprises three key phases:
    1. Assessing, calculating and mapping the energy intensity of key agricultural sectors
    2. Mapping of network capacity
    3. Estimating the scope and cost of transitioning to on-farm, low carbon energy sources

Sector coverage

- Energy consumption data was obtained from the 2015 Agrifutures report *Benchmarking Energy Use on Farm*, additional data sources from DPI and publicly available studies across the five agricultural sectors:
    - Grain
    - Horticulture
    - Dairy
    - Pig and poultry
    - Feedlot cattle

Approach

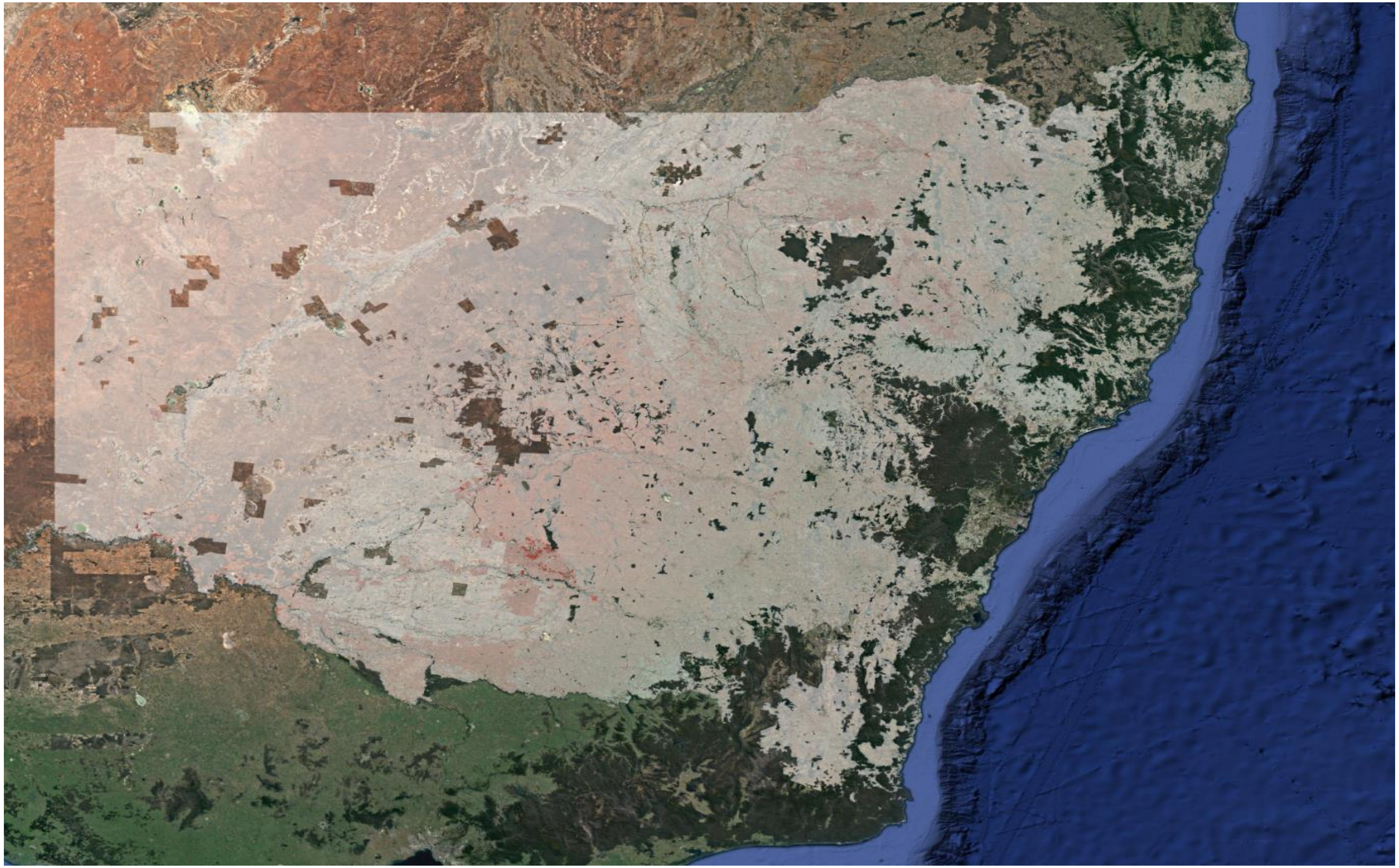
- NSW energy consumption data used in preference to other States where available
- Data from other States utilised where NSW data was not available, of poor quality, or soil and climatic characteristics were of low relevance
- Assumptions were applied to convert energy consumption data provided per unit of volume, or mass, to hectares, to a universal energy intensity benchmark of gigajoules per hectare (GJ/ha)
- Calculated energy intensities were aligned to the appropriate Australian Land Use and Management (ALUM) Classification system
- Spatial mapping of energy intensities linked to National Map database of ALUM categories

Results – Energy Intensity Summary

Australian Land Use and Management Classification (ALUM)	Agricultural Sector	Total direct energy (GJ/ha)	%Diesel (and/or petrol)	%Electricity	%Gas (LPG, Propane)
5.1.4 Glasshouses - hydroponic	Horticulture	11398	-	29%	71%
5.2.2 Feedlots	Feedlot cattle	3984	94%	6%	-
5.1.2 Shadehouses	Horticulture	3189	7%	7%	87%
5.1.3 Glasshouses	Horticulture	3189	7%	7%	87%
5.2.4 Piggeries	Pig and poultry	130	10%	49%	41%
4.4.0 Irrigated perennial horticulture	Horticulture	802	7%	7%	86%
5.1.1 Production nurseries	Horticulture	542	12%	66%	21%
5.2.3 Poultry farms	Pig and poultry	33	7%	37%	56%
4.3.6 Irrigated cotton	Grain**	12.5	95%	5%	0%
4.2.0 Grazing irrigated modified pastures*	-	8.7	51%	49%	0%
2.1.0 Grazing native vegetation*	-	0.01	100%	-	0%
3.2.0 Grazing modified pastures*	-	0.6	100%	-	0%
4.3.0 Irrigated cropping	Grain	2.1	98%	2%	0%
4.3.1 Irrigated cereals	Grain	2.1	98%	2%	0%
5.2.1 Dairy sheds and yards	Dairy	79.0		100%	
3.3.0 Cropping	Grain	1.52	98%	2%	0%
3.3.1 Cereals	Grain	1.52	98%	2%	0%

*Typically associated with cattle and sheep grazing
**Irrigated cotton assumed to include grain production in rotation

Sample Mapping Outputs - NSW Energy Intensity



- The map provides a representation of State-wide energy consumption based on the calculated energy intensities aligned to the National Map database
- Areas of red contain the highest energy intensity

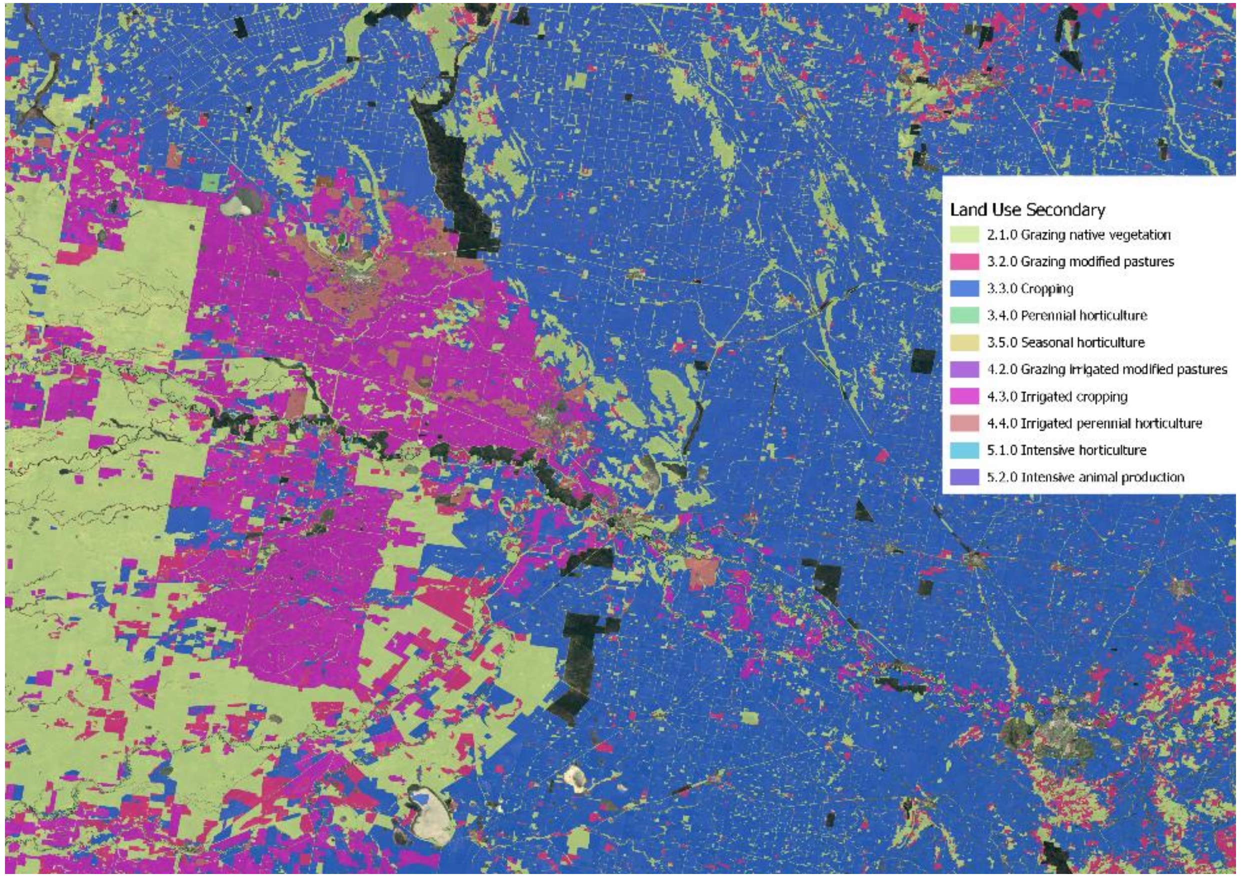
Energy Intensity (GJ/ha)

0 - 0.87
0.87 - 4.63
4.63 - 11.69
11.69 - 40.65
40.65 - 80.72
80.72 - 139.12
139.12 - 542.2
542.2 - 801.8
801.8 - 3189
3189 - 11398

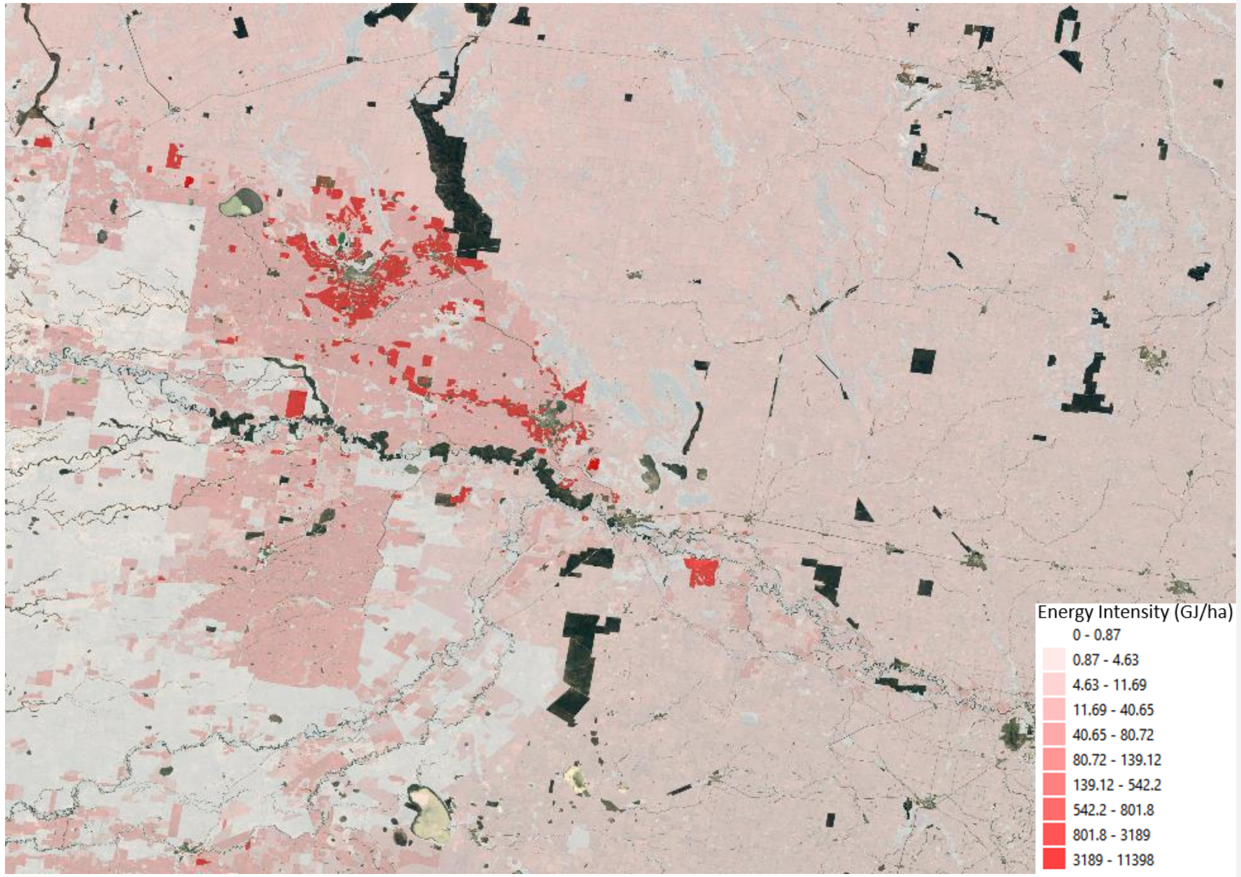
Sample Mapping Outputs – Murrumbidgee Region

- The maps provide a representation of land use based on ALUM classifications and energy consumption in the Murrumbidgee region based on the calculated energy intensities aligned to National Map database

Land use categories



Energy Intensity



Network data

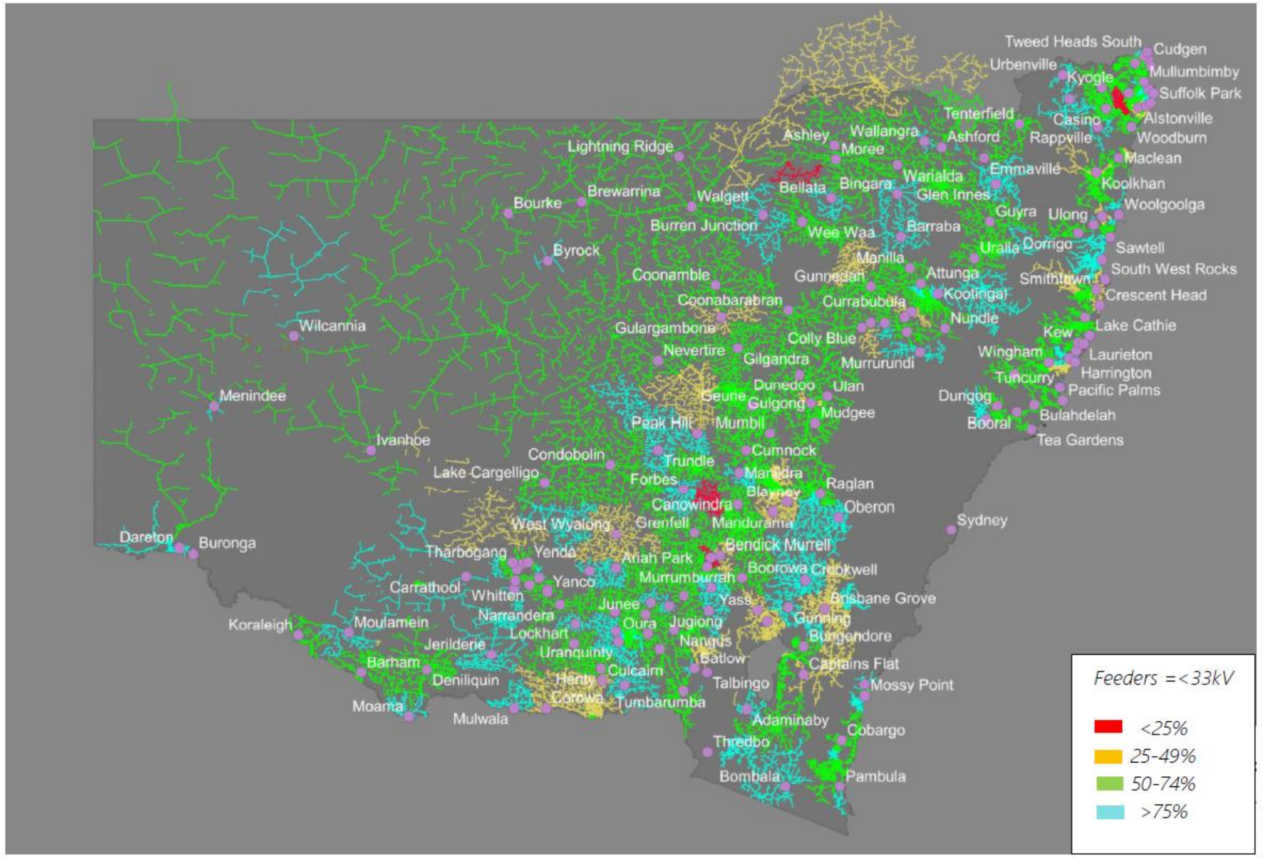
- Essential Energy provided a range of data to support a high-level snapshot of network capacity, including:
  - zone substation capacities
  - maximum demand figures from winter and summer for feeders and zone substations
- CutlerMerz applied an assumption that the remaining capacity on the feeders was proportional to the remaining capacity of the zone substation to which they connect as per the formula below:

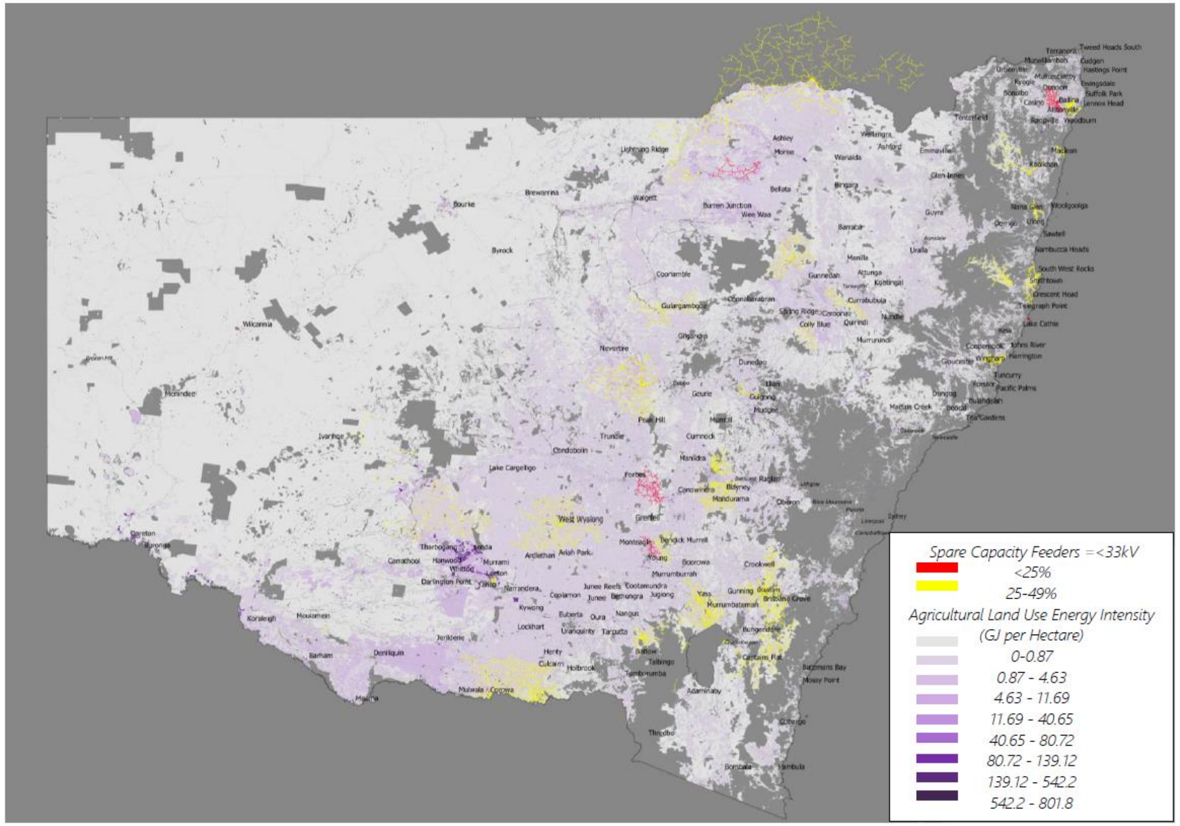
$$Spare\ Capacity = 1 - \left(\frac{Highest\ Peak\ Demand}{HV\ Transformer\ Capacity}\right) * 100$$

- This enabled a preliminary, top-down indication of available network capacity to be assembled
- It is pertinent to note that the purpose of this Phase is to produce a coarse-scale, point-in-time view of network capacity, as opposed to a detailed, bottom-up assessment. As such, the outputs should not be relied upon for individual business cases

Results - Capacity constrained areas in NSW

- Indicative capacity mapping across the network at a point in time indicates areas (in red) with less than 25% network capacity supporting the High Voltage (HV) feeders. Areas of the network for which there were data integrity issues have not been mapped.





- There is limited scope for Network Service Providers to support growth in constrained areas without upgrades to HV networks
- Upgrades to these networks would ordinarily be triggered by network planning and forecasting undertaken by networks, or by new connection applications from customers seeking to increase their load

Results – cost to upgrade network infrastructure

- The electricity network infrastructure supporting agricultural industries falls into two broad categories:

1. High voltage (HV) 11-33kV. This includes distribution feeders with distribution substations to step down to low voltage
2. Low voltage (LV) - 415V (or less). Consists of lines or cables to deliver power to end customers

- The long run marginal cost (LRMC) for upgrading each of these categories of network infrastructure was obtained from Essential Energy's 2019-24 Tariff Structure Statement

LRMC of network upgrades in $/kW

Category	Capex	Opex	LRMC
High voltage	$46/kW	$11/kW	$57/kW
Low voltage	$8/kW	$2/kW	$10/kW

- This infrastructure generally falls into the category of 'shared' network, with costs distributed across Essential Energy's entire consumer base
- A portion of shared network costs may be borne directly by individual farming customers, in circumstances where a customer is seeking to connect a significant new load
- In addition to any shared network costs, customers must also fund any required dedicated customer substation equipment

Energy Transition Capacity

- The performance across the key energy transition metrics for all of the case studies reviewed across different agriculture sectors is summarised below

Technology	System Description	Agriculture Sector	% Offset
Solar	<=100kW	Dairy/ Poultry/Cotton	9% -28%
Solar	>100kW (228kW)	Cotton-wheat-peanut crop	60%
Solar + Battery Storage	<=30kW Solar PV system <=60kWh Battery Capacity	Dairy	67-68%
Solar + Battery Storage	<=100kW Solar PV system <=300kWh Battery Capacity	Feedlot	100%
Solar + Thermal Storage	Chilled water technology coupled with solar PV	Dairy	11% - 46%
Biomass	Covered anaerobic pond with combined heat and power (CHP) generation/ electricity production only (generator)/ heat production only (boiler)	Piggery	50-100%
Biomass	Biogas fired boiler and cogeneration engine	Feedlot	100%
Biomass	Solar+ Biomass	Feedlot	70%

Energy Transition Cost Benchmarks

Rooftop solar panels	Large-scale solar	Integrated solar and battery (2hrs)	Biomass (small scale)	Wind
1333	1441	2004	6954	1805

- The main source used to determine the above benchmarks for the on-farm generation technologies assessed above was the December 2021 draft release of GenCost 2021-2022
- Large-scale solar has been included since benchmarks for small-to medium scale ground-mounted solar PV were unavailable
- Ground-mounted solar is generally costlier than rooftop due to the pole structures and cement foundations required

Energy Transition – Factors for Consideration

- It is technically feasible to run virtually all farming processes, plant and equipment via low or zero carbon alternatives.
- Transition decisions need to be analysed at the individual farm level, supported by specialist advice and cost-benefit analysis.
- CutlerMerz' review of the literature, case studies and other information has identified a number of universal factors that will impact the transition to on-site, low carbon energy generation:
  - Affordability of generation systems inclusive of the presence of economic incentives, such as government subsidies
  - Overall budget, including access to and cost of finance
  - Cost-effectiveness of generation technologies relative to network supplied energy – high retail electricity prices would be expected to make on-site generation more attractive
  - Availability and quality of on-site energy resources e.g. good solar radiation and overall land surface area of property capable of hosting energy infrastructure
  - Ease of obtaining approvals (including planning approval) and meeting regulatory requirements for power generation
  - Motivation to make farming operations more sustainable and reduce carbon footprint, which can also have marketing benefits
  - Motivation to decrease level of reliance on external providers due to price volatility and frequency of outages
  - Diversification of energy sources and income as a risk management measure
  - How substitutable the energy source is with low-carbon alternatives on an individual use-case basis e.g. diesel mobile equipment
  - Cost of conversion or new purchase of plant or fleet (e.g. electric irrigation systems)
  - Timing for solution, including potential production delays
  - Comparative long-run costs of grid-power vs on-farm generation and break-even point

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