

DEECA Victorian Biomass and Biomethane Potential Assessment

Summary Report

Prepared by SMEC Australia Pty Ltd

February 2026



We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria’s land and waters, their unique ability to care for Country and deep spiritual connection to it.

We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

DEECA is committed to genuinely partnering with Victorian Traditional Owners and Victoria’s Aboriginal community to progress their aspirations.



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- Energy and Renewables
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Executive Summary

SMEC was engaged by the Department of Energy, Environment and Climate Action (DEECA) to deliver the Victorian Biomass and Biomethane Potential Assessment project. The project aims to build on previous assessments undertaken in Victoria and involves quantifying the availability and sustainability of biomass residues, defining the realistic commercial potential for biomethane, and identifying key regions where resources and infrastructure present the best development opportunities.



The project was delivered in four key stages as follows:

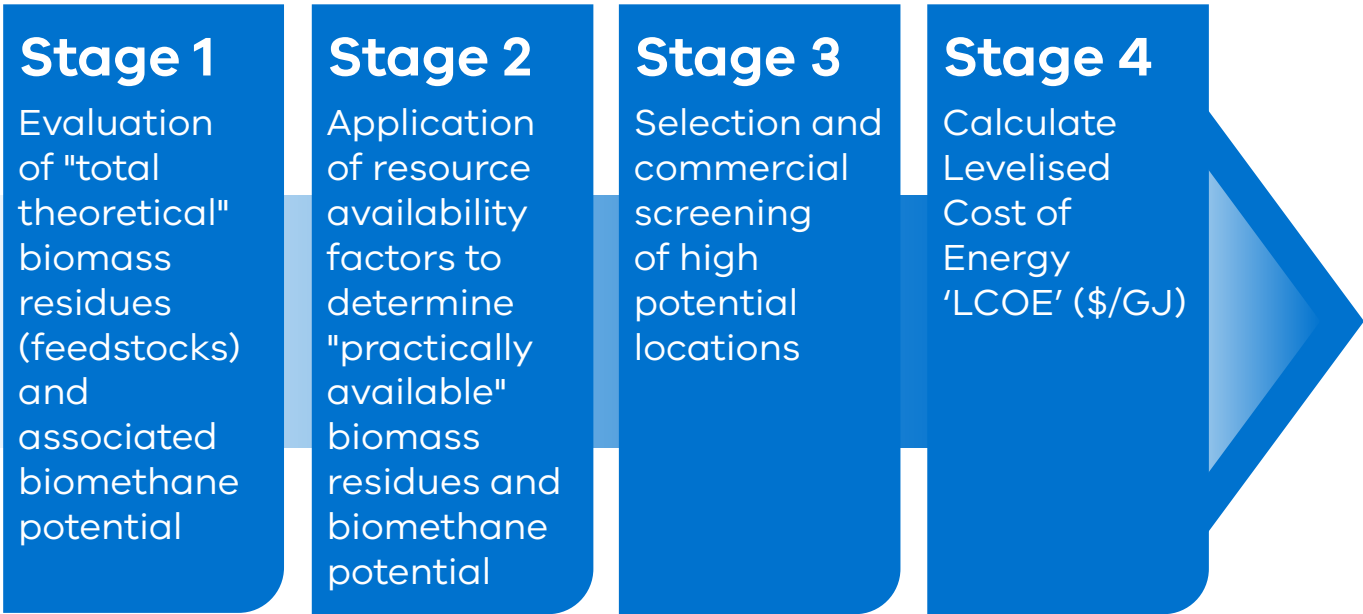


Figure i: Overview of project stages

Stage One – Total Theoretical Assessment

An assessment was conducted to determine the availability of biomass residues across Victoria which could be used as a feedstock for biomethane production. The study assessed total theoretical biomass residues available from a number of key sectors including:

- Broadacre;
- Horticulture;
- Livestock and meat processing;
- Plantation and wood processing;
- Municipal solid waste (MSW);
- Commercial and industrial (C&I) waste;
- Construction and demolition (C&D) waste.

Once the total theoretical biomass residues were evaluated, the total theoretical biomethane potential from these residues when applied as a feedstock in anaerobic digestion was calculated. Anaerobic digestion is a biological treatment where microorganisms breakdown organic material in the absence of oxygen to produce biogas and a solid nutrient rich digestate. Biomethane potential (BMP) refers to the theoretical maximum amount of methane that can be produced from a specific organic biomass through anaerobic digestion, providing an indication of biomass's biodegradability and methane-producing capacity. The total theoretical biomethane potential from other biogas producing sectors including wastewater treatment plants (WWTP) and landfills were also evaluated. The current total theoretical biomethane potential is estimated at 130 PJ, which is projected to increase to just over 200 PJ by 2045, with broadacre being the predominant source.

Stage Two – Practically Available Assessment

Stage Two involved an assessment of how much of the total theoretical values identified in Stage One are “practically available” which was conducted by applying a factor for ‘resource availability’ against Stage One outputs.

The quantity assessed as practically available indicates that, should a biomethane facility be proposed for development, it would be able to access a defined proportion of the solid biomass residue as feedstock for the plant. The resource availability factors (%) account for any existing business-as-usual management/ processing or competing market for the material. Based on this assessment, a total of over 6.4 million tonnes of biomass residue is estimated to be practically available in Victoria in 2025 across all the different residue sources, which is projected to increase to over 9 million by 2045.

WWTP and landfills were excluded from the residue availability assessment however are included in the biomethane potential assessment, as biogas is produced as a by-

product of integrated waste management processes at these two types of facilities. Therefore no biomass residues are available from these sites as a feedstock, just gas as a resource which has the opportunity to be upgraded to biomethane. The corresponding total practically available biomethane potential for Victoria is estimated to be approximately 47 PJ in 2025, which is forecasted to increase to over 69 PJ by 2045.

Victoria’s current industrial gas demand as per AEMO’s Gas Statement of Opportunities (GSOO) under the ‘Step Change’ scenario is estimated to be around 51 PJ in 2025, which is forecasted to decrease slowly to 48 PJ by 2045. Additionally, the estimated gas consumption from the gas powered generation (GPG) sector is estimated to be approximately 5 PJ in 2025, which is projected to increase to 16 PJ by 2045. To assess the percentage of the industrial and GPG gas demand which could be fulfilled by renewable biomethane, the forecasted gas consumption was assessed against the total statewide estimate for practically available biomethane potential.

Due to the dispersed nature of the biomass residues across Victoria which can be applied in biogas and biomethane production, investment could be targeted towards areas with higher volumes of highly energy dense biomass residue. Another critical element is having the appropriate infrastructure in place to support enhanced commercial viability e.g. in close proximity to existing gas transmission network, and presence of potential co-location opportunities.

Although the waste sector contributed the largest share of practically available residues statewide with around 50% of the total, it accounted for only 20% of the practically available biomethane potential. In contrast, broadacre agriculture was the second largest source of practically available residues, making up approximately 35% of the statewide total. However broadacre represented the single greatest opportunity for biomethane production, contributing around 52% of the total practically available biomethane potential (compared with 21% from the waste sector).

This is due to the energy density of broadacre residues, with broadacre having lower moisture content and higher calorific values (~285m³ CH₄/t) when compared to waste sector feedstocks (~62-107m³ CH₄/t). Further details on the calorific values of feedstocks applied in the study are presented in **Appendix A – ‘Methodology – Total Theoretical Assessment’**.

Stage Three – Commercial Screening Assessment

As part of Stage Three, practically available residues and biomethane potential were assessed by LGA, and locations were identified for development of a biomethane production facility. To enable this assessment for the metropolitan region, a collaborative procurement scenario was assumed for metropolitan LGAs where feedstocks from LGAs within close distance to each other could potentially aggregate feedstock contracts for processing (and resulting biomethane potential). Metropolitan LGAs were aggregated based on the Municipal Association of Victoria (MAV) ‘Regional grouping of councils’ (December 2022).

Several criteria were used to assess the commercial viability of high potential locations for a biomethane production facility. These were:

- Percentage of grouping/LGA within 50km buffer of gas transmission network.
- Gas transmission line passes through grouping/LGA.
- Co-location opportunities within the grouping/LGA (no. of anaerobic digestion/ organics recycling/WWTP/landfill facilities).
- Potential sites with appropriate land use zoning located along gas transmission network.

The availability of a specific site either on, or close to, the existing gas network would likely result in a lower cost of connection to the existing gas network. Additionally the presence of existing sites such as AD/organics recycling/ WWTP/landfill facilities would likely have the desired traits for a proposed biomethane

facility (e.g. near distribution network, appropriate buffers in place) and could act as a potential opportunity for co-location. Three regional LGAs (Ararat, Moira, Horsham) and two metropolitan groupings (Metropolitan South, Metropolitan West) were selected as high potential locations for further assessment as they displayed high practically available biomethane potential and met the above criteria, and were further explored for possible development of a biomethane production facility.

There are other regional LGAs and metropolitan groupings which met the commercial criteria and may be suitable for potential project development.

Stage Four – Levelised Cost of Energy Assessment

An LCOE Assessment was conducted on the high potential locations accounting for key input factors such as feedstock availability, biomethane potential, feedstock purchase/ gate fees, capital and operating costs and salary, with a final \$/GJ value obtained for each of the top biomethane locations. To calculate LCOE for each of the locations, a proposed biomethane facility was sized and assessed based on the practically available feedstocks accounting for seasonality and storage considerations. LCOE viability factors for feedstock, feedstock transport, plant operation, capital costs and operational costs were applied. A discount rate of 7% and project life of 25 years was assumed. LCOE values were calculated for the regional LGAs and metropolitan groupings based on the practically available biomethane potential for 2025 and 2035, expressed in real 2025 terms.

A sensitivity analysis of potential additional revenue streams for a biomethane facility, (including digestate, green carbon dioxide (CO₂) and Australian carbon credit units (ACCU)), was conducted and identified that the LCOE could be reduced by approximately 13–22% based on plant size and feedstock mix.

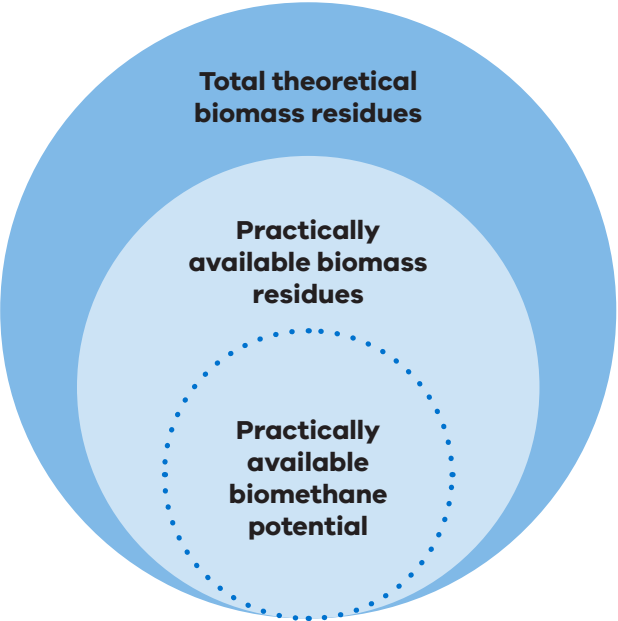


Figure ii: Total theoretical compared to practically available

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Glossary

Term	Definition
Australian carbon credit units (ACCUs)	Australian Carbon Credit Units (ACCUs) are tradable financial products that provide an additional income stream for individuals and businesses undertaking carbon abatement projects, such as reforestation or energy efficiency. Each ACCU represents one tonne of carbon dioxide equivalent (tCO ₂ -e) avoided or removed from the atmosphere, and they are managed through Australian National Registry of Emissions Units (ANREU) accounts.
Anaerobic digestion	Anaerobic digestion is a biological treatment process where microorganisms break down organic matter in the absence of oxygen, producing biogas and digestate (a solid nutrient-rich residue). Biogas composition is typically 50-75% methane (CH ₄), 25-50% carbon dioxide (CO ₂), plus trace amounts of other gases including nitrogen (N ₂) and hydrogen sulphide (H ₂ S).
Australian Biomass for Bioenergy Assessment (ABBA)	A \$3 million project funded by the Australian Renewable Energy Agency (ARENA) in 2015 and completed in 2021 which collected and collated data on feedstock locations and availability for upload onto the Australian Renewable Energy Mapping Infrastructure (AREMI), making it available for project developers, policy makers, and other stakeholders. Outputs included a detailed analysis of the types, volumes and locations of potential bioenergy feedstocks in each state.
Bioenergy	Bioenergy is form of renewable energy generated from the conversion of biomass into heat, biogas, electricity, and fuel.
Biomass	Biomass refers to renewable organic matter derived from plants and animals, which can be used as a source of energy or converted into biogas and biofuels. It can be derived from a range of sectors including agriculture, forestry, food processing, or the combustible components of municipal solid waste.
Biomethane	Biomethane, also known as renewable natural gas, is a renewable fuel produced by upgrading biogas, a mixture of methane and other gases, through a process that removes carbon dioxide and other contaminants, resulting in a methane-rich gas suitable for injection into existing natural gas infrastructure.
Biomethane potential (BMP)	Biomethane potential (BMP) refers to the theoretical maximum amount of methane that can be produced from a specific organic biomass through anaerobic digestion, providing an indication of biomass’s biodegradability and methane-producing capacity.
Broadacre	Broadacre refers to large-scale farming operations that focus on cultivating crops like wheat, barley, and oilseeds, or raising livestock for meat or wool, often using extensive land areas and advanced machinery.

Term	Definition
Capping (i.e. <i>landfill capping</i>)	Landfill capping (in accordance with EPA Victoria <i>Best Practice Environmental Management</i>) occurs once waste is deposited and compacted at a landfill site and is full, the landfill site is capped with clay (at a minimum), and rehabilitated. Landfill capping contains the waste material from escaping, and minimises water infiltration reducing risk of groundwater contamination from leachate (contaminated liquid generated when water percolates through solid waste).
Chemical Oxygen Demand (COD)	Chemical Oxygen Demand (COD) measures the amount of oxygen required to chemically oxidise organic and inorganic compounds in water.
Commercial and industrial waste (C&I)	Solid materials and waste generated from trade, commercial and industrial activities. It includes waste from offices, manufacturing, factories, schools, universities, state and government operations and small to medium enterprises.
Construction and demolition waste (C&D)	Solid materials and waste generated from residential and commercial construction and demolition activities, e.g. bricks and concrete.
Digestate	A nutrient-rich residue remaining after the anaerobic digestion of a biodegradable biomass feedstock.
Feedstock	In the context of anaerobic digestion, the biomass material applied to generate biogas and biomethane.
Horticulture	Horticulture is a specialised branch of agriculture focused on the cultivation of fruits, vegetables, flowers, and ornamental plants.
Landfill	A landfill is a specially designed and engineered facility for the burial of solid waste. Waste is deposited and compacted within the landfill, and once the landfill cell is full, it is capped and rehabilitated.
Landfill gas (LFG)	Landfill gas (LFG) is a natural byproduct of the decomposition of organic waste in landfills, primarily composed of methane and carbon dioxide. It can be captured and used for energy generation or flared to prevent its release into the atmosphere.
Levelised Cost of Energy (LCOE)	The average cost to build and operate a generator over its lifetime, expressed per unit of energy.
Livestock	Livestock refers to domesticated animals raised in an agricultural setting for the production of goods like meat, eggs, and milk.
Methane	Methane (CH ₄) is the key component of natural gas and is a valuable fuel source used for heating, electricity generation, and even transportation. When methane is released to the atmosphere it is a potent greenhouse gas with more than 28 times the global warming potential of carbon dioxide.

Term	Definition
Municipal Solid Waste (MSW)	Solid materials and waste generated from municipal and residential activities, and including that collected by, or on behalf of, municipal councils.
National Greenhouse and Energy Reporting (NGER) Scheme	The National Greenhouse and Energy Reporting (NGER) Scheme is a single national framework for reporting company information about greenhouse gas emissions, energy production, and energy consumption.
Paunch	Paunch waste is a major solid byproduct of cattle slaughterhouses, consisting of partially digested food (grass, grain) from the stomach.
Petajoule (PJ)	Petajoule (PJ) is a unit of energy measurement – One petajoule is 10 ¹⁵ joules.
Residue	Residue refers to the remaining material leftover after the main components have been taken or used.
Resource	Resource in the context of this study refers to the biogas and biomethane which is produced from the anaerobic digestion process.
Terajoule (TJ)	Terajoule (TJ) is a unit of energy measurement – One terajoule is 10 ¹² joules.
Volatile solids (VS)	Volatile solids are the portion of total solids in a material sample that are lost when heated (at 550°C), representing the organic content of a material that can be converted to biogas.
Wastewater Treatment Plant (WWTP)	Wastewater treatment plants, also known as sewage treatment plants, use mechanical, chemical, and biological processes to remove contaminants from wastewater, to enable it safe for discharge or reuse.



Yarra Valley Water Lilydale Food Waste to Energy Project (YVW) - Lilydale, Victoria
(image source: Yarra Valley Water)

1. Introduction

SMEC has been engaged by the Department of Energy, Environment and Climate Action (DEECA) to deliver the Victorian Biomass and Biomethane Potential Assessment.

Electrification is generally acknowledged as the most cost-effective way to decarbonise residential and commercial building gas use. However, electrification alone is unlikely to be commercially or technically feasible for all of Victoria's industrial and gas-powered generation (GPG) sectors (DEECA, 2024). Biomethane is a renewable alternative to natural gas that can be produced from biomass and waste feedstocks and can be injected into the existing gas transmission and distribution network as a drop-in replacement.

This report provides **a comprehensive quantification of Victoria's biomass resources for the present day and forward projections to 2035 and 2045**. It builds on previous assessments undertaken in Victoria, including the Australian Biomass for Bioenergy Assessment (ABBA) (2015–2021) and the associated assessment of Biogas Potential in Victoria. This report updates and expands the dataset to include wastewater treatment plants (WWTP) and landfills, with both feedstock sources representing promising opportunities for development of the biomethane sector in Victoria.

The assessment quantifies the availability of biomass resources across Victoria and defines the realistic commercial potential for biomethane now and into the future. To move beyond theoretical resource estimates, availability factors were applied to account for existing business as usual management practices and competing uses for feedstocks. On this basis, **the practically available biomethane potential for Victoria is estimated to be approximately 47 PJ per year in 2025, and is forecasted to increase to over 69 PJ per year by 2045**.

The report then evaluates the extent to which this biomethane potential could contribute to future renewable gas and fuels demand, in industrial and gas powered generation (GPG). Comparison of forecasted industrial and GPG gas demand with statewide practicable available biomethane potential indicates that, at a statewide level, **biomethane has the potential to meet, and in 2035 and 2045 may exceed, projected industrial and GPG gas demand, under Australian Energy Market Operator (AEMO) projections**. Realisation of this potential is contingent on feedstock availability, competing biomass uses and commercial deployment rates.

To support commercial decision making the study also identifies prospective regions for biomethane production and estimates the levelised cost of energy (LCOE) of injecting biomethane into the gas network (\$/GJ). Locations were screened against multiple criteria, including:

- Biomethane potential;
- Percentage within 50km buffer of gas transmission network;
- Gas transmission line passes through the Local Government Area (LGA);
- Potential site locations with appropriate land use zoning located along gas transmission network;
- Co-location opportunities within the LGA.

Three regional LGAs and two metropolitan groupings which passed the commercial screening progressed for further assessment with LCOE estimates developed for both 2025 and 2035 based on key cost and performance assumptions.

Consistent with other Australian biomethane and bioenergy studies, the report considers common co-products, revenue streams and incentive mechanisms, including digestate utilisation, green CO₂, and food-versus-fuel considerations. This project recognises that Victoria's biomethane opportunity sits within a broader Australian policy and market context and notes the importance of national consistency to support investment, cross-border data harmonisation and project development. By situating Victoria's biomethane potential within this national landscape, the report aims to inform future policy development and support industry-led efforts to facilitate the development of viable, scalable biomethane projects.

2. Methodology

2.1 Total Theoretical Assessment

2.1.1 Desktop review and industry engagement

A review of existing government data as well as publicly available information was conducted which was used to inform the foundation of the modelling. Targeted engagement was carried out with stakeholders across the agriculture, energy, waste and water sectors in order to fill data gaps identified in the initial desktop review and to validate initial figures and residue factors. A list of stakeholders engaged can be viewed in **Appendix A ‘Methodology – Total Theoretical Assessment’**.

2.1.2 Feedstocks evaluated

A total of 41 feedstock sources were evaluated including those outlined in Figure 2-1.

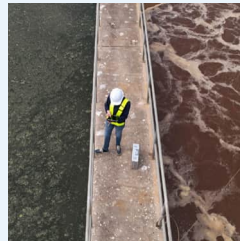
Feedstock category						
 Broadacre	 Horticulture	 Livestock and meat processing	 Plantation and wood processing	 Wastewater Treatment Plant (WWTP)	 Landfill	 Waste sector
Feedstocks evaluated						
 Cereal straw and chaff Non-cereal straw and chaff Oilseed straw and chaff	 Fruit and vegetable cull Fruit and vegetable processing solids Fruit and vegetable processing effluent Almond husks and shells Olive pomace Grape marc	 Chicken poultry litter Dairy cattle manure slurry Pig manure slurry Cattle paunch Pig paunch Sheep paunch Poultry wastewater Cattle wastewater Pig wastewater Sheep wastewater Dairy processing wastewater	 Plantation bark Plantation branch Plantation stump Sawmill bark Sawmill wet sawdust Sawmill wet woodchips Sawmill draft sawdust	 Wastewater	 Landfill organics	 MSW organics C&I organics, paper and cardboard C&D organics

Figure 2–1: Feedstocks evaluated as part of the study

2.1.3 Model development

A data model was developed to estimate the total theoretical residues and total theoretical biomethane potential across each of the feedstocks evaluated, projecting volumes at 2025, 2035, and 2045.

Analysis at the local government area (LGA) level was selected in order to achieve the level of granularity required for later spatial analysis.

Regional boundaries were defined using the former Waste and Resource Recovery Group boundaries in order to align with the regional boundaries used in the previous Australian Biomass for Bioenergy Assessment (ABBA) study conducted and include:

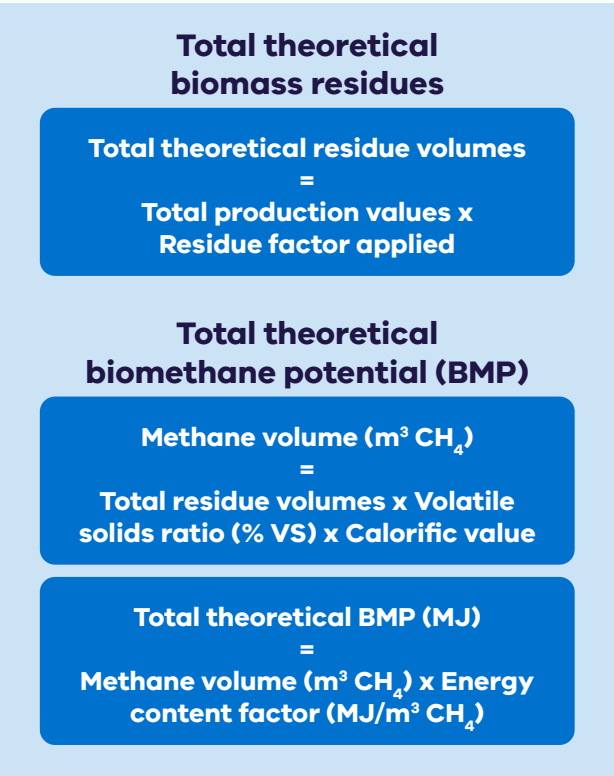
- Barwon South West;
- Gippsland;
- Grampians Central West;
- Goulburn Valley;
- North East;
- Loddon Mallee;
- Metropolitan.

2.1.4 Determining total theoretical biomass residues and biomethane potential

There are quality standards in place for natural gas in pipelines including Australian Standard AS 4564 which ensure its safe and efficient transportation and use. These standards specify parameters such as energy content, contaminants, and water content. A potential biomass residue will produce a biogas comprising of a mixture of methane (CH₄, 50-75%), carbon dioxide (CO₂, ~25%), and trace amounts of other gas such as nitrogen (N₂), hydrogen sulphide (H₂S), and water vapour (USEPA, 2024). An upgrading process is required to remove the carbon dioxide and other harmful gases from the biogas. This is done by increasing the methane content value to greater than 90% in order to be carried through the gas pipeline.

As part of this assessment the biomethane potential has been calculated dependent on their calorific value (CH₄ content) and assumes upgrading from biogas to biomethane has taken place.

The following calculations were applied:



An assessment of the top five local government areas (LGA) and corresponding region producing the highest volume of residue types was conducted including an estimate on:

- Production (the quantity or volume produced e.g. tonnes of almond, megalitres of milk, no. livestock pigs);
- Residue (what is leftover or considered waste after the main product is processed and recovered e.g. dry tonnes almond husks and shells, tonnes chemical oxygen demand (COD) of wastewater, tonnes volatile solids (VS) of pig manure slurry);
- Theoretical biomethane potential (the potential bioenergy which could be recovered if the residues are processed via anaerobic digestion).

Volatile solids (VS) are the portion of total solids in a material sample that are lost when heated (at 550°C), representing the organic content of a material that can be converted to biogas.

The energy density, moisture content, and calorific value of feedstocks are key properties that influence the efficiency, stability, and overall biogas yield of an anaerobic digestion system. These characteristics directly affect the methane generation potential, process stability (including factors such as pH balance), and the overall energy performance of the anaerobic digestion process.

For instance a biomass residue may be available in large quantities but if its calorific value is low, it will produce comparatively less biomethane than a smaller volume of residue with a much higher calorific value.

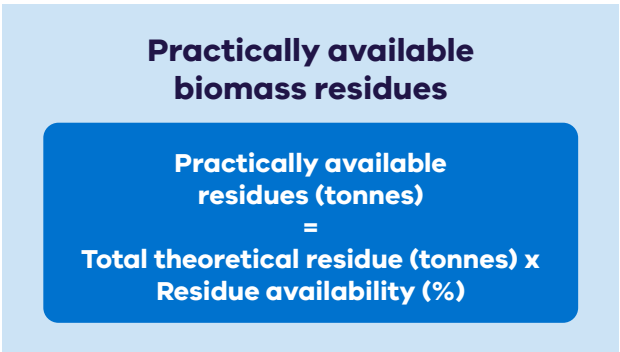
The full detailed methodology for the Total Theoretical Assessment is available in **Appendix A ‘Methodology – Total Theoretical Assessment’**.

2.2 Practically Available Assessment

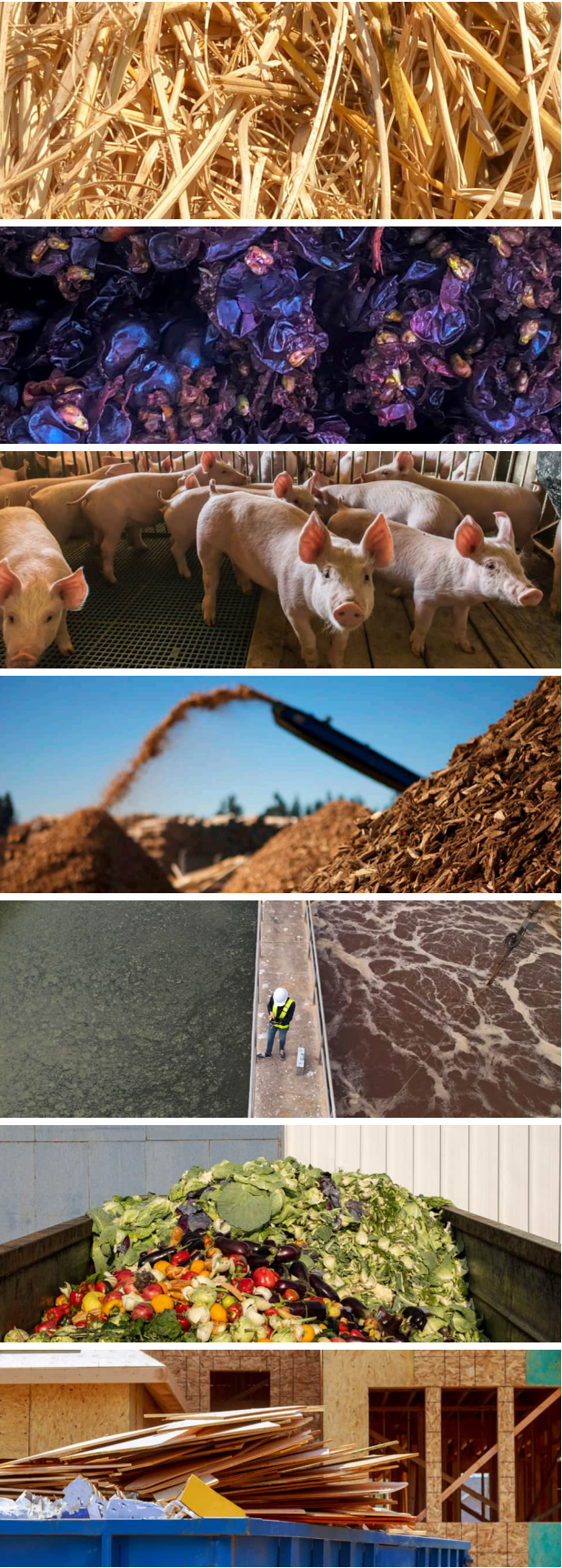
2.2.1 Determining practically available biomass residues

To assess how much of the total theoretical residues and biomethane potential is practically available, residue availability factors were applied to account for any business-as-usual (BAU) use or competing market for this residue. As an example, looking at broadacre straw and chaff, it was seen as best practice to retain it on site with 21% of farms reporting crop residues were burned, and another 7% removing it from the paddock (resulting in 28% resource availability factor).

The following calculation was applied to determine practically available residues:



Yarra Valley Water Lilydale Food Waste to Energy Project (YVW) - Lilydale, Victoria (image source: Yarra Valley Water)



 Broadacre

Straw and chaff

Straw and chaff availability across all broadacre residues (cereals, non-cereals, and oilseeds) was assumed to be 28%, with the National Inventory Report estimating that 21% of crop residues are burned while an additional 7% of crop residues are removed from paddock (DCCEEW, 2024). The remaining straw and chaff (~70%) is expected to be retained on site, viewed as best practice by farmers where it acts as a protective layer for the soil by maintaining moisture through reduced evaporation, increasing water filtration, reducing erosion of soil, and nutrient recycling (GDRC, 2021). Burning was assumed to incur a cost to the farm with no potential revenue associated. Removing straw and chaff was seen as a potential revenue to the farmer with the ability to sell it as a baled product.

 Horticulture

Fruit and vegetable cull

Availability of fruit and vegetable cull (from horticultural residues) was assumed to be 94%. This is based on crop which was assumed to be left on ground (52%), ploughed into ground (20%), disposed of (10%), recovered for compost (9%), and buried on farm (3%) as identified by ABARES in their study on crop loss/waste on Australian horticultural farms (ABARES, 2024).

 Livestock and meat processing residues

Livestock residues

Livestock residues (chicken poultry litter, dairy cattle manure, pig manure slurry) were assumed to be 100% available due to the management requirements associated with these feedstocks as informed by engagement with the livestock industry peak bodies.

Meat processing residues

Meat processing solid residues (cattle paunch, pig paunch, sheep paunch) are typically composted and was assumed to be 100% available.

 Plantation and wood processing

Plantation residues

A total of 5% of the total residues from plantation (including bark, branch, and stump) was assumed available with industry experts/ stakeholders noting up to 5% of field slash from plantation being recoverable and available.

Wood processing (sawmills)

Availability of residues from wood processing (sawmills) was assumed to be limited to bark and sawdust (100% availability) with no (0%) availability of woodchip residue, with industry engagement noting that a majority of woodchips were exported as pulp grade wood chip at export prices.

 WWTP and landfills

WWTP and landfills have been assessed differently to other biomethane pathways as biogas is produced as a by-product of their existing waste management process, therefore no solid biomass residues would be available from these facilities (only biogas).

As a result, residue availability as a measure is not valuable. Rather only biogas and its potential upgrade to biomethane is measurable, referred to as its resource availability.

There are currently no WWTP and landfills in Victoria which are upgrading the biogas produced and therefore their resource availability was assumed to be 100%. This presents an opportunity for biogas produced at these sites to be upgraded to biomethane and injected into the network.

This assessment only covers domestic and commercial WWTP managed by water corporations, and excludes industrial wastewater facilities managed by private businesses.

 Waste sector

MSW Organics (food organics, garden organics, other, wood/timber), C&I Other (Organics)

Municipal solid waste (MSW) organics includes food organics, garden organics, other organics, and wood/timber sourced from the residential sector. Engagement with a major waste and resource recovery company noted contamination rates in organics bins had been observed to be between 1.5% and 12% in Victoria. This was dependent on factors such as housing type (e.g. house versus multi-unit development), frequency of collection (e.g. weekly versus fortnightly), and service roll-out (e.g. universal roll-out versus opt in/out). An average contamination rate of 6.75% was assumed for all organics resulting in an assumed 93.25% availability.

C&I Other (Paper and cardboard)

C&I Other (Paper and cardboard) was assumed to be recovered via a dedicated collection system (i.e. a relatively homogenous feedstock stream). Recycling Victoria's 2024 Market Insights Report identified that a significant proportion is locally stored or reprocessed, as opposed to landfilled (RV, 2024). The report notes that industry need to reduce reliance on virgin pulp for paper and reduce reliance on exports of recyclable material. This means the conversion of recovered paper and cardboard back into a recycled paper/packaging product is a more desirable outcome than "destruction" of the paper fibre through alternative processes such as composting or energy from waste. As a result, C&I Other (Paper and Cardboard) was assumed to be 0% available.

Note that this is a theoretical study. Further work is required to confirm that 'practically available' estimates do not overstate supply where residues are needed to maintain soil health, mitigate other environmental impacts, or face emerging or established supply chain constraints.

2.2.2 Determination of practically available biomethane potential

The following calculations were applied to determine practically available biomethane potential (BMP):

Practically available biomethane potential (BMP)

Practically available BMP (TJ)

=

Total available BMP (TJ) x Resource availability (%)

Factors for resource availability were applied to determine practically available biomethane potential.

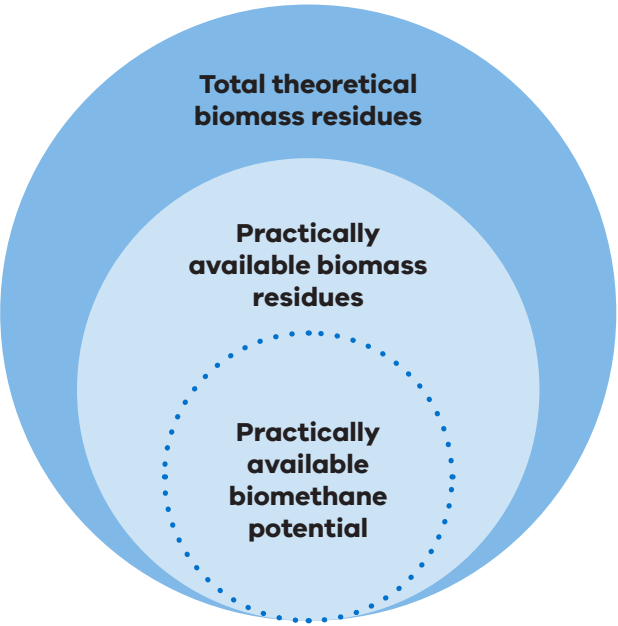


Figure 2-3: Total theoretical compared to practically available

2.3 Commercial Screening Assessment

2.3.1 Aggregation of metropolitan feedstocks

Metropolitan groupings

There are 79 local government areas (LGA) across Victoria and 31 of these LGAs are located within the metropolitan Melbourne area. A collaborative procurement scenario was considered for metropolitan LGAs where feedstocks from LGAs within close proximity to each other would aggregate feedstock contracts for processing. The practically available feedstocks (and resulting biomethane potential) from metropolitan LGAs were aggregated based on the Municipal Association of Victoria (MAV) ‘Regional grouping of councils’ (December 2022).

Regional LGA

A total of 48 LGAs are located in regional Victoria. Regional LGAs were assessed in isolation (i.e. without aggregation of feedstock) and sorted based on highest practically available biomethane potential.

2.3.2 Selection of potential locations and screening

Practically available residues and biomethane potential were assessed by LGA, sorted based on highest practically available biomethane potential, and locations identified for development of a potential biomethane production facility. Screening involved an assessment of each of the potential locations against the following commercial criteria which are further described below:

- Percentage within 50km buffer of gas transmission network
- Gas transmission line passes through LGA
- Potential site locations with appropriate land use zoning located along gas transmission network
- Co-location opportunities within the LGA (no. of AD/organics recycling/WWTP/landfill facilities)

A statewide map presenting key infrastructure used to inform the Commercial Screening Assessment is shown in Figure 2-4.

Based on this, a list of three regional LGAs and two metropolitan groupings were selected for further cost assessment.

Percentage within 50km buffer of gas transmission network

The primary focus of this assessment is the production of biomethane for injection into the natural gas grid. Therefore distance to the existing gas network was identified as a key metric in determining commercial viability of a particular location. The availability of a specific site location either on or close to the existing gas network is likely to result in a lower cost of connection to the existing gas network.

It was assumed that large-scale projects would connect to the transmission lines as the scale of the biomethane production would be too large for connection into distribution lines. The gas network data was mapped spatially and a 50km buffer was applied to the transmission pipeline data to determine a catchment area of LGAs within the 50km buffer of the transmission network.

It should be noted that while the commercial screening focused on proximity to gas transmission network, the later LCOE assessment focuses on connection to the gas distribution network. It is also important to note that while a particular LGA may be situated outside of the 50km transmission catchment area, there are still great opportunities for these LGAs to explore small-scale biogas projects for on-site use (as biogas or conversion into electricity) as opposed to upgrade and injection into the natural gas grid.

Gas transmission line passes through LGA

The location was then assessed to determine if the gas transmission line ran through the regional LGA or metropolitan grouping. This was done to identify whether a potential site could be located within the regional LGA or metropolitan grouping itself, and not just nearby in a neighbouring LGA or area.

Land use zoning of potential site locations within LGA

An assessment of existing anaerobic digestion facilities in Victoria was conducted to identify typical planning zones for these sites. Many of the reference facilities were identified as being located in either Farming Zone (FZ) and Industrial 1 Zone (IN1Z), with the exception of the one facility located in a Rural Conservation Zone (RCZ1). Whilst a waste to energy facility is not prohibited in this zone unlike industry, the purpose of RCZ1 is to protect the biodiversity values in the area, and there are likely environmental constraints associated with establishing a biomethane facility within this zone.

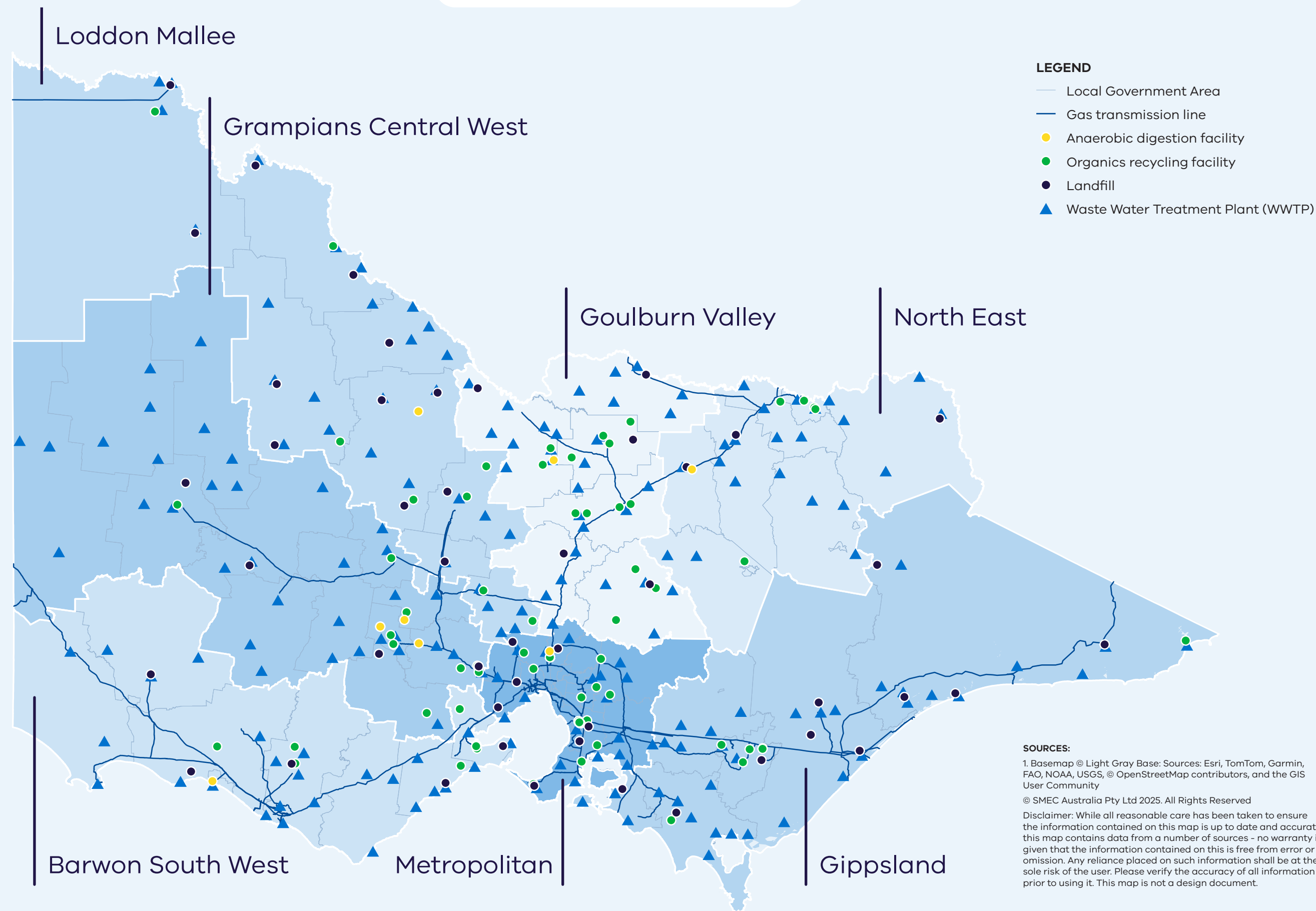
The high-level assessment assumed the following zones would be best suited for the establishment of a waste to energy facility: IN1Z, IN2Z, Public Use Zone 1 (Service and Utility) (PUZ1) to be co-located with an existing WWTP, and potentially FZ.

An appropriate separation distance should be established between the facility and these sensitive uses to prevent any potential land use conflicts.

Co-location opportunities within LGA

The number of existing waste and resource recovery facilities (organics recycling, anaerobic digestion), WWTP, and landfills, located within the LGA or metropolitan grouping which could be leveraged for potential co-location opportunities was assessed. Identifying suitable sites can be challenging for potential anaerobic digestion proponents and therefore co-location at existing facilities that already meet key requirements (e.g. compatible land-use zoning, established buffers, and proximity to the gas network) may provide more rapid pathways to development. Co-location of facilities also presents the opportunity to facilitate regional circular economy and development of bioenergy hubs.

Figure 2–4: Statewide Infrastructure



2.4 Levelised Cost of Energy Assessment

To calculate the Levelised Cost of Energy (LCOE) for a potential biomethane location, a proposed biomethane facility was sized and assessed based on the maximum practically available feedstocks accounting for seasonality and storage considerations. LCOE viability factors for feedstock, feedstock transport, plant operation, capital costs and operational costs were applied, and a discount rate of 7% and project life of 25 years was assumed.

2.4.1 Cost considerations

Capital expenditure

- The following was considered for each of the shortlisted locations when assessing capital costs:
- Capital cost for anaerobic digestion plant infrastructure;
 - Storage capital costs where additional storage of feedstock is required;
 - Capital cost for biogas upgrading and biomethane injection including compression, metering, and injection;
 - Biomethane connection was assumed to be to the existing distribution network rather than the transmission network, due to the significant infrastructure and cost requirements associated with achieving the high pressures needed for connection to the transmission network (see Section 6.2.3 for further detail);
 - Additional capital costs for decontamination for waste derived feedstocks where a decontamination step is required;
 - Costs associated with engineering and procurement were assumed to be minor when compared to capital expenditure and absorbed into general capital costs.

Yearly operational costs

The following was considered for each of the shortlisted locations when assessing yearly operational costs:

- Yearly cost was determined using industry-based assumptions where approximately 5-7% of the capital cost is estimated to be the maintenance cost;
- All feedstocks were assumed to be purchased at a cost or received at a gate fee (revenue) aligned with current market value;
- Feedstock transport costs;
- Labour costs;
- Landfilling of contaminated material associated with waste derived feedstocks;
- Digestate was considered to have an existing \$0 commodity value with environmental guidelines only recently established in Victoria (though noted to have high agronomic value with established end markets overseas e.g. UK and Germany).

2.4.2 LCOE calculation and assumptions

To determine the LCOE, key viability factors were identified based on available studies and SMEC's industry experience. An overview of the system model is presented below in Figure 2–5.

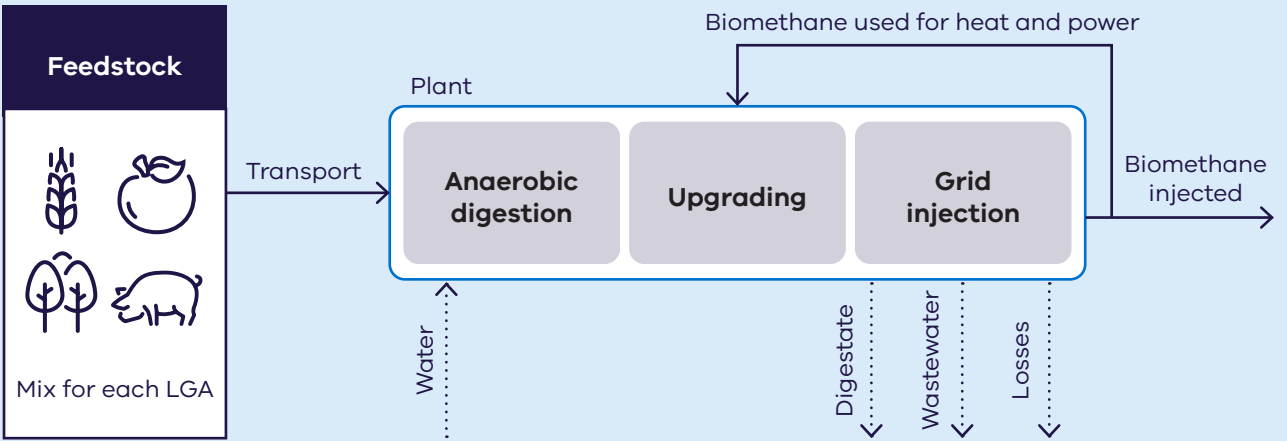


Figure 2–5: Illustrative representation of the system model

The focus has been on inclusion of the key factors impacting the LCOE which include:

- **Feedstock:** a unique mix is estimated for each LGA based on practically available feedstocks.
- **Transport of feedstock:** collection and transport of feedstock to the plant.
- **Plant:** it is assumed anaerobic digestion, biogas upgrading, compression and biomethane injection into the grid occurs in a location close to the gas network. Feedstock, energy, and water are the main inputs to the plant and the outputs are digestate, wastewater, and biomethane.
- **Biomethane injected to the network:** the maximum amount of biomethane available to inject to the grid after losses in the plant and parasitic load (power supply to the plant).

LCOE has been calculated using the following formula:

$$LCOE = \frac{I_0 + \sum_{t=1}^n \frac{M_t}{(1+r)^t}}{\sum_{t=1}^n \frac{E_t}{(1+r)^t}}$$

Where, n = lifetime (years), r = discount rate (%), t = project year, I₀ = CAPEX (Capital Expenditure, \$) amount, M_t = net cash flow in year t (\$, including any revenues), and, E_t = energy produced in year t (GJ).

3. Total Theoretical Assessment

An assessment of the total theoretical biomass residues and biomethane potential for each feedstock type was conducted and a high-level summary of the results is presented in this section. Detailed results for each feedstock category are presented in **Appendix B ‘Results – Total Theoretical Assessment’**.

The current total theoretical biomethane potential is estimated at 130 PJ, which is projected to increase to just over 200 PJ by 2045.

Broadacre residues including straw and chaff from cereal, non-cereal, and oilseed crops, represent the most significant opportunity across all residue streams assessed in the study. Broadacre accounts for 67% of the total theoretical potential, with major volumes sourced from the Grampians Central West and Loddon Mallee regions.

The waste sector constitutes the second-highest contributor to the total theoretical biomethane potential (20% of the total). This includes food organics, garden organics, wood/timber, and paper/cardboard, which are recovered through waste management systems such as council kerbside collections and dedicated recycling services. As expected, the majority of this material is generated in the Metropolitan region, where population and industry are concentrated.

Landfills represent the third-largest contributor (5% of the total), with most of this resource also originating from the Metropolitan region.

A detailed breakdown of results for the total theoretical assessment (including residue quantities and biomethane potential) for each feedstock category is provided in **Appendix B: ‘Results – Total Theoretical Assessment’**.

- Broadacre is currently and estimated to remain over the next 20 years, the greatest source of theoretical biomethane potential, concentrated in the Grampians Central West (46%), Loddon Mallee (32%), and Goulburn Valley (13%) regions.
- Waste sector feedstocks are driven by the metropolitan areas, with greater population density and increased recycling initiatives driving the recovery of high potential feedstocks.
- Remaining feedstock types have lower potential but provide biomethane pathways in regions that do not have large broadacre residues or waste sector feedstocks, including Loddon Mallee (1.9 PJ from horticulture) and Barwon South West (1.7 PJ from plantation and wood processing).
- Similar to waste sector feedstocks, most of the biomethane potential from WWTPs and landfills is concentrated in the Metropolitan region, where higher population densities requires more large-scale water treatment and landfill facilities resulting in greater biogas production.

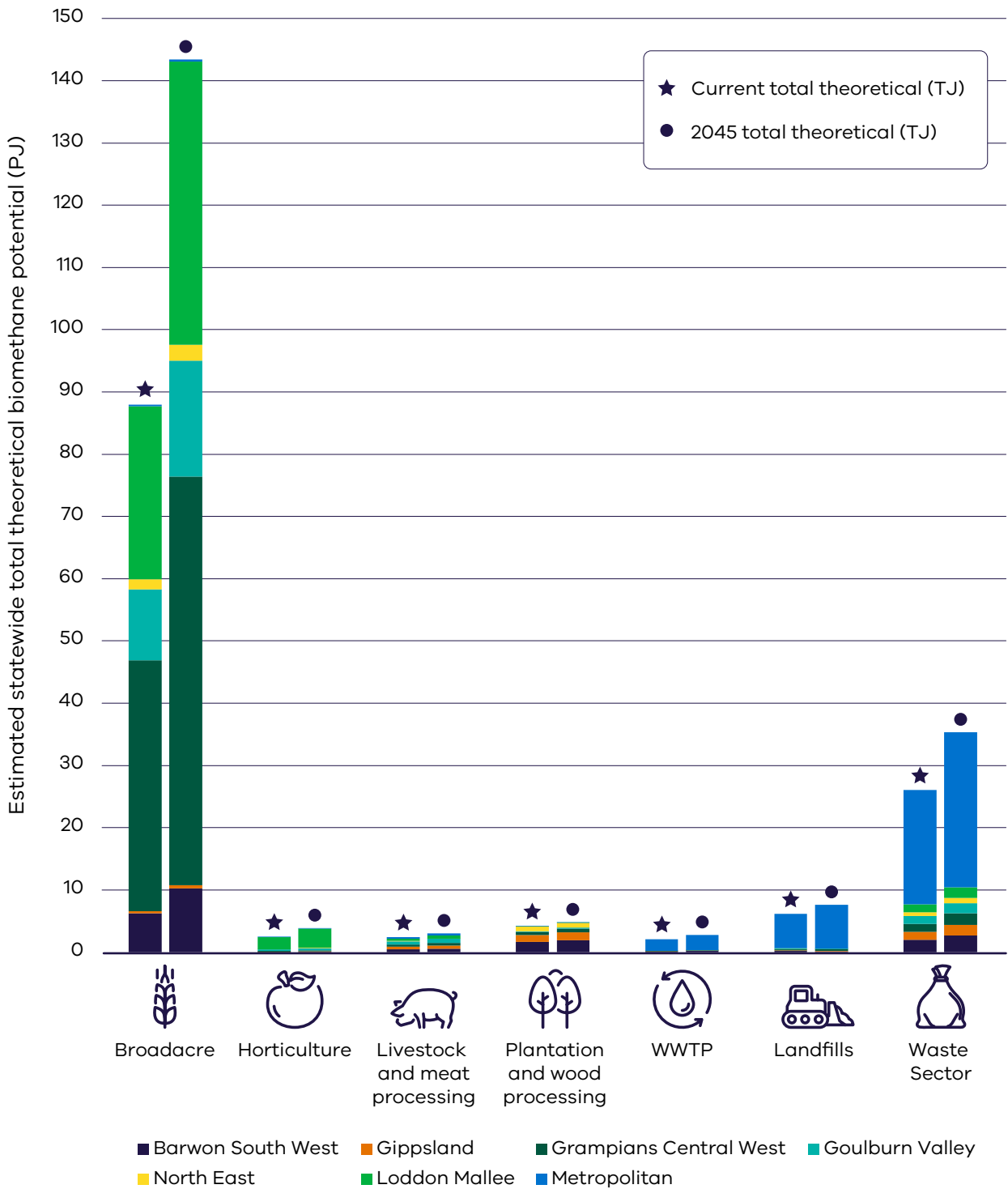


Figure 3–1: Estimate of total theoretical biomethane potential for statewide Victoria

4. Practically Available Assessment



4.1 Practically available biomass residues

An assessment of practically available residues was conducted by applying residue availability factors outlined in Section 2.2.1 against the total theoretical residues calculated as part of the earlier Total Theoretical Assessment. The following Figure 4-1 outlines the total statewide practically available tonnes per year of biomass residues. A total of over 6.3 million tonnes of residue is estimated to be practically available in Victoria in 2025 across all residue sources, which is projected to increase to over 9 million by 2045.

While C&I Paper and Cardboard was assumed to be 0% available with this residue source having an established paper recycling market, the waste sector is still responsible for the greatest volume of practically available residues, which is estimated at 3.5 million tonnes in 2025 and expected to grow to approximately 4.7 million tonnes by 2045. This can be attributed to the large volume of MSW organics expected to be recovered from residents including food organics and garden organics via council kerbside collections and

other waste and resource recovery services (e.g. hard rubbish collection, transfer station drop off).

This is followed by broadacre (~2.2 million tonnes in 2025 growing to 3.7 million tonnes by 2045). Broadacre was by far the largest contributor to total theoretical residues, representing nearly 67% of the total (refer to Figure 3-1). With an assumed residue availability rate of 28%, practically available residues are estimated at 2.3 million tonnes in 2025, increasing to 3.7 million tonnes by 2045 (refer to Figure 4-1).

Broadacre residues are seen to be significantly higher than other agricultural residue streams due to the already high production of grain estimated in 2025, which is only expected to grow.

Practically available residues (tonnes) by Region for 2025, 2035, and 2045 are presented in the following figures.

Note that this is a theoretical study. Further work is required to confirm that 'practically available' estimates do not overstate supply where residues are needed to maintain soil health, mitigate other environmental impacts, or face emerging or established supply chain constraints.

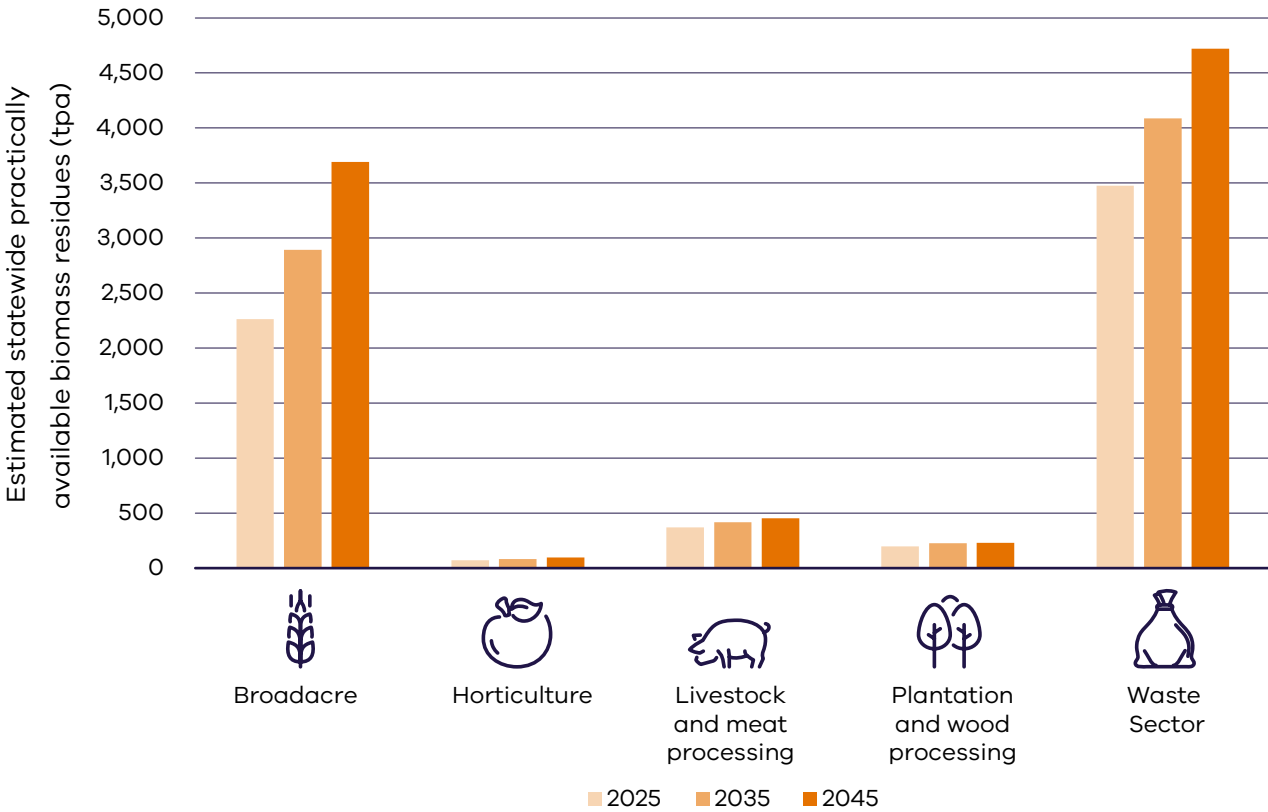


Figure 4-1: Estimate of practically available residues for statewide Victoria from 2025 to 2045

Figure 4–2: Current statewide practically available biomass residues by Region (ktpa)

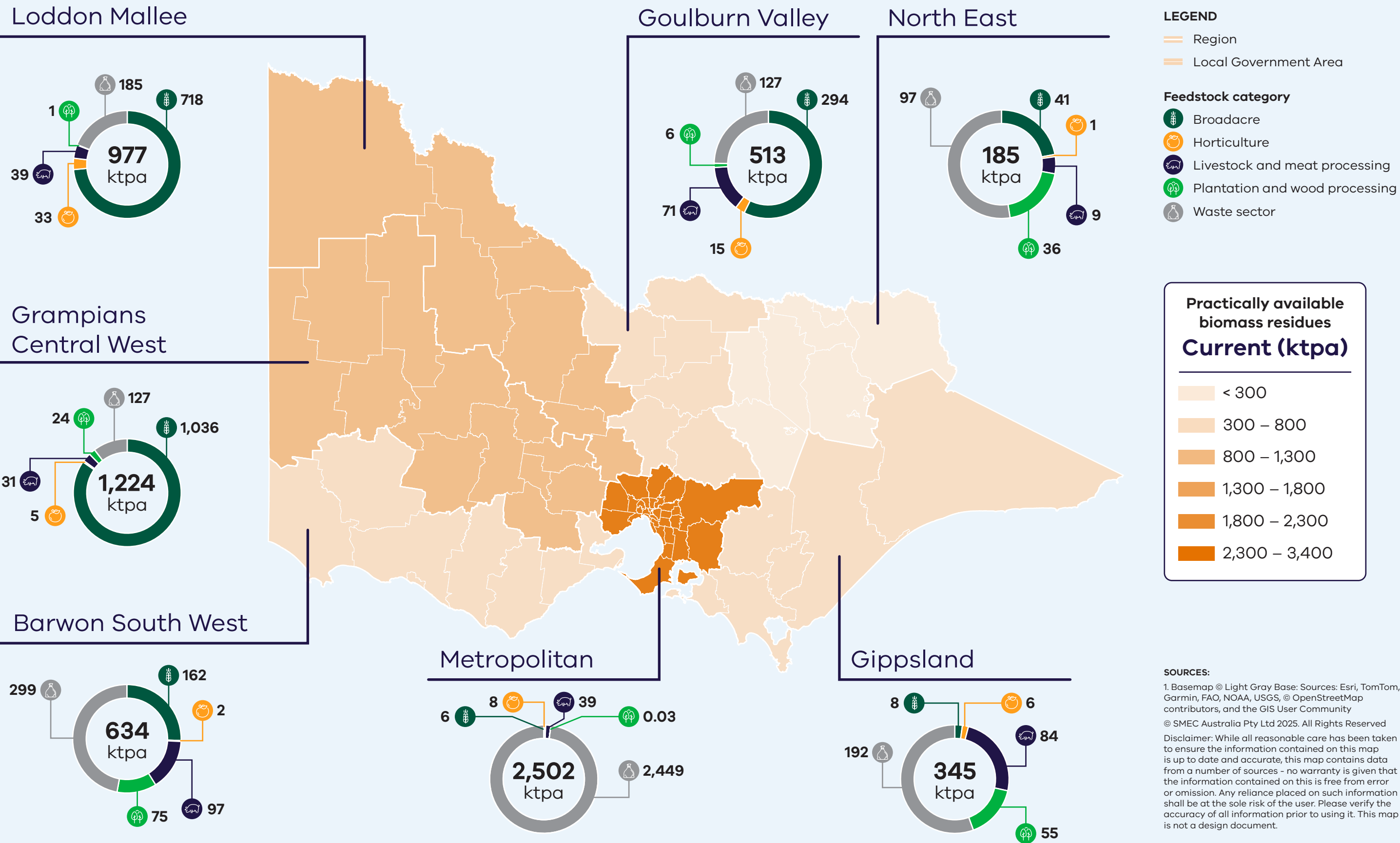


Figure 4–3: Statewide practically available biomass residues for 2035 by Region (ktpa)

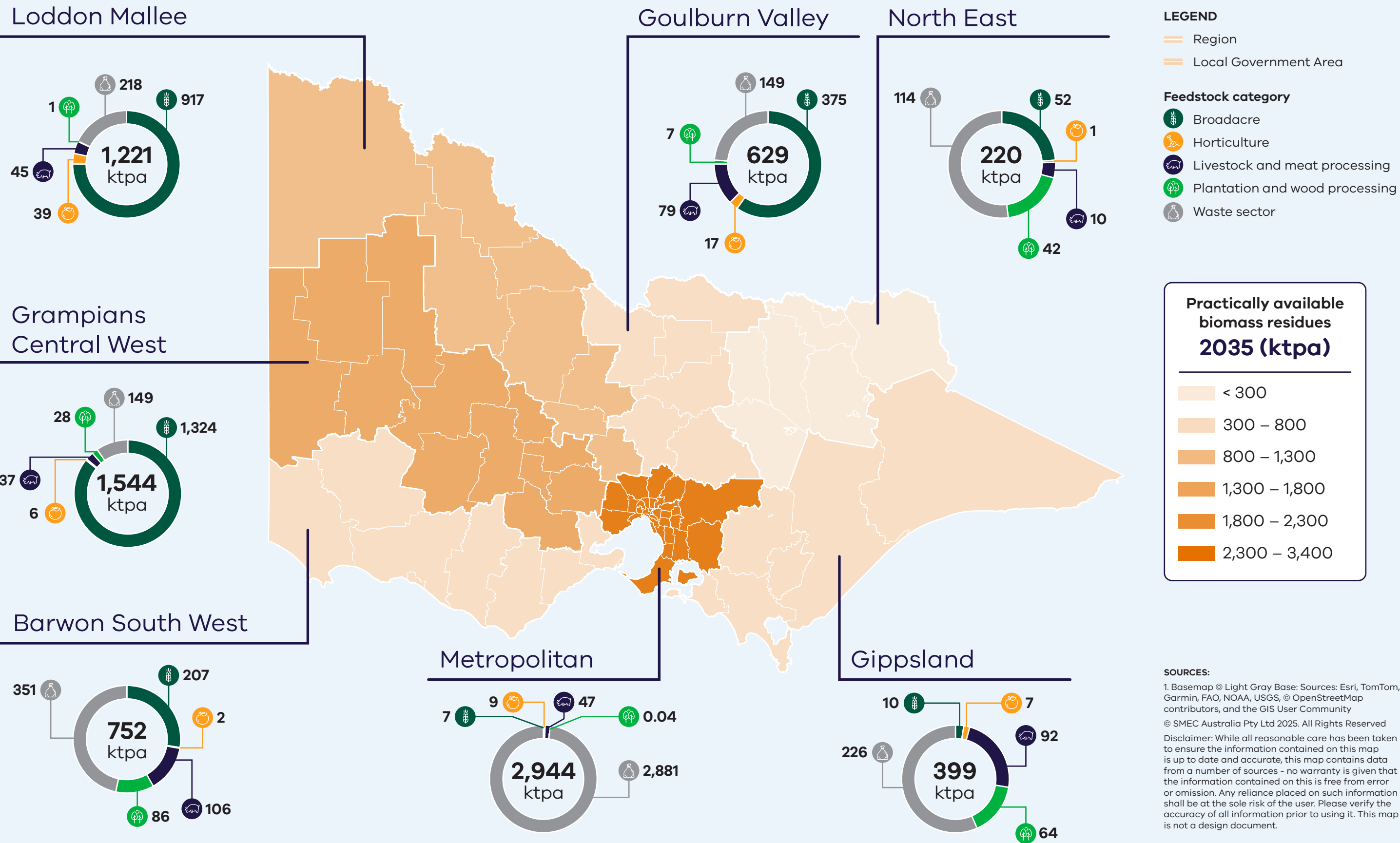
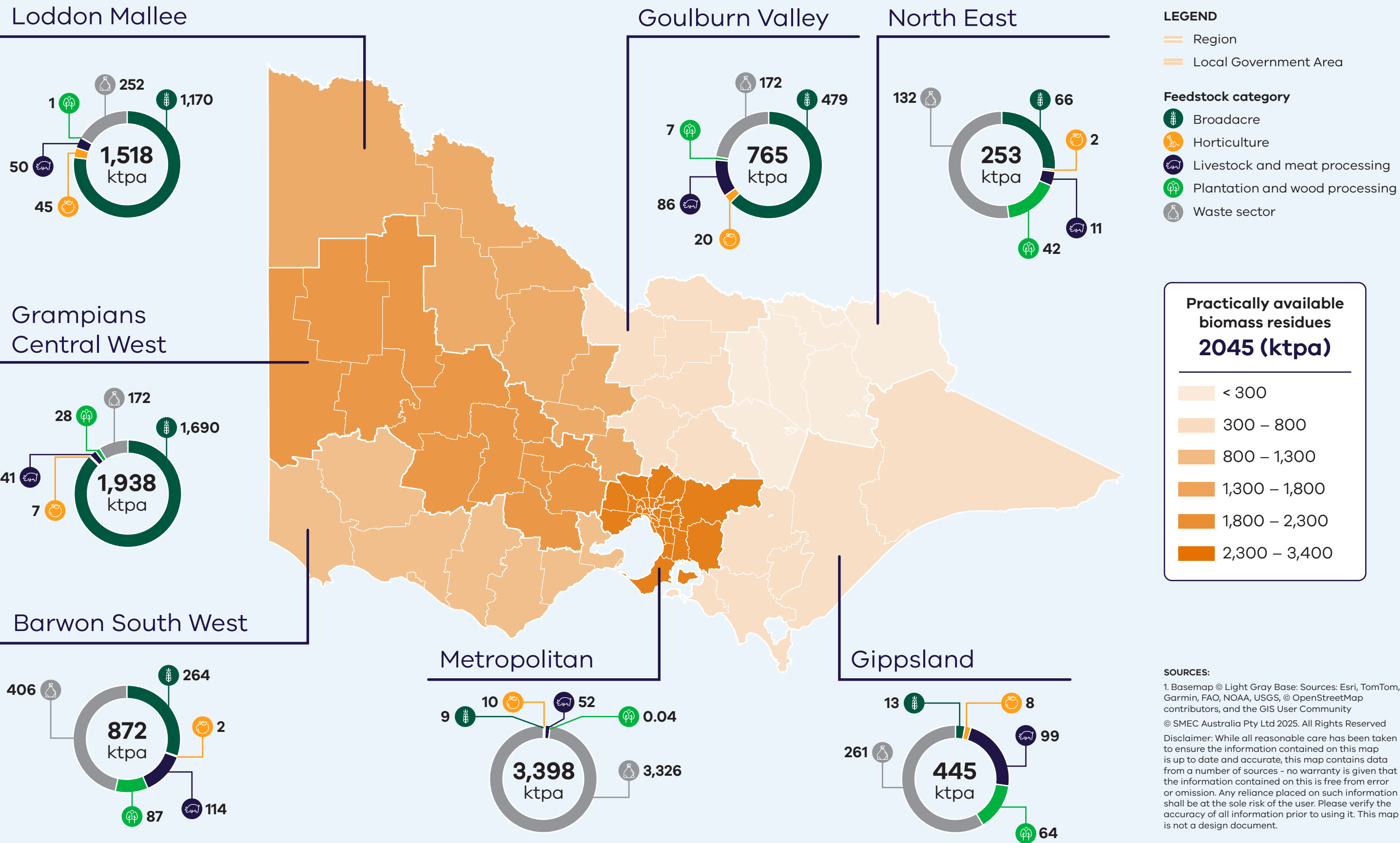


Figure 4–4: Statewide practically available biomass residues for 2045 by Region (ktpa)



4.2 Practically available biomethane potential

An assessment of practically available biomethane potential was conducted by applying resource availability factors outlined in Section 2.2.1 against the total theoretical biomethane potential calculated as part of the earlier Total Theoretical Assessment. The below Figure 4–5 outlines the total statewide practically available biomethane potential for Victoria which is estimated to be approximately 47 PJ in 2025 and is forecasted to increase to over 69 PJ by 2045. The greatest opportunity for biomethane potential is from broadacre, with approximately 24.6 PJ estimated in 2025 which is projected to grow to just over 40 PJ in 2045. This is followed by the waste sector with approximately 10.1 PJ

estimated in 2025 expected to increase up to approximately 13.7 PJ by 2045, and landfills with 6.2 PJ in 2025 forecasted to grow to 7.6 PJ by 2045.

Practically available biomethane potential (PJ) by Region for 2025, 2035, and 2045 are presented in the following figures.

While the waste sector is estimated to generate the largest proportion of practically available residues statewide, expected to be around 50% of the total, it accounts for only about 20% of the practically available biomethane potential. In contrast, broadacre accounts for approximately 35% of statewide residues yet offers a substantially greater biomethane opportunity, contributing around 52% of the total practically available biomethane potential (compared with 21% from the waste sector).

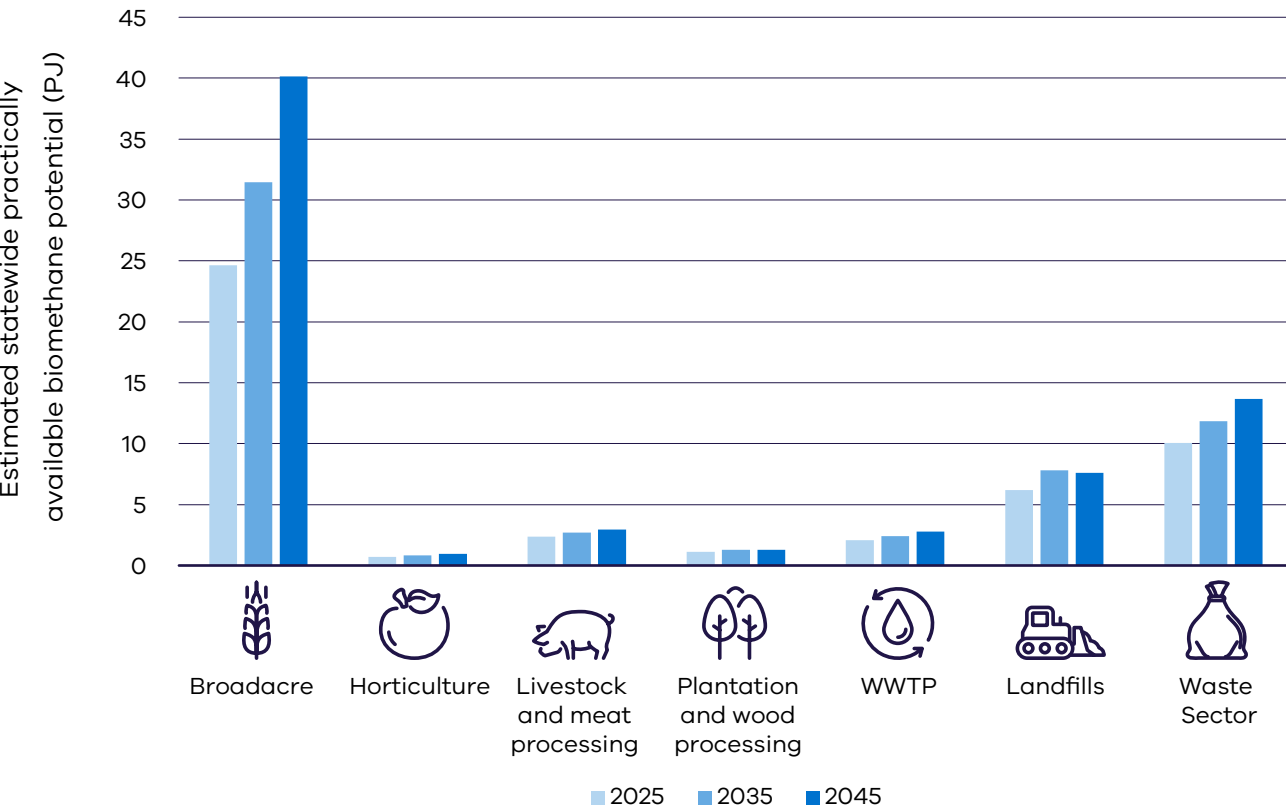


Figure 4–5: Estimate of practically available biomethane potential for statewide Victoria from 2025 to 2045

This difference is largely due to the higher energy density of broadacre residues. Broadacre feedstocks typically have lower moisture content and significantly higher calorific values (~285 m³ CH₄/t) when compared to waste-sector feedstocks (~62-107 m³ CH₄/t). Further detail on the calorific values applied in this study is provided in **Appendix A: 'Methodology: Total Theoretical Assessment'**.

While broadacre presents the greatest opportunity for biomethane potential across all feedstocks evaluated, and there will likely be growing interest to integrate anaerobic digestion into relevant farming systems, the decision on how to use agricultural residues ultimately rests with farmers. This includes choosing the option that delivers the best return on investment for their farming system, whether that involves incorporating residues to improve soil health, generating on-farm energy, or creating new value-added products.

Maps displaying practically available biomethane potential (PJ) by LGA are presented in **Appendix C: 'Maps – statewide practically available biomethane potential by LGA (PJ)'**.

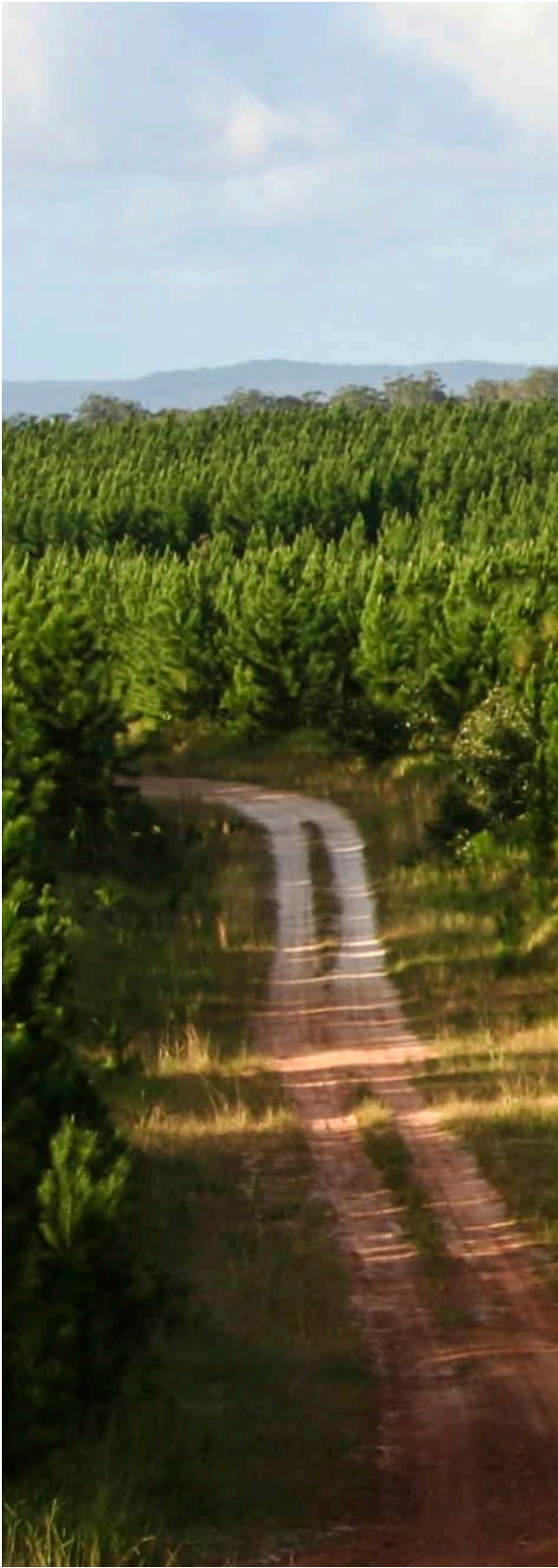


Figure 4–6: Current statewide practically available biomethane potential by Region (PJ)

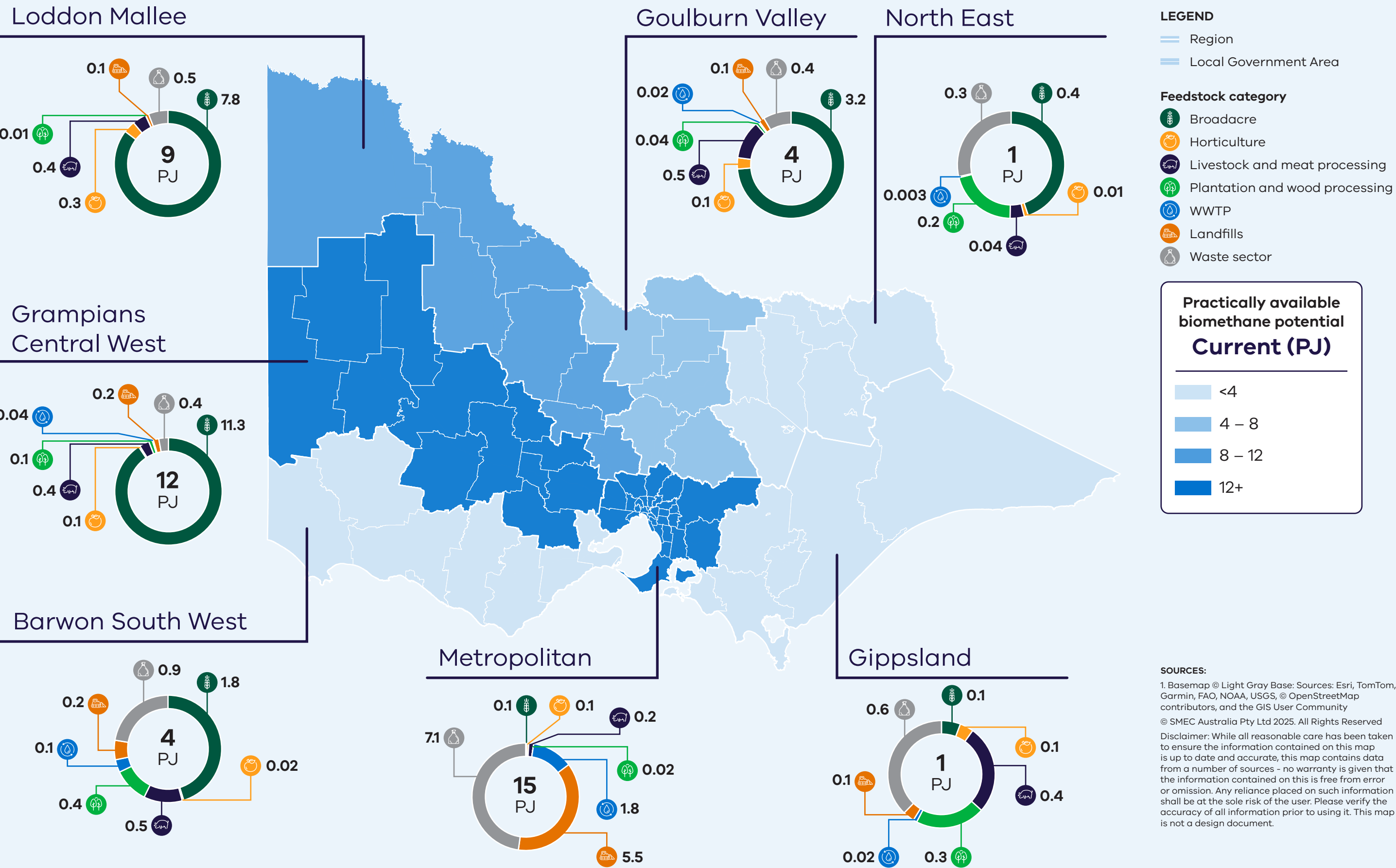


Figure 4–7: Statewide practically available biomethane potential for 2035 by Region (PJ)

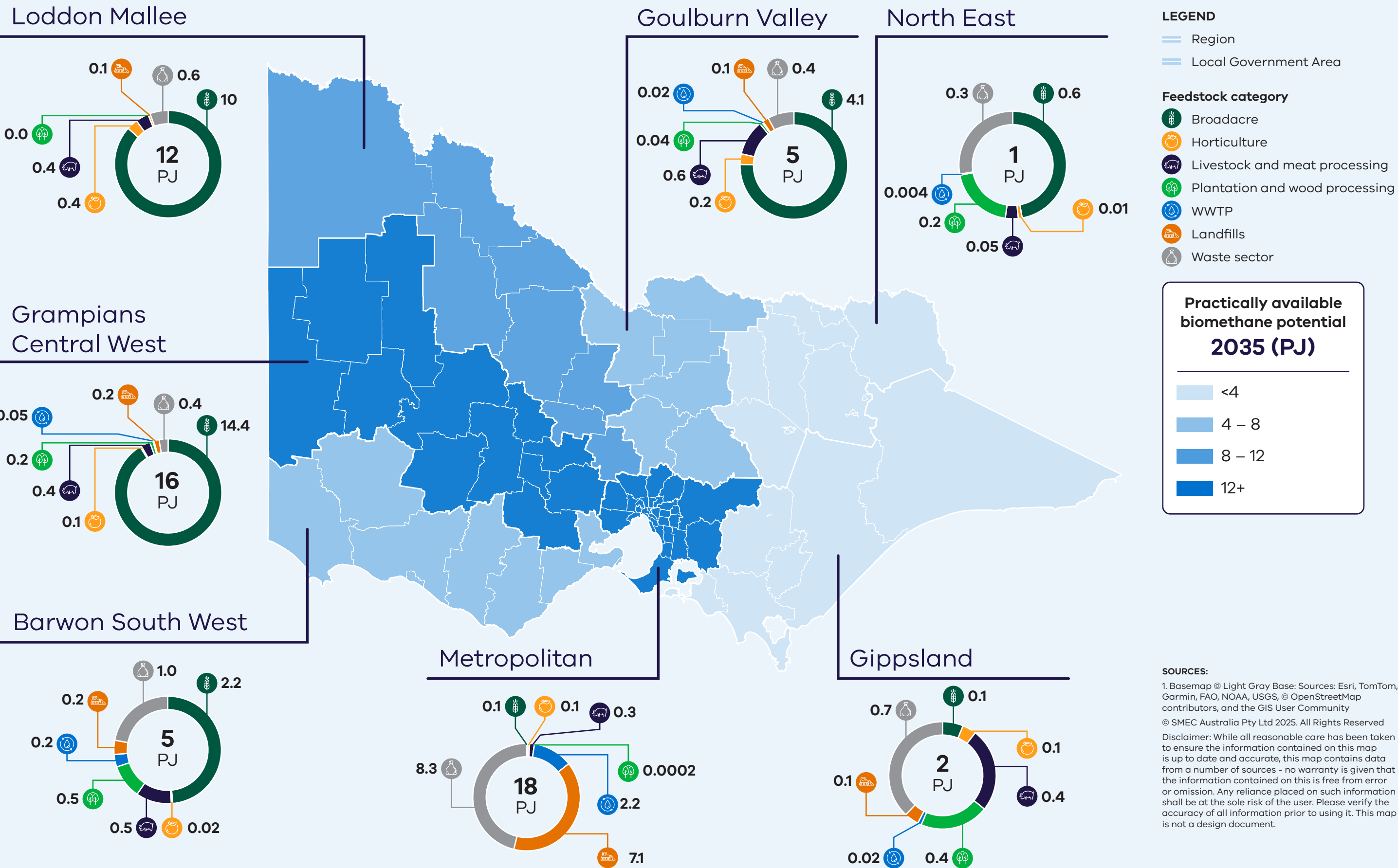
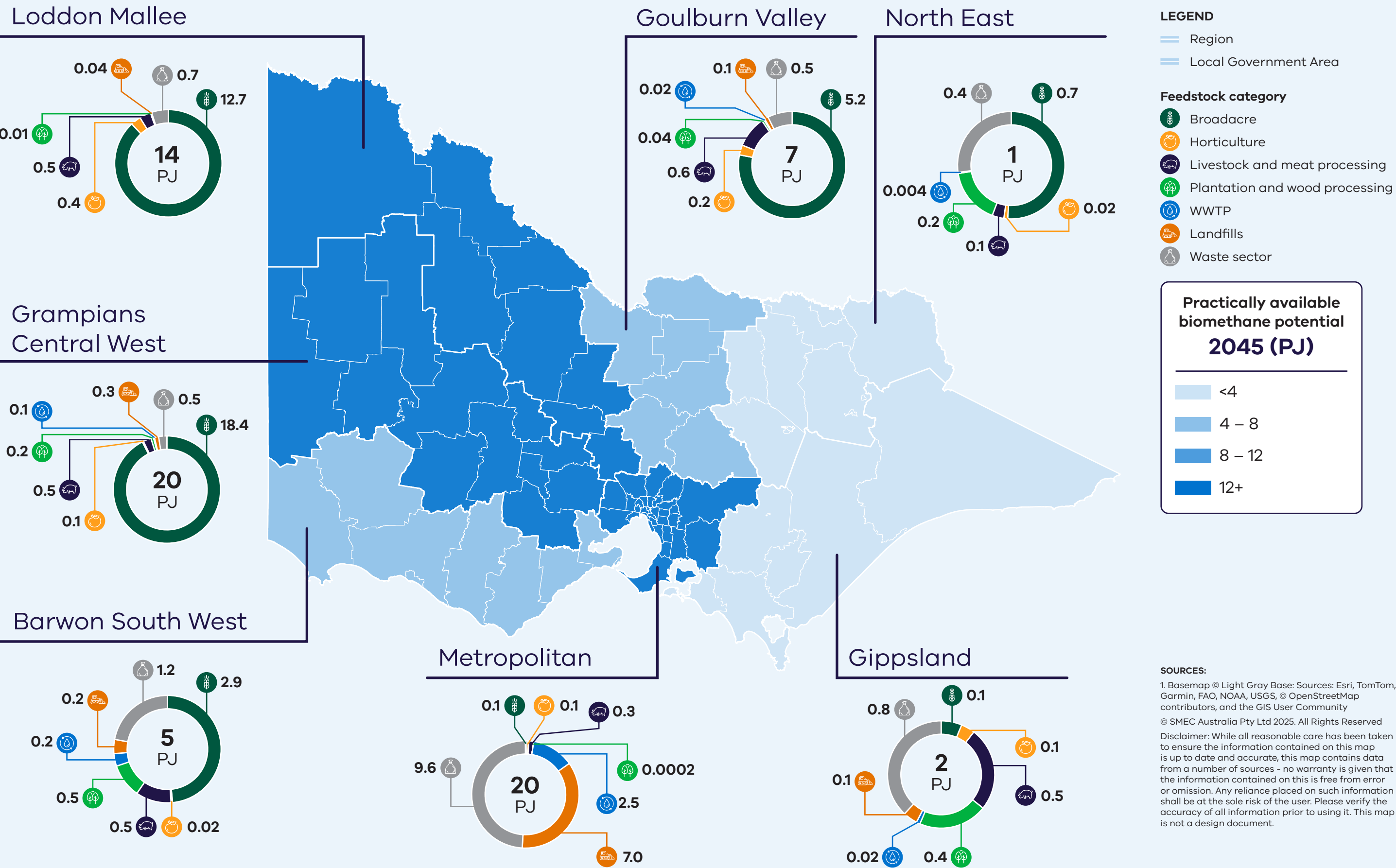


Figure 4–8: Statewide practically available biomethane potential for 2045 by Region (PJ)



5. Current and potential industrial gas use in Victoria



5.1 Major gas users

An evaluation of Victoria’s top twenty natural gas users identified a range of industries, including GPG, paper and glass manufacturing, brick and tile production, aggregate and sand drying, and malt production. Collectively these users consume an estimated 18,867 TJ (approximately 18.8 PJ) of natural gas annually.

Electrification is known to be the lowest cost way to decarbonise a majority of Victorian fossil gas consumption with the largest gains expected to be made in the residential and commercial sectors. Electrification however is not necessarily commercially or technically feasible for Victoria’s industrial and GPG sectors (DEECA, 2024). With high-heat industrial applications requiring gas to achieve the required high temperatures, these industrial applications will likely require an alternative source to natural gas in the future. GPG is also expected to play a critical role in the energy transition by supporting and stabilising renewable energy supplies.

5.2 Industrial gas demand

Victoria’s current industrial gas demand as per AEMO’s Gas Statement of Opportunities (GSOO) under the ‘Step Change’ scenario is estimated to be around 51 PJ in 2025, which is forecasted to decrease slowly to 48 PJ by 2035 and plateau at this level by 2045. Alongside this, the estimated gas consumption from the GPG sector is estimated to be approximately 5 PJ in 2025 which is projected to increase to 16 PJ by 2045.

To assess the percentage of the industrial and GPG gas demand that could be fulfilled by renewable biomethane, the forecasted gas consumption was assessed against the total statewide estimate for practically available biomethane potential. As seen in the Table 5–1 below, if all practically available biomethane potential was produced today (in 2025) it would be able to meet approximately 91% of the current industrial gas demand, growing to 144% by 2045. If assessed against total industrial and GPG gas usage, it is expected that 83% of the total gas usage could be met by practically available BMP in 2025, increasing to 98% in 2035 and exceeding demand by 2045 at 108%.

Table 5–1: Percentage of forecasted industrial/GPG gas usage which could be fulfilled by practically available biomethane potential (note 2045 forecast is AEMO data for latest year – 2044)

	2025	2035	2045
Practically available BMP (PJ)	47.1	58.3	69.4
Forecast of industrial gas use (PJ)	51.7	48.7	48.2
Forecast of GPG gas use (PJ)	5.3	10.7	16.1
Forecast of total industrial and GPG gas use (PJ)	57.0	59.4	64.3
Percentage of forecasted industrial demand fulfilled by practically available BMP (%)	91%	120%	144%
Percentage of forecasted total industrial and GPG demand fulfilled by practically available BMP (%)	83%	98%	108%

Pathway for renewable gas

These key points are highlighted by the practically available BMP (orange line) indicated in Figure 5–1 where the practically available BMP can be seen to exceed forecasted industrial gas demand (green line) around 2028 and forecasted total industrial and GPG gas demand (navy blue line) around 2037.

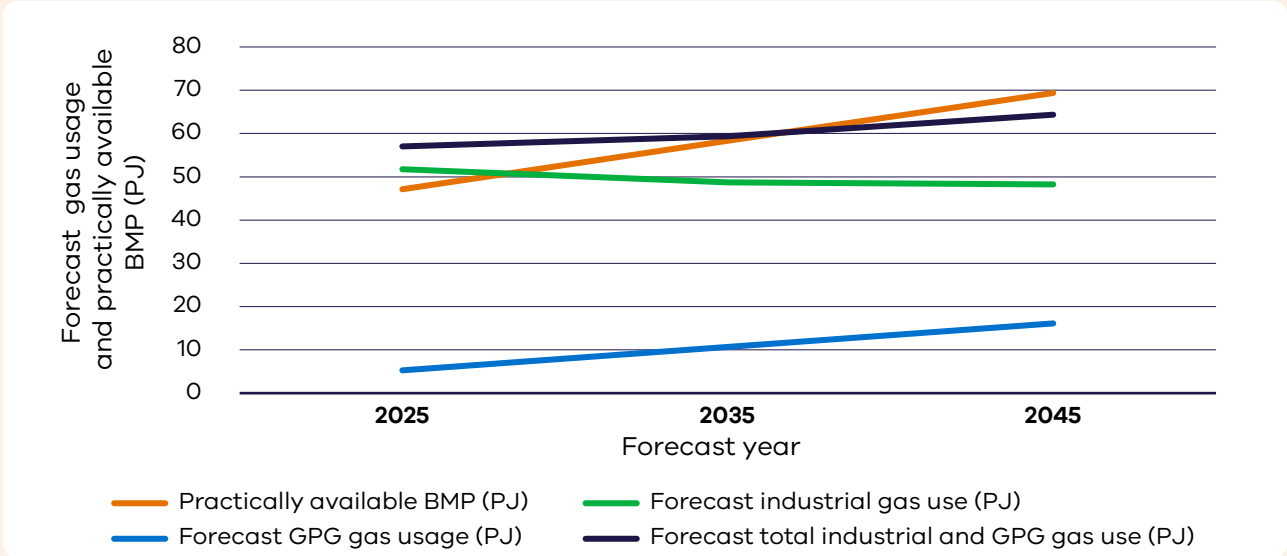


Figure 5–1: Forecasted timing of practically available BMP meeting forecasted industrial and GPG gas demand in Victoria

Meeting these early timelines (especially for 2028) assumes that all potential anaerobic digestion projects are for biomethane and not just developed for behind-the-meter use. Additionally it assumes that all associated infrastructure (biogas production, biomethane upgrading, gas network and gas injection) is built. It’s important to highlight that new biomethane facilities will have long lead times, accounting for appropriate site identification, necessary regulatory approvals for all elements, feasibility studies, design and construction, taking many years to develop.

Despite long development timelines and the possibility of feedstock competition from other sources this presents an opportunity for the renewable gas sector in Victoria, with a significant proportion (83%) of the current total industrial and GPG gas demand assessed to be practically available. This highlights the possibility for early investment in the biomethane sector to make significant and rapid steps forward to decarbonising the gas sector.

6. Developing biomethane production facilities

This chapter provides an overview on development of biomethane production facilities in Victoria, including the identification of high-potential locations through commercial screening and the assessment of LCOE. It also summarises the key considerations that project developers should account for when planning and delivering a biomethane facility.

6.1 Assessment of high potential locations

6.1.1 Selection and commercial screening

Regional LGAs and metropolitan groupings with the highest practically available biomethane potential were screened against a commercial criteria including:

- Percentage within 50km buffer of gas transmission network;
- Gas transmission line passing through the LGA;
- No. of co-location opportunities within the LGA;
- Land use zoning of potential site locations within the LGA along gas transmission network.

The following regional LGA and metropolitan groupings outlined in Table 6–1 were selected as high potential locations as they displayed high practically available biomethane potential and met the above criteria, and were further explored for possible development of a biomethane production facility.

A statewide map presenting a profile for each of the high potential locations is shown in Figure 6–3. It is important to note that there are other regional LGAs and metropolitan groupings which were found to meet the above commercial criteria and may be suitable for potential project development.

6.1.2 Storage considerations

To determine the LCOE for a proposed biomethane facility across each of the identified high potential locations, the seasonality and storage of available feedstocks in the location was considered. A storage capital cost of \$100 per tonne was assumed and the required storage (tonnes) and associated capital cost (\$) was determined with results indicated in Figure 6–2.

Table 6–1: Overview of selected high potential locations

Location	Region	2035 BMP (TJ)	% within 50km buffer	Gas pipeline passing through location?	Co-location opportunities
Metropolitan West	Metropolitan	4,949	100%	Yes	2 organics, 3 WWTP, 2 landfills
Metropolitan South	Metropolitan	4,936	100%	Yes	11 organics, 8 WWTP, 3 landfills
Moira	Goulburn Valley	2,446	100%	Yes	1 landfill, 7 WWTP
Horsham	Grampians Central West	1,910	~95%	Yes	1 organics, 1 landfill, 2 WWTP
Ararat	Grampians Central West	1,765	~98%	Yes	3 WWTP

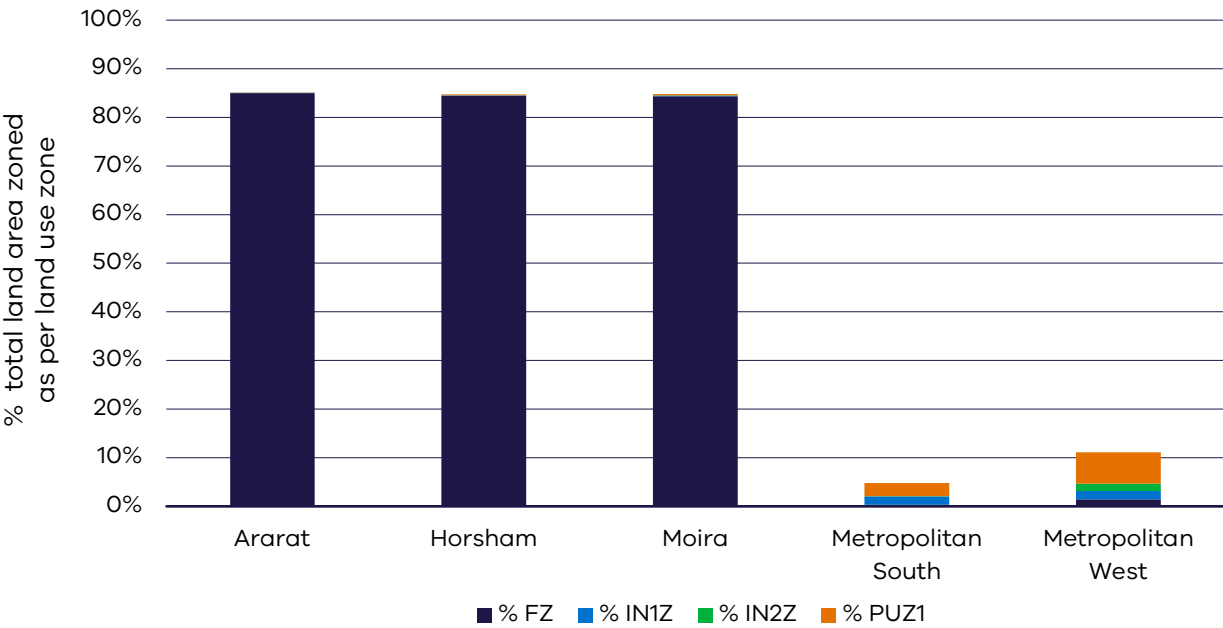


Figure 6–1: Overview of land use zoning of selected high potential locations

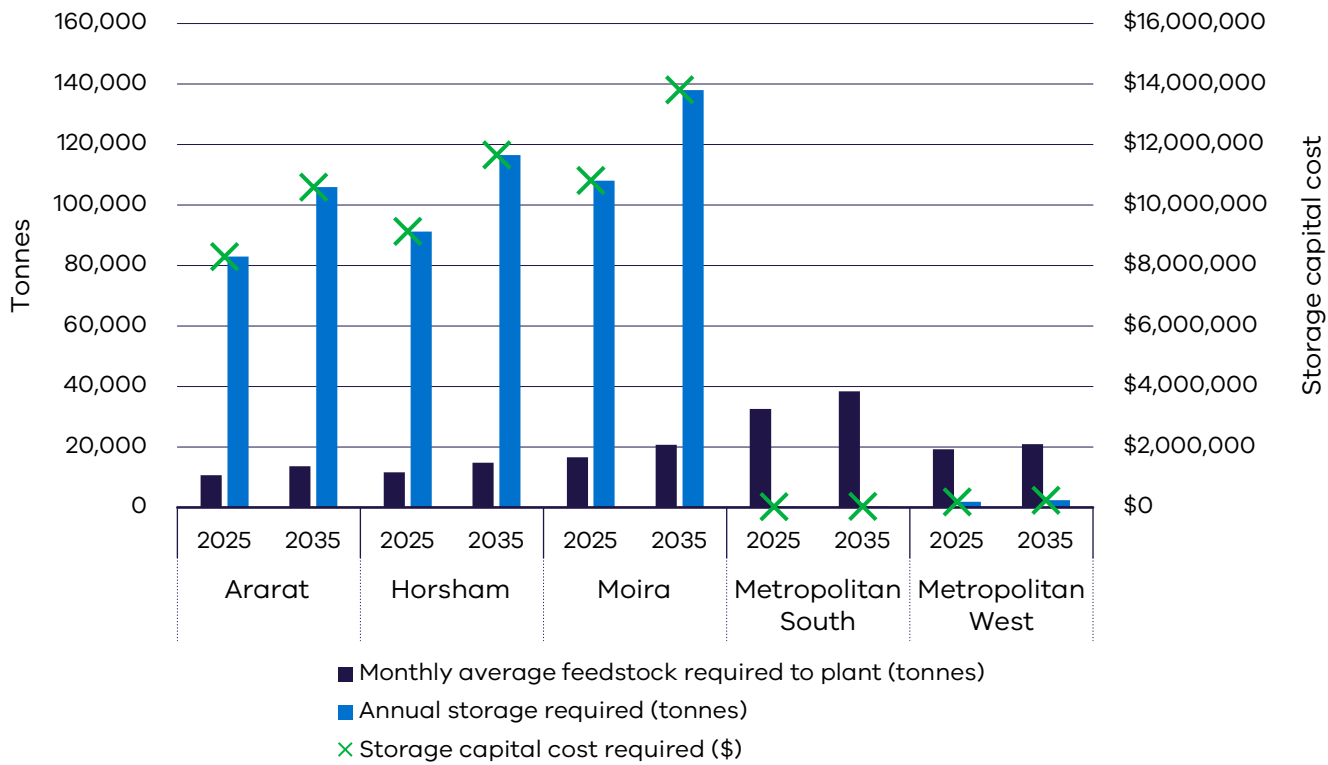
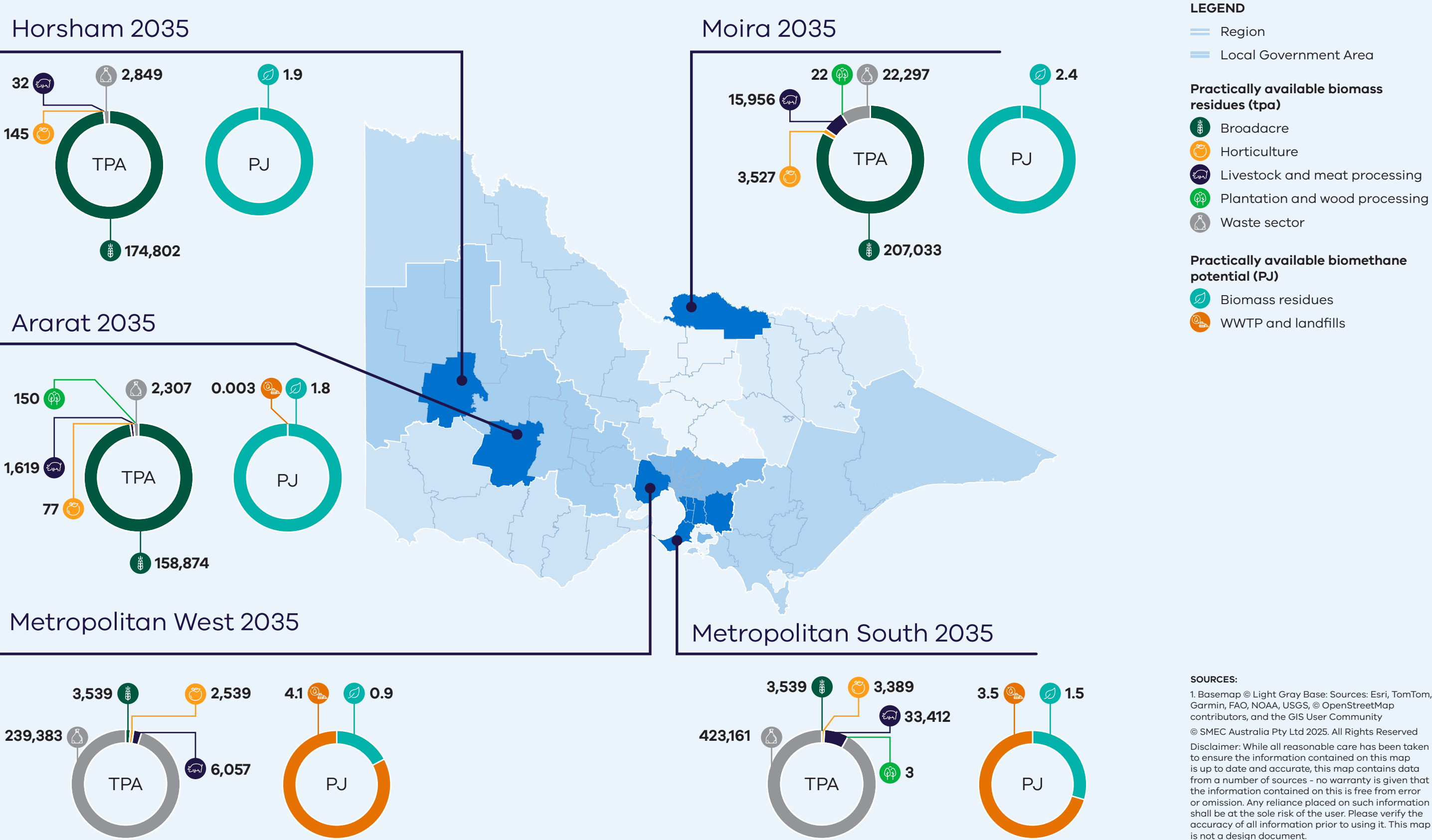


Figure 6–2: Storage considerations across high potential locations

Figure 6–3: Statewide map outlining key infrastructure – high potential location profiles



6.1.3 Calculation of LCOE

The LCOE was calculated for each of the high potential locations based on current 2025 estimates and 2035 projections. The final LCOE values are based on the practically available feedstock input and associated biomethane potential for 2025, expressed in real 2025 terms. Please note that when referring to locations, this means the metropolitan grouping/regional LGA (e.g. Ararat, Metropolitan South), and not an exact site location for a proposed plant.

While an exact site location hasn’t been accounted for in the LCOE calculation, distance has been factored in as part of transport (fuel) considerations which were assumed to be \$40/tonne. The assessment has assumed that a proposed biomethane facility would be located close to the gas network line within the specific metropolitan grouping/ regional LGA.

The results from the LCOE assessment indicate that the LCOE for biomethane for the high potential locations can range from \$28.1 to \$33.6 per GJ in 2025, and \$26.7 to \$32.1 per GJ in 2035 (expressed in real 2025 terms). This range is broadly within the range of other studies, for example AGIG (2024), FFCRC (2022) and Australia’s Bioenergy Roadmap (ARENA, 2021) which have identified ranges approximately from \$9-\$50 per GJ. The broad range indicates the LCOE’s high sensitivity to key input parameters, including feedstock type and other underlying assumptions such as feedstock mix, plant size, maintenance and operational costs (such as transport, contamination, water and wastewater and so on), and revenue streams beyond energy (such as gate fee, ACCU, green CO₂ and digestate).

It was found that Metropolitan LGAs benefit from economies of scale due to higher volumes of organic and commercial & industrial (C&I) waste. Additionally these LGAs can generate gate fee revenue from waste acceptance, which has been included as the only revenue stream in this analysis. In contrast regional LGAs with abundant agricultural feedstock benefit from the higher energy density of residues such as straw and chaff. However, these projects often face higher feedstock acquisition costs, seasonal availability, typically during summer when gas demand is low, and a need for additional capital investment in storage infrastructure, all of which increase LCOE.

It is important to note that this LCOE analysis focuses solely on feedstock-related costs and gate fee revenues, and does not account for additional potential revenue streams (further discussed in Section 6.3.5). These factors are local market- and policy-dependent and could enhance the commercial viability of biomethane projects if included.

This assessment provides an indicative LCOE estimate based on available state-wide data and assumptions. While it offers preliminary insights into the cost and potential of biomethane in Victoria, more detailed case-specific modelling will be necessary to support business case development.

Table 6–2: LCOE for high potential locations

Location	LCOE 2025 (\$/GJ)	LCOE 2035 (\$/GJ)
Regional LGA	28.8 – 30.7	28.0 – 29.8
Metropolitan grouping	28.1 – 33.6	26.7 – 32.1



Blue Lake Milling Bioenergy Plant – Bordertown, South Australia (image source: Delorean Energy)

6.2 Key technical considerations for project development

The following sections provide a technical overview to inform planning and delivery of a biomethane production facility, with a focus on connection to the natural gas grid.

6.2.1 Feedstock availability

Identifying feedstock availability is a critical first step in assessing the feasibility of any biomethane facility. In Victoria, feedstocks in regional LGAs were largely driven by the presence of broadacre residues, while available feedstock residues in the metropolitan groupings were primarily sourced from waste sector feedstocks.

6.2.2 General anaerobic digestion plant overview

Receipt and handling

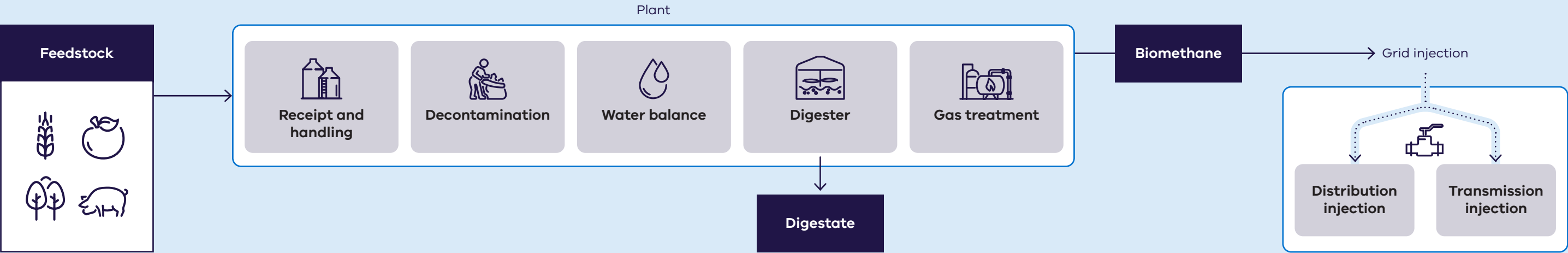
A typical plant begins with a materials receipt and handling stage, where incoming feedstock is inspected for contamination and processed for immediate use or storage. Dry feedstocks may be stored loose or baled, while those with higher moisture content or liquid characteristics generally require tank storage.

Decontamination

A dedicated treatment step where feedstock is processed to remove contaminants to a level required for downstream digestion. Decontamination systems can range from simple processes, such as identifying and removing baling twine, to highly complex material recovery facilities.

Water balance

Materials are transferred into the main plant, where they must be conditioned to a ‘pumpable’ state. Feedstock characteristics are critical at this stage: materials with high dry matter (DM) content require significantly more liquid (typically water) than feedstocks such as grease trap waste, which are already in liquid form.



Digestion phase

Digestion is the main stage of the anaerobic digestion operation, where feedstock enters large digester tanks fitted with flexible balloon tops. Many digestion plants incorporate an initial high-temperature thermophilic phase, typically combined with pasteurisation, to minimise the risk of introducing pathogens into the main digester tanks. During this process, feedstock is transferred to a smaller tank and heated to above 45 °C (up to approximately 55 °C) for a duration determined by the specific characteristics of the in-feed material and the pasteurisation requirements.

Material is then pumped into the main mesophilic tanks, where it is mixed and circulated semi-continuously for up to 30 days. During this phase, biogas is generated and naturally rises to the top of the tank, where it is collected and directed via pipework to the gas treatment system. The remaining material, called digestate, undergoes separation into solid and liquid fractions. Solids are removed from the site for further treatment, while the liquid portion is generally recycled back into the process.

Gas treatment

The captured biogas consists primarily of methane (CH₄) and carbon dioxide (CO₂), and typically contains high levels of water vapour. Depending on the feedstock, significant concentrations of hydrogen sulphide (H₂S) may also be present. Most treatment processes begin by reducing water vapour by running the gas through a chiller to condense moisture, followed by H₂S removal. This can be achieved using various technologies such as activated carbon filtration, oxygen dosing, or chemical scrubbing. After these steps, the gas is predominantly CH₄ and CO₂, which can either be combusted in an internal combustion engine to generate heat and power, or upgraded and compressed for grid injection or used on-site behind-the-meter.

6.2.3 Grid injection

The location of a proposed biomethane facility in Victoria must consider whether gas is injected into the distribution or transmission network. Distance to the existing distribution or transmission gas pipelines is critical and connection costs are highly site-specific and depend on a number of key factors including distance (assumed to cost approximately \$1 million per km), land and easement availability. Custody transfer from transmission to distribution occurs at transmission-operator-owned custody transfer metering, with pressure reduced from approximately 2,000 kPa (transmission) to around 400 kPa (high-pressure distribution). For flows from distribution into transmission, custody transfer metering owned by the distribution operator would be required, together with compression to step gas up to transmission pressure.

Distribution networks are predominantly residential however the average gas use per household is relatively low. In contrast, industrial users provide a more consistent and reliable source of demand. Key considerations for both are presented below:

Distribution injection

Distribution-level injection generally offers lower capital costs and quicker connection as it has lower pressure and infrastructure requirements than transmission injection. It can closely match production with nearby industrial demand, but producers must meet strict gas-quality, odourisation, and monitoring requirements. Injection may be limited by local network capacity, and if demand is low, reverse flow into the transmission system may be needed which is subject to technical feasibility, approvals, and potential extra infrastructure. Compliance with both the local distribution network operator and AEMO standards is essential.

Transmission injection

Transmission-level injection provides statewide access to industrial and generation customers and can accommodate large, steady biomethane flows. However it requires higher compression, more expensive custody-transfer metering, longer approval timelines, and strict gas-quality compliance with both the transmission network owner and AEMO/APA. Given its greater ability to balance flows and manage variability, it is best suited to projects producing multi-TJ per day of biomethane.

6.3 Other considerations

6.3.1 Food versus fuel

While biomass streams outlined in this report present opportunities for emissions reduction and regional economic development, they can intersect with broader food-versus-fuel and land-use concerns. International experience shows that biofuel production can place pressure on prime agricultural land when it relies on dedicated food or feed crops. However the feedstocks assessed in this report do not rely on food-grade crops or high-value agricultural land. They are predominantly derived from residues, waste streams and gaseous by-products, which reduces the likelihood of creating competition with food markets. Acknowledging these considerations helps ensure a balanced approach to bioenergy development in Victoria while maintaining food security and productive land use.

Table 6–3: Overview of environmental factors considered

Item	Impact	Comment
Transport	Medium	Transport emissions may have a moderate impact. However they have been excluded as part of this study,as a uniform travel distance has been assumed across all LGAs and heir contribution will be proportional to feedstock volume.
Leakage from plant	Low	The leakage from the plant is assumed to be negligible.
Displacement of natural gas	High	Emissions abatement (avoided emissions) is estimated by calculating how much natural gas is displaced by the volume of biomethane injected into the grid, using the emission factors below (DCCEEW, 2024): - Natural gas distributed in pipeline: 51.53kg CO₂-e/GJ - Biomethane: 0.13kg CO₂-e/GJ As biogenic emissions from the feedstock are avoided, biomethane has a significantly lower emissions factor compared with natural gas.

6.3.2 Environmental

Environmental benefits of a potential biomethane facility were based on its emissions abatement potential. Emissions abatement potential in tonnes of carbon dioxide equivalent (tCO₂-e) is considered as an indicator for the environmental performance with below Table 6–3 providing a summary of the contributing factors for calculating Scope 1 and 2 related carbon savings. Scope 3 emissions are not included in this assessment.

As shown in Table 6–4 over 2 million tCO₂-e could be abated statewide through the production of biomethane, increasing to 2.5 million tCO₂-e by 2035. Assuming 4 tCO₂-e per car per year, Table 6–5 provides an estimate of the equivalent number of cars removed from the road based on the emissions reduction.

Table 6–4: Statewide summary of emissions abatement potential by region

Region	2025 (tCO ₂ e)	2035 (tCO ₂ e)
Barwon South West	171,885	204,963
Gippsland	65,417	76,363
Grampians Central West	549,948	697,202
Goulburn Valley	191,842	239,800
North East	43,809	53,150
Loddon Mallee	404,394	508,969
Metropolitan	655,447	798,167
Total	2,082,742	2,578,613

Table 6–5: Equivalent number of cars removed from the road based on emissions reduction potential

Region	2025 (no. cars removed)	2035 (no. cars removed)
Barwon South West	42,971	51,241
Gippsland	16,354	19,091
Grampians Central West	137,487	174,301
Goulburn Valley	47,961	59,950
North East	10,952	13,288
Loddon Mallee	101,099	127,242
Metropolitan	163,862	199,542
Total	520,686	644,653

6.3.3 Social acceptance

Social licence to operate is the approval from stakeholders and the community of a company or facility's operations. Alongside the regulatory approvals a company or facility must obtain including environmental permissions (EPA Victoria) or planning permits (local government), it is regarded as an informal licence which is granted by the community based on trust and confidence as opposed to legal or regulatory mandates. It can be more difficult to obtain social licence in metropolitan areas when compared to regional areas due to higher population density, diversity in stakeholder expectations, as well as increased complexity and scrutiny. Community engagement is often a necessary requirement during the project planning stage in order to obtain the required approvals before development and construction can take place.

6.3.4 Policy

Existing and proposed changes to government policies may affect the viability of biomethane projects. A list of relevant policies are outlined below:

- [Renewable Gas Certification](#)
- [Australian Carbon Credit Unit \(ACCU\) Scheme](#)
- [Guarantee of Origin \(GO\)](#)
- [Product GO \(PGO\)](#)
- [Renewable Electricity GO \(REGO\)](#)
- [NGERS update – Biomethane](#)
- [AS4564 biomethane standards update](#)

6.3.5 Co-products and incentives

Producing valuable co-products through anaerobic digestion can significantly improve both the financial and environmental performance of biomethane projects. In addition to renewable gas, the process yields nutrient-rich digestate and renewable (green) CO₂, which provide additional revenue streams and environmental benefits, strengthening the overall business case for investment.

Digestate

Digestate is the nutrient-rich by-product remaining after anaerobic digestion of organic materials such as animal manure, crop residues, wastewater sludge, and food waste. It presents a valuable opportunity to recover and recycle nutrients (e.g. nitrogen, phosphorus, and potassium) back to agricultural land therefore reducing reliance on synthetic fertilisers and supporting circular economy outcomes. When properly treated, digestate can improve soil structure, increase organic matter content, and reduce nitrogen leaching risks compared to untreated manures or synthetic fertilisers (Drosg et al., 2015). Its composition, however, is highly dependent on feedstock type and post-treatment processes such as pasteurisation.

While digestate can represent a secondary revenue stream for biomethane projects, the current market remains underdeveloped with limited commercial uptake largely due to handling, treatment, and compliance costs.



In Victoria, digestate is regulated as a "reportable priority waste" under EPA waste code N205. Producers must meet contamination thresholds and undertake pasteurisation process to eliminate microbial risks such as E. coli, ensuring the product is safe for land application. These regulatory guidelines establish a clearer framework for proponents (and operators) regarding the use of digestate, while imposing duties around environmental safety, transport, and traceability. In New Zealand, digestate has been valued at around \$20/tonne with potential to contribute up to 40% of the revenue generated by biomethane production based on "Unlocking New Zealand's Biomethane Potential" study (Beca, 2021).

Green carbon dioxide

In biomethane production, the upgrading process involves removing impurities such as CO₂, H₂S, and moisture from raw biogas. This CO₂ (typically comprising 25–35% of biogas volume) can be captured and refined into a valuable by-product. When high-purity CO₂ is recovered using technologies such as cryogenic separation or membrane-based upgrading, it can meet food-grade or industrial-grade standards, offering a significant revenue stream. Biogenic CO₂ is considered carbon-neutral, making it attractive for applications in food and beverage production, dry ice manufacturing, welding, and greenhouse enrichment.

Based on the study 'Unlocking New Zealand's Biomethane Potential' completed by Beca (2021), market prices for food-grade CO₂ vary in NZ typically range from \$200 to \$500 per tonne, depending on quality, regional supply chains, and distribution logistics. However, the opportunity to monetise green CO₂ depends on project scale, technology configuration, and local market demand. While smaller anaerobic digestion facilities may not justify the capital expenditure for CO₂ recovery systems, larger plants may find CO₂ valorisation enhances commercial viability.

Australian carbon credit units (ACCU)

ACCUs are Australia's primary carbon offset instrument, with each ACCU representing one tonne of CO₂-equivalent emissions avoided or stored through approved projects. Issued by the Clean Energy Regulator (CER), ACCUs incentivise emissions reduction across farms, businesses, and communities, while serving as tradable financial assets for both voluntary offsetting and regulatory compliance.

For biomethane facilities in Victoria, accessing ACCUs through methane capture and displacement of fossil fuels can significantly enhance economic viability. By monetising emissions reductions, operators can create an additional revenue stream, offset operational costs, and improve project returns, making biomethane production more competitive and attractive in the renewable energy market. In an agricultural setting, if ACCUs are being considered as an incentive for farmers, the once-off immediate revenue they provide must be weighed against the loss of ongoing opportunities to make potential net-zero claims, which could influence future access to markets and financing.

Sensitivity analysis of potential revenue streams

A sensitivity analysis of potential additional revenue streams was conducted. The most significant contributors to this reduction are revenues from ACCUs and digestate sales, with recovered green CO₂ contributing to a lesser extent as outlined in Table 6–6.

Results of the sensitivity analysis demonstrate the potential decrease in LCOE via additional revenue streams, estimated at an approximate 13–22% reduction. This is influenced by factors including plant size and feedstock mix which directly impact the scale of the additional revenue streams to be realised. For example, the calculated LCOE of LGAs with higher throughputs were observed to be more sensitive to these additional revenue streams. It is important to consider that additional capital investment and operational expenditure may be necessary to realise these benefits.

Overall the analysis highlights that supportive policy settings (e.g. ACCU Scheme, Guarantee of Origin for renewable gas, and similar) and the monetisation of co-benefits or by-products (such as revenue from ACCUs, sale of digestate as a soil conditioner, or utilisation of green CO₂ for industrial applications) can play a critical role in enhancing the economic viability of biomethane projects.

The cost assumptions in Table 6-6 are presented in AUD and should be treated as indicative only to inform the sensitivity analysis of potential revenue streams. These revenue streams require further investigation to validate assumptions and assess their applicability. Due to their uncertainty, proponents of potential biomethane facilities should conduct detailed case-by-case investigations to determine a more accurate LCOE specific to their project.

Table 6–6: Assumptions related to potential additional revenue streams

Revenue stream	Assumptions	Reference
Digestate	Assumed 40% of feedstock amount is recovered based on Future Fuel, \$20/tonne digestate	FFCRC (2022), BECA (2019)
Green CO ₂	Assumed 20% of biogas volume, \$200/tonne CO ₂ and 0.0124 Tonnes CO ₂ per GJ biomethane	BECA (2019)
ACCU	Assumed \$2.5/GJ biomethane produced	DEECA and Oakley Greenwood (2025)

7. Final remarks

This Summary Report provides an overview of the Technical Reports which were delivered as part of the Victorian Biomass and Biomethane Potential Assessment project.



Stage One and Stage Two

Stage One and Stage Two identified the total theoretical and practically available biomass residues (and resulting biomethane potential) available in Victoria, forecasting this from 2025 to 2045.

A total of over 6.3 million tonnes of residue is estimated to be practically available in Victoria in 2025 across all the different residue sources, which is projected to increase to over 9 million by 2045. The waste sector is responsible for the greatest volume of practically available residues, which is estimated at to grow to approximately 4.7 million tonnes by 2045, followed by broadacre (~2.2 million tonnes in 2025 growing to 3.7 million tonnes by 2045).

The total statewide practically available biomethane potential is estimated to be approximately 47 PJ in 2025 and is forecasted to increase to over 69 PJ by 2045. The greatest opportunity for biomethane potential is from broadacre with approximately 24.6 PJ of biomethane potential estimated in 2025 which is projected to grow to just over 40 PJ in 2045.

Stage Three

Stage Three of the project identified potential locations for development of a biomethane production facility. A commercial criteria to assess the commercial viability of potential locations was developed and identified three regional LGAs (Ararat, Moira, Horsham) and two metropolitan groupings (Metropolitan South, Metropolitan West).

Stage Four

An LCOE assessment was conducted on the identified high potential locations as part of Stage Four. The results from this assessment indicate that the LCOE for biomethane for the investigated high potential locations ranged from \$28.1 to \$33.6 per GJ in 2025, and \$26.7 to \$32.1 per GJ in 2035 (expressed in real 2025 terms). This assessment provides an indicative high-level LCOE estimate based on available statewide data and assumptions, and does not account for potential variations due to technology advancements, exchange rate changes, or cost escalations. While it offers preliminary insights into the cost and potential of biomethane in Victoria, more detailed case-specific modelling is required to support potential business case development.

While upgrade of biogas to biomethane and injection into the grid is the core focus of this study, it is important to note that there were strong opportunities for behind-the-meter usage of biogas.

This study aims to enable development in the biomethane (and bioenergy) sector by building on previous assessments undertaken in Victoria and provide an up-to-date statewide estimate of biomass residues and realistic biomethane potential in Victoria.

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Yarra Valley Water ReWaste Facility - Wollert, Victoria (image source: Yarra Valley Water)

