Ironbark Sustainability

Shire of Strathbogie Community Emissions Profile Report

Prepared for
Shire of Strathbogie

Version	Author	Date	Description of changes
V0a	Jenny Frieden	5/3/2019	First Draft
V0b	Hannah Snape	13/03/2019	Review
V1a	Jenny Frieden	14/03/2019	Final draft for release
V1b	Jenny Frieden	2/04/2019	Added definitions of agricultural emissions types (especially enteric fermentation).

Prepared by
Ironbark Sustainability
Suite 8, 70-80 Wellington St, Collingwood 3066
ABN: 51 127 566 090
Ph: 1300 288 262 | info@realaction.com.au | www.realaction.com.au

About Ironbark Sustainability
Ironbark Sustainability is a specialist consultancy that works with government and business around Australia by assisting them to reduce energy and water usage through sustainable asset and data management and on-the-ground implementation.

Ironbark has been operating since 2005 and brings together a wealth of technical and financial analysis, maintenance and implementation experience in the areas of building energy and water efficiency, public lighting and data management. We pride ourselves on supporting our clients to achieve real action regarding the sustainable management of their operations.

Our Mission
The Ironbark mission is to achieve real action on sustainability for councils and their communities.

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1. Abbreviations and Definitions

Term	Definition
ABS	Australian Bureau of Statistics
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences (previously Australian Bureau of Agricultural and Resource Economics or ABARE)
Activity Data	Activity data is a quantitative measure of a level of activity that results in GHG emissions taking place during a given period of time (e.g., volume of gas used, kilometres driven, tonnes of solid waste sent to landfill, etc.)
AEC	Australian Energy Council
AFOLU	Agriculture, Forestry, and Other Land Use
C40	C40 Cities Climate Leadership Group
CCA	Climate Change Authority
CCP	Cities for Climate Protection
cCR	Carbon*n* Climate Register
CH_4	Methane
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalent. The universal unit of measurement to indicate the global warming potential (GWP) of each GHG, expressed in terms of the GWP of one unit of carbon dioxide. It is used to evaluate the climate impact of releasing (or avoiding releasing) different GHGs on a common basis.
Global Covenant of Mayors	Global Covenant of Mayors for Climate & Energy is a coalition of city leaders addressing climate change by pledging to reduce their greenhouse gas emissions, tracking their progress and preparing for the impacts of climate change. It was formed through a merger of the Compact of Mayors and the Covenant of Mayors.
DNSP	Distribution Network Service Provider (Electricity Network)
Emissions Factor	An emissions factor is a measure of the mass of GHG emissions relative to a unit of activity.
Enteric fermentation	Enteric fermentation is a microbial digestive process that occurs in the digestive tract of ruminant animals like cattle and sheep and produces methane emissions.
ERF	Emissions Reduction Fund
ENA	Electricity Networks Australia
GHG	Greenhouse Gas
GHG Protocol	The Greenhouse Gas Protocol, developed by World Resources Institute and World Business Council on Sustainable Development, sets the global standard for how to measure, manage, and report GHG emissions.
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GRP	Gross Regional Product
GSP	Gross State Product
Gt	Gigatonne

GWP	Global Warming Potential. The Global Warming Potential was developed to allow comparisons of the global warming impacts of different gases. Specifically, it is a measure of how much energy the emissions of one tonne of a gas will absorb over a given period of time, relative to the emissions of one tonne of carbon dioxide
ICLEI	International Council for Local Government Initiatives
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
kt	Kilotonne
Mt	Megatonne
MCF	Methane Correction Factor
SDT	Science-derived Targets
SEIFA	Socio-Economic Indexes for Areas
WRI	World Resources Institute

1.1 City, Community and Council

Please note that throughout this report the terms city and municipality are used interchangeably to refer to the total area within a given municipal boundary and under the jurisdiction of the presiding local government of that area. We understand that often municipalities in Australia are not considered cities by typical definitions, but in order to remain consistent with language contained in the Global Protocol for Community-scale Greenhouse Gas Emissions Inventories (GPC), the term city has been used in some sections of the report.

The term "community" refers to the individuals and businesses that reside and work within the city or municipality.

Where the term "Council" is used, it refers to the corporate entity that governs and manages the operations of the city or municipality.

2. Executive Summary

This report provides an overview of the community greenhouse gas emissions profile for Shire of Strathbogie for the 2017/18 financial year. The development of this profile is the first step in the preparation of a full process for mitigating climate change.

This community emissions profile has been prepared in compliance with the Global Protocol for Community-scale Greenhouse Gas Emissions Inventories (GPC). In line with GPC requirements, this profile includes an emissions total, as well as exploring emissions through a number of filters: sector, gas type, and scope.

The total emissions summary is provided below (Table 1). Strathbogie's community emissions have been calculated as 449 kt CO_2-e for the financial year 2017/18. The largest source of community emissions by sector in Strathbogie is stationary energy from electricity, which accounts for 45% (200 kt CO_2-e) of total emissions and is mainly from electricity consumed by buildings and facilities. The other major source of emissions is agriculture, accounting for just over a third (149 kt CO_2-e) of emissions. On-road transportation is responsible for 15.5% of emissions, stationary energy from gas accounts for 6% of emissions, emissions from solid waste accounts for 0.4% and wastewater 0.1%.

Table 1: Total emissions summary for Strathbogie

Category	Emissions (t CO_2e)	Percentage (%)
Stationary Energy – Electricity	200,264	44.7%
Stationary Energy - Gas	26,524	5.9%
Transportation	69,436	15.5%
Waste	1,866	0.4%
Wastewater	338	0.1%
Agriculture	149,481	33.4%
Total	447,909	100%

Around 53% of Strathbogie's community emissions are scope 1, which refers to emissions that are released at the time of the activity, occurring wholly within the municipal boundary. Agriculture, on-road transport, natural gas consumption and waste water treatment are the main sources of scope 1 emissions.

Strathbogie also has a significant proportion of scope 2 emissions (42%), which refers to emissions that are released as a result of grid-supplied energy, generally from outside of the municipal boundary to heat, steam and/or cool within the boundary.

It is important to note that while this profile is compliant with the international standard (GPC), and covers emissions from the entire community, Council only has a limited amount of control and influence over many of the emissions sources. While Council can continue to advocate and assist the broader community to implement energy efficiency and renewable energy projects, a cross-sectoral approach – with residents, businesses and other levels of government – is required for substantial emissions reductions throughout the municipality.

Rather than use this profile as a baseline upon which to develop targets and measure the impact of climate change mitigation actions by Council, targeted monitoring should instead be used to measure and report the impact of these items.

Recommended next steps from here are:

- Work with other councils, greenhouse alliances, state government and stakeholders, such as ICLEI Oceania and Ironbark, to source improved and updated data that can feed into future profiles and improve accuracy.
- Use Strathbogie's community emissions profile and associated information to engage with community stakeholders including key industrial emitters, residents, other levels of government and others to consolidate and focus action on the identified most effective pathways to reductions.
- Quantify potential emissions reductions available and seek most efficient pathways to interventions through evidence-based climate planning.
- Continue to support climate mitigation and adaptation interventions and report the impact of these activities through targeted monitoring.
- Consider engaging with cohort councils (i.e. councils with similar emissions profiles) to share learnings and gain efficiencies in emissions reduction interventions.

3. Introduction

3.1 Background

Sourcing and analysis of community GHG emissions data has long been a cause of frustration for Australian councils. A decade ago, hundreds of councils had access to "top-down" community data provided by ICLEI Oceania based on ABS (Australian Bureau of Statistics) and ABARES (Australian Bureau of Agricultural and Resource Economics and Sciences) data. However, the development of this data ceased in 2009 with the closure of the Cities for Climate Protection funding.

Over the last 3 years, Ironbark has been working with Australian councils, ICLEI Oceania, the Global Covenant of Mayors for Climate & Energy, Distribution Network Service Providers (DNSPs) and other data providers. Through these collabroations we have gathered data to develop community greenhouse gas profiles for Australian councils that are compliant with international reporting standards.

This has included the development and submission of GPC-compliant community inventories for the purpose of complying with the Global Covenant of Mayors.

The development of the Strathbogie community emissions profile has been undertaken by a team from Ironbark Sustainability who have extensive experience working at and with councils. What's more, members of the team have been certified through the World Bank's City Climate Planner Certificate Program, a training and professional certificate program that aims to increase the global talent base of climate planning professionals.

3.2 Shire of Strathbogie

The Shire of Strathbogie is located in north-eastern Victoria, around 150 km from Melbourne. It is bordered to the east by the Strathbogie Ranges and to the west by the Nagambie Lakes.

It is a rural shire, with agriculture being dominated by wool, grain, cattle and vineyards. Tourism is also an increasingly significant industry.

Figure 1: Shire of Strathbogie

For the purpose of this community emissions profile, the population of the Shire of Strathbogie was estimated as 10,329 for the financial year 2017/18.

Council has a number of emissions reduction projects currently underway or recently completed. For example, Strathbogie Shire Council is working with Tesla on installing an innovative supercharger station for electric vehicles in Euroa. In 2017/18, a solar bulk buy program was organised for residents, businesses, clubs, farms, weekenders, and off-grid properties. More than half a megawatt of solar was purchased and installed on Strathbogie Shire rooftops.

Council is also currently developing Sustainable Strathbogie 2030. This strategy addresses greenhouse gas emissions and sets out targets for both Council's own operations and more broadly community emissions across the shire. The blueprint for the Sustainable Strathbogie 2030 strategy is drawn from:

- Strathbogie Shire Council Plan 2017 - 2021
- Protecting Victoria's Environment: Biodiversity 2037 (Victorian State Government)
- Goulburn Broken Catchment Biodiversity Strategy 2016-2021 (GBCMA)
- Victoria's Renewable Energy Roadmap 2015 (Victorian State Government)
- Victoria's Climate Change Adaptation Plan 2017 – 2020
- United Nations Sustainable Development Goals 2015 – 2030

3.3 Use of this Profile

It is important that this profile is read and used appropriately. It should be stressed that while this profile contains a snapshot of the GHGs allocated to activity within Strathbogie, it is not suitable as a monitoring tool for measuring the success of targets or actions. Instead, this profile can be used as a tool for understanding the key emissions sources within Strathbogie, focussing efforts, planning for emissions reductions, seeking funding and engaging with key stakeholders.

The GPC values completeness over accuracy, which ensures that when profiles are compiled across municipalities, emissions are not double-counted nor unaccounted for. This means that it is sometimes preferable to use state or national level data scaled down to a municipal level, over more detailed data that may not be complete or correctly aligned to municipal boundaries.

This profile contains a mixture of modelled and detailed data. As new data sources become available and methods for calculating emissions become more sophisticated, the calculated profile for Strathbogie will change, regardless of actual changes to emissions.

4. Methodology and GPC Compliance

The GPC requires cities to measure and disclose a profile of GHG emissions and to total these emissions using two distinct but complementary approaches. One captures emissions from both production and consumption activities taking place within the city boundary, including some emissions released outside the city boundary. The other categorises all emissions into "scopes," depending on where they physically occur. Separate accounting of emissions physically released within the city boundary should be used for aggregation of multiple city inventories in order to avoid double counting.

The GPC enables a city's emissions to be broken down into the five sectors (where relevant data is available), summarised in Table 2.

Table 2: Sector descriptions used for GPC profiles

Sector	Description
Stationary Energy	Stationary energy sources are one of the largest contributors to a city's GHG emissions. These emissions come from the combustion of fuel in residential, commercial and institutional buildings and facilities, and manufacturing industries and construction, as well as power plants to generate grid-supplied energy. This sector also includes fugitive emissions, which typically occur during extraction, transformation, and transportation of primary fossil fuels.
Transportation	Transportation covers all journeys by road, rail, water and air, including inter-city and international travel. GHG emissions are produced directly by the combustion of fuel or indirectly by the use of grid-supplied electricity. Collecting accurate data for transportation activities, calculating emissions and allocating these emissions to cities can be a particularly challenging process. To accommodate variations in data availability, existing transportation models, and profile purposes, the GPC offers additional flexibility in calculating emissions from transportation.
Waste (solid waste and wastewater)	Waste disposal and treatment produces GHG emissions through aerobic or anaerobic decomposition, or incineration. GHG emissions from solid waste are calculated by disposal route, namely landfill, biological treatment and incineration and open burning. If methane is recovered from solid waste or wastewater treatment facilities as an energy source, it is reported under Stationary Energy. Similarly, emissions from incineration with energy recovery are reported under Stationary Energy.
Industrial Processes and Product Use (IPPU)	GHG emissions are produced from a wide variety of non-energy related industrial activities. The main emission sources are releases from industrial processes that chemically or physically transform materials (e.g., the blast furnace in the iron and steel industry, and ammonia and other chemical products manufactured from fossil fuels and used as chemical feedstock). During these processes, many different GHGs can be produced. In addition, certain products used by industry and end-consumers, such as refrigerants, foams or aerosol cans, also contain GHGs which can be released during use and disposal.

Agriculture, Forestry and Other Land Use (AFO LU)	Emissions from the Agriculture, Forestry and Other Land Use (AFOLU) sector are produced through a variety of pathways, including livestock (enteric fermentation and manure management), land use and land use change (e.g., forested land being cleared for cropland or settlements), and aggregate sources and non-CO_2 emission sources on land (e.g., fertilizer application and rice cultivation). Given the highly variable nature of land-use and agricultural activity across geographies, GHG emissions from AFOLU are amongst the most complex categories for GHG accounting.

The GPC provides overarching and sector-specific reporting guidance for sourcing data and calculating emissions. Councils should select the most appropriate methodologies based on the purpose of their profile, availability of data, and consistency with their country's national profile and/or other measurement and reporting programs in which they participate. The GPC does not require specific methodologies to be used to produce emissions data; rather it specifies the principles and rules for compiling a city-wide GHG emissions profile. Where relevant, the GPC recommends using methodologies aligned with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Ironbark, in partnership with HuxConnect, has developed an activity data tool with methods that have been approved by ICLEI Oceania as being GPC-compliant. Emissions are calculated from a mix of state, national and local data, and are defined by gas type as either carbon dioxide (CO_2), methane (CH_4) or nitrous oxide (N_2O). Emissions are then converted into carbon dioxide equivalent (CO_2-e) for comparison and to measure total impact.

The Strathbogie Shire profile complies with GPC's BASIC levels of GHG emissions accounting, which has been used as a first step in greenhouse gas accounting by municipalities around the world. The BASIC level of reporting includes emissions sources that are relevant to almost all municipalities, namely, stationary energy, transport and waste.

Strathbogie Shire has also requested the inclusion of agricultural emissions, which is an additional emission source to the GPC BASIC profile. This is a recent addition to Ironbark's Activity Data Tool, making Strathbogie a leading council in this area.

The Strathbogie Shire community emissions profile includes the following emissions:

- Scope 1 emissions from stationary energy sources (excluding energy production supplied to the grid)
- Scope 1 emissions from transportation sources
- Scope 1 emissions from agriculture (enteric fermentation, manure management and agricultural soils)
- Scope 1 emissions from waste sources (excluding emissions from imported waste)
- Scope 2 emissions from stationary energy sources and
- Scope 2 emissions from transportation
- Scope 3 emissions from treatment of exported waste
- Scope 3 emissions from transmission and distribution losses from stationary energy sources

Please note that this emissions profile does not capture emissions from the following sources:

- Forestry and other land use
- Industrial processes and product use

4.1 Disclaimer

This profile has been developed in accordance with the GPC by experts certified under the City Climate Planner Certificate Program.

The GPC is designed to promote best practice GHG accounting and reporting that was developed through an inclusive multi-stakeholder process. This involved input from experts from nongovernmental organisations, governments, and others convened by WRI, C40 and ICLEI.

Data has been sourced from a variety of third parties (such as electricity providers and the CSIRO). While every effort has been made to use data from reputable sources and a thorough quality assurance process undertaken, neither Council nor Ironbark Sustainability are responsible for data inaccuracies by third parties.

4.2 IPCC Greenhouse Gas System Boundary

To comply with the GPC, and indeed for any best-practice GHG emissions profile development, a council (or organisation or sub-national body) must first define a profile boundary. This identifies the geographic area, time span, gases, and emission sources, covered by a GHG profile. Any geographic boundary may be used for the emissions profile.

For this profile, the boundary aligns with the administrative boundary of Shire of Strathbogie and accounts for the GHG emissions in the 2017/18 financial year. It covers the seven gases covered by the Kyoto Protocol.

Activities taking place within Strathbogie can generate GHG emissions that occur inside the municipal boundary as well as outside the municipal boundary. To distinguish between them, the GPC groups emissions into three categories based on where they occur: scope 1, scope 2 or scope 3 emissions. Definitions are provided in Figure 2, based on an adapted application of the scopes framework used in other international GHG protocol and standards.

Scope	Definition
Scope 1	GHG emissions from sources located within the city boundary
Scope 2	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary

Figure 2: Emissions scopes definitions

Municipalities, by virtue of their size and connectivity, inevitably give rise to GHG emissions beyond their boundaries. Measuring these emissions allows cities to take a more holistic approach to tackling climate change by assessing the GHG impact of their supply chains and identifying areas of shared responsibility for upstream and downstream GHG emissions.

The GPC also includes scope 3 accounting for a limited number of emission sources, including transmission and distribution losses associated with grid-supplied energy, waste disposal and treatment outside the city boundary and transboundary transportation.

The scopes framework helps to differentiate emissions occurring physically within the city (scope 1), from those occurring outside the city (scope 3) and from the use of electricity, steam, and/or heating/cooling supplied by grids which may or may not cross city boundaries (scope 2). Scope 1 emissions may also be termed "territorial" emissions because they occur discretely within the territory defined by the geographic boundary.

Figure 3 illustrates which emission sources occur solely within the geographic boundary established for the profile, which occur outside the geographic boundary, and which may occur across the geographic boundary.

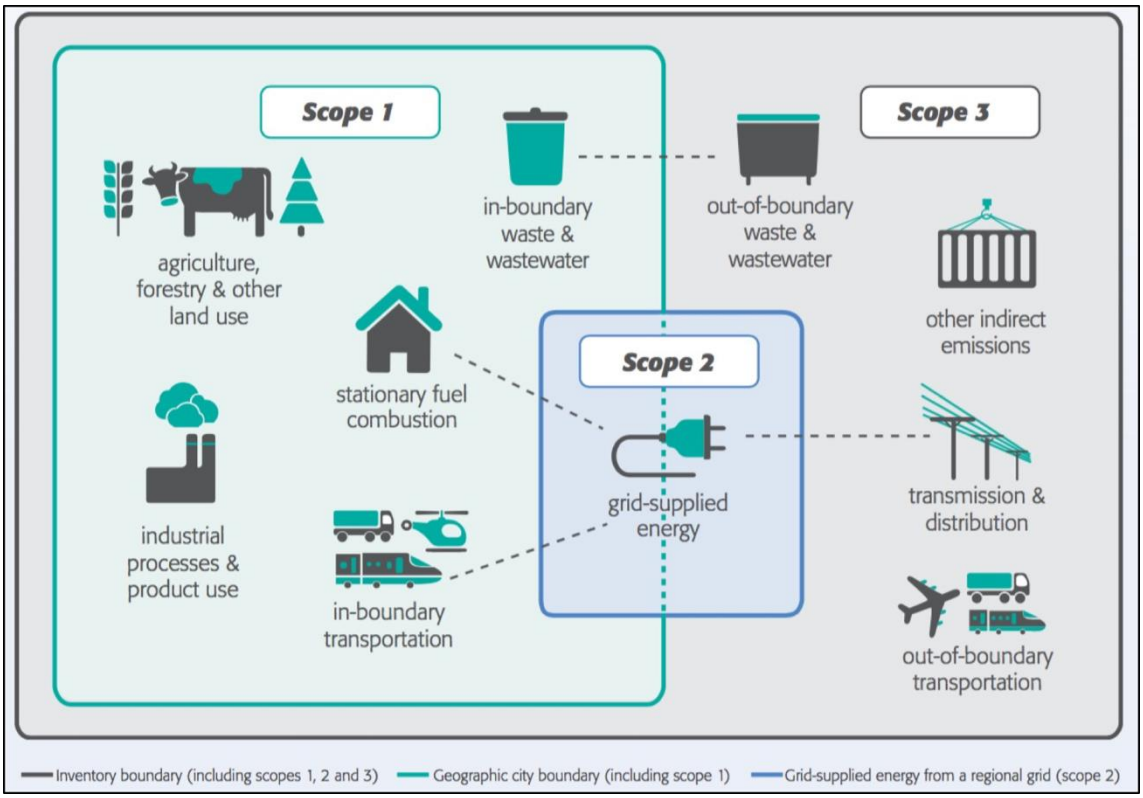

Figure 3: Representation of emission scopes and scope boundaries

5. Total Emissions Profile

5.1 Emissions Breakdown

Strathbogie's community emissions for the financial year 2017/18 have been calculated as 449 kt CO_2-e (carbon dioxide equivalent).

Table 3: Strathbogie's community emissions summary according to sector

Category	Emissions (t CO_2e)	Percentage (%)
Stationary Energy – Electricity	200,264	44.7%
Stationary Energy - Gas	26,524	5.9%
Transportation	69,436	15.5%
Waste	1,866	0.4%
Wastewater	338	0.1%
Agriculture	149,481	33.4%
Total	447,909	100%

As seen in Table 3 and Figure 4, the largest source of total GHG emissions is stationary energy, which includes residential buildings; commercial and institutional facilities; and manufacturing and construction industries.

Agriculture produced the next highest emissions per category, 33% of total emissions or 149 kt CO_2-e. The livestock emissions sources that have been included in this profile arise from enteric fermentation and manure management of sheep, cattle and pigs, which generally account for the majority of livestock emissions. Enteric fermentation occurs when microbes in the digestive tract of ruminants decompose food, while 'manure management' emissions arise as livestock manure breaks down. Agricultural soils emissions from application of nitrogen-based fertilizers are also included. Note that some emissions from the agriculture sector will be captured in other sections of the profile, for example use of farm machinery is captured in transportation for tractor fuel use and stationary energy for farm electricity use.

On-road transportation produced 15.5% total emissions or 69 kt CO_2-e. No emissions have been included under transport for rail, aviation, water transport or other off-road transportation sources as this data was not readily available. Where transport sources are responsible for emissions through use of electricity, such as rail, these emissions have been included under stationary energy.

Waste sources produced less than 1% of total emissions at 2.2 kt CO_2-e, largely from disposal of solid waste (0.4%) and also from biological treatment of wastewater (0.1%) including sewerage.

Note that emissions from forestry, land use change and industrial processes and product use were out of the scope of this project.

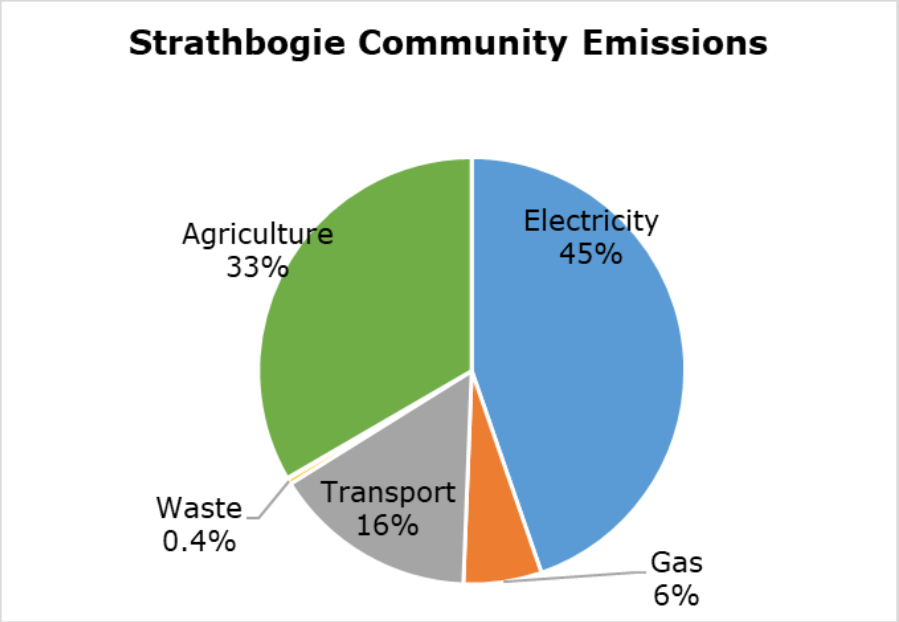

Figure 4: Strathbogie community emissions breakdown by source

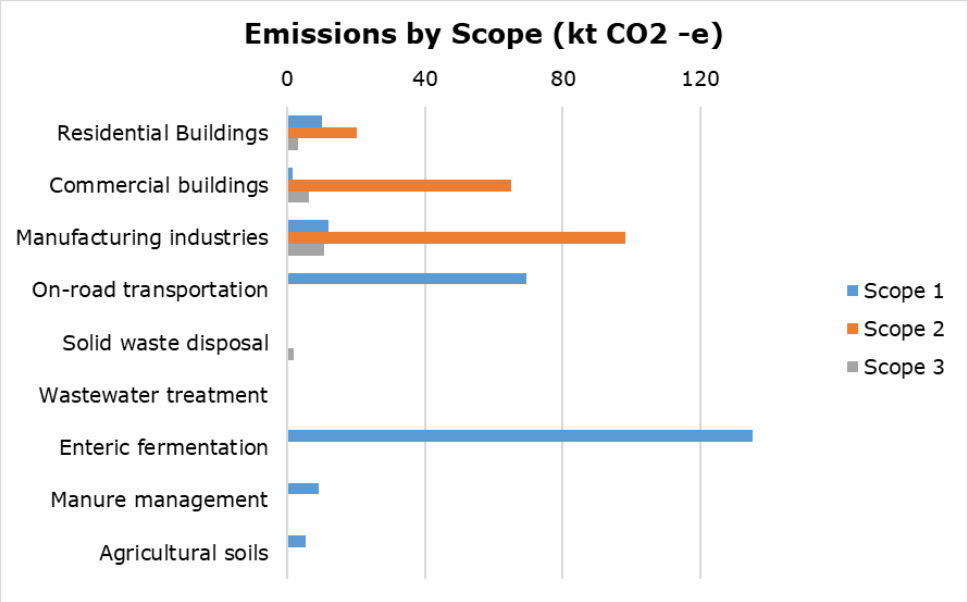

Figure 5: Strathbogie community emissions breakdown by scope and subsector

Around 53% of Strathbogie's community emissions are scope 1, which refers to emissions that are released at the time of the activity, occurring wholly within the municipal boundary. Agriculture, on-road transport, natural gas consumption and waste water treatment are the sources of scope 1 emissions considered here. Note that the emissions from wastewater treatment are low (<1 kt CO_2-e) and are therefore not visible in the graph above.

Strathbogie also has a significant proportion of scope 2 emissions (42%), which refers to emissions that are released as a result of grid-supplied energy, generally from outside of the municipal boundary to heat, steam and/or cool within the boundary.

Solid waste disposal is considered a scope 3 emission, because waste generated within the municipal boundary is treated outside of the boundary. The other source of scope 3 emissions reported here are electricity and gas distribution losses.

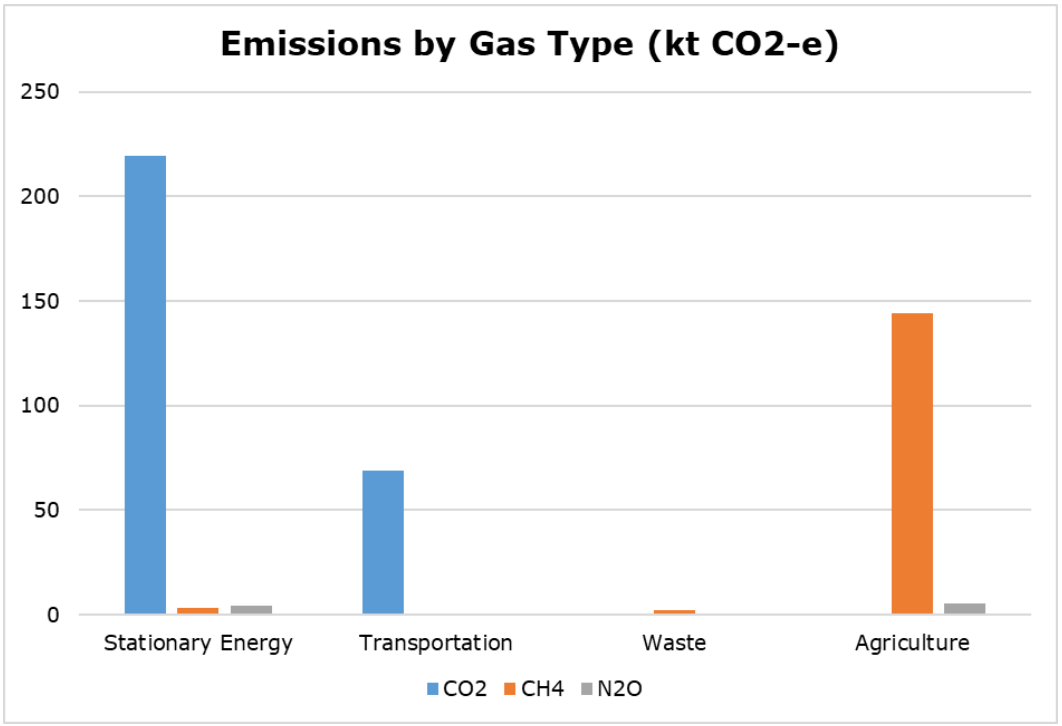

Figure 6: Strathbogie emissions breakdown by gas type

Figure 6 compares the emissions by source and also shows the amount of each GHG that is produced either directly or indirectly through activities within the municipality. Gases are measured in carbon dioxide equivalent to ensure they are comparable. Both stationary energy and transportation are largely responsible for releasing carbon dioxide (CO_2) with trace amounts of methane (CH_4) and nitrous oxide (N_2O), whilst emissions from agriculture and waste are mostly released as methane.

5.2 Completeness

Data collection is an integral part of developing and updating a community emissions profile. Data will likely come from a variety of sources and will vary in quality, format, and completeness. In many cases, it needs to be adapted for the purposes of the profile. The GPC recognizes these challenges and sets out data collection principles and approaches. It also provides guidance on gathering existing data, generating new data and adapting data for profile use.

According to the GPC, a community emissions profile shall follow the principles of relevance, completeness, consistency, transparency and accuracy. With regards to completeness, an emissions profile should account for all required emissions sources within the profile boundary and any exclusion of emission sources shall be justified and clearly explained.

To accommodate for limitations in data availability and differences in emission sources between cities, the GPC requires the use of "notation keys", as recommended in IPCC Guidelines. These are provided in Figure 7.

Notation key	Definition	Explanation
IE	Included Elsewhere	GHG emissions for this activity are estimated and presented in another category of the inventory. That category shall be noted in the explanation.
NE	Not Estimated	Emissions occur but have not been estimated or reported; justification for exclusion shall be noted in the explanation.
NO	Not Occurring	An activity or process does not occur or exist within the city.
C	Confidential	GHG emissions which could lead to the disclosure of confidential information and can therefore not be reported.

Figure 7: Notation keys

Where notation keys are used for this profile, an accompanying explanation is provided to justify exclusions or partial accounting of GHG emission source categories.

The GPC gives councils the option of selecting between two reporting levels: BASIC or BASIC+. The **BASIC** level covers emission sources that occur in almost all councils (stationary energy, in-boundary transportation, and in-boundary generated waste). The calculation methodologies and data are more readily available for BASIC sectors. The **BASIC+** level has a more comprehensive coverage of emissions sources (BASIC sources plus IPPU, AFOLU, transboundary transportation, and energy transmission and distribution losses). BASIC+ sectors involve more challenging data collection and calculation procedures.

This profile satisfies the requirements of GPC BASIC with the addition of agriculture. Localised granular data has been sought where possible, however time spent seeking granular data and/or BASIC+ level data has been capped.

5.3 Data Accuracy and Completeness

Due to variances in the availability of some data there was the need to extrapolate and rely on assumptions in some cases.

The quality of data has been categorised and is outlined in the table below. Further information on the classifications is provided below:

High - Detailed Activity Data: denotes data that was directly available from a reliable source, such as energy billing data provided by Council.

Medium - Modelled activity data using robust assumptions: where more reliable data is not available granular data has been modelled.

Low - Highly modelled or uncertain activity data: denotes data that was modelled from a highly reliable source, such as the Australian Bureau of Statistics.

Overall, data accuracy for this emissions profile is considered to be medium, but compliant with the GPC BASIC requirements. Recommendations for improving data accuracy are at Section 6.

Table 4: Data accuracy classifications

Profile Key Parameters	Method Used	Data Reliability		
		Description	Activity data	Emissions factors
Basic Municipal				
BM1	BM1.1	Using ABS data for municipal characteristics	Detailed activity data	n/a
BM2	BM2.1	Using ABS data for municipal characteristics	Detailed activity data	n/a
Stationary Energy				
SE1	SE1.1	Deriving municipal emissions from scaled state-level data	Modelled activity data using robust assumptions	More general emission factors
SE2	SE2.1	Deriving municipal emissions from scaled state-level data	Modelled activity data using robust assumptions	More general emission factors
SE3	SE3.2	Using STC data from the REC registry to estimate total solar PV capacity	Detailed activity data	More general emission factors
SE4	NO	There are no thermal coal mines	n/a	n/a

Profile Key Parameters	Method Used	Data Reliability		
		Description	Activity data	Emissions factors
		occurring in this municipality		
Transport				
TR1	TR1.2	Using fuel sales scaled by vehicle type/fuel type registrations by municipality	Modelled activity data using robust assumptions	More general emission factors
Waste				
WS1	WS1.6	Using locally supplied data from total waste by category and state level data for commercial and industrial and construction and demolition	Detailed Activity Data	More general emission factors
WS2	WS2.3	Using locally supplied data from wastewater treatment plants	Detailed Activity Data	Default emission factors
Agriculture				
AG1	AG1.1	Using SA2 level agricultural commodities data applied to IPCC Tier 1 methods for enteric fermentation	Detailed Activity Data	Default emission factors
AG2	AG2.1	Using SA2 level agricultural commodities data applied to IPCC Tier 1 methods for manure management	Detailed Activity Data	Default emission factors
AG3	AG3.1	Using SA2 level agricultural commodities data applied to IPCC Tier 1 methods for agricultural soils	Detailed Activity Data	Default emission factors

As noted earlier, industrial processes and product use emissions have not been estimated for this profile. These are likely to be minor for the Shire of Strathbogie given the economic profile of the municipality. Emissions from forestry and land use change have also not been estimated.

Transportation emissions have been derived from fuel sales data. As no fuel data was available for Mangalore airport, aviation emissions from kerosene are not included in this profile. Given the small size of the airport, we expect these emissions to be minor. It is also worth noting that GPC aviation emissions are only considered to be scope 1 emissions if the plane takes off and lands within the municipality. If the plane originates outside of the municipality or lands outside of the municipality, they are considered scope 3 emissions.

Wastewater emissions have been calculated based on data provided for emissions at Nagambie and the advice from GV Water that the emissions at Avenal and Euroa are negligible.

More than 97% of agricultural emissions for which data is available at a national scale have been estimated, as outlined in Table 5 below. It's worth noting that the emissions from enteric fermentation (i.e. livestock gut microbial emissions) and manure management are calculated based on estimates of the numbers of the following livestock: sheep, dairy cattle, non-dairy cattle, pigs. Other livestock, such as chickens and horses, are not included. However, we consider that they would be a minor source of emissions for the municipality

The emissions referred to as 'agricultural soils' emissions are calculated from N-fertilizer application, which is the primary source of these emissions and accounts for the majority of emissions from cropping. However, recent farm-scale research suggests that liming emissions may be important for crops like wheat and canola[1], which are grown in Strathbogie. Unfortunately, GPC-compliant methods for estimating liming emissions have not yet been developed. However, when considered as a proportion of Strathbogie's total emissions, liming emissions are nonetheless expected to be minor.

[1] Soil Carbon and Greenhouse Gas Emissions Fact Sheet, GRDC, 2016
https://grdc.com.au/__data/assets/pdf_file/0032/229595/soil-carbon-and-greenhouse-gas-emissions-factsheet.pdf.pdf

Table 5: Total Australian Agricultural emissions by source and inclusion in this profile

Agricultural emissions source	Total Australian emissions (kt CO2e)	Proportion of Australian agriculture emissions	Included
Enteric Fermentation	14,678	80.22%	Yes
Manure Management	988	5.40%	Yes
Rice Cultivation	5.5	0.03%	No
Agricultural Soils	2,309	12.62%	Yes
Prescribed Burning of Savannas	Data is not available	NA	No
Field Burning of Agricultural Residues	39	0.21%	No
Liming	32	0.17%	No
Urea Application	246	1.34%	No
Other Carbon-containing Fertilisers	Data is not available	NA	No

6. Recommendations and Next Steps

The development of this GPC-compliant profile is the first step towards developing a full climate mitigation system that is based on data. This profile has been developed in a way that future improvements in data (be that around relevance, completeness, consistency, transparency and accuracy) can be easily adapted. This starting point is about developing a platform; reaching GPC BASIC compliance; ensuring there is no double-counting across council boundaries and that metrics are consistent across time.

As discussed in Section 3.3, this profile should not be used as a baseline for developing and monitoring targets and actions. Instead, it should provide a summary of the relative GHGs for which the Shire of Strathbogie is responsible and sit alongside, rather than above, these other items.

It is recommended that Council use this profile as a tool for understanding, planning, decision-making and engaging stakeholders in a program to reduce community greenhouse gas emissions. Together with a science-derived target, this will provide a valuable tool for Council in finding the most efficient emissions-reductions pathways and facilitating those reductions using appropriate interventions.

It is expected that there will be changes to this profile as more granular data becomes available and methods for calculating and allocating emissions become more sophisticated.

6.1 Proposed Next Steps

From here there are a number of actions that Council may undertake to work towards a full evidence-based climate mitigation system:

- Work with other councils, greenhouse alliances, state government and stakeholders, such as ICLEI Oceania and Ironbark, to source improved and updated data that can feed into future profiles and improve accuracy.
- Use Strathbogie's community emissions profile and associated information to engage with community stakeholders including key industrial emitters, residents, other levels of government and others to consolidate and focus action on the identified most effective pathways to reductions.
- Quantify potential emissions reductions available through Shire of Strathbogie Zero Carbon Emissions Strategy 2017-2020 and seek most efficient pathways to interventions through evidence-based climate planning.
- Continue to support climate mitigation and adaptation interventions and report the impact of these activities through targeted monitoring.
- Consider engaging with cohort councils (i.e. councils with similar emissions profiles) to share learnings and gain efficiencies in emissions reduction interventions.

7. Appendix 1: Data Inputs

7.1 Source Data

The following sources have been used to develop this profile.

NB: Ironbark Sustainability has attempted to retrieve sources published at dates commensurate to the activity data generated in the community emissions profile. However, due to a number of factors around data confidence and publishing cycles, the quality of the reporting would be diminished if reports and recommendations are based on data from poor sources. Ironbark is always assessing the availability of data sources and aims to use more up to date and better-quality sources where possible.

Table 6: Data sources

Name	Author	Publication date
Electricity Gas Australia 2015	Electricity Gas Australia	April 2015
Small-scale Technology Certificates - Registered	Clean Energy Regulator	September 2016
Population Estimates by Local Government Area (ASGS 2015), 2006 to 2016	Australian Bureau of Statistics	July 2017
National Postcode Concordances 2011	Australian Bureau of Statistics	June 2012
ABS National Regional Profile Industry LGA 2010-14	Australian Bureau of Statistics	June 2016
Waste Generation and Resource Recovery – 2010-11	Randell Environmental Consulting	February 2014
Waste Account, Australia, Experimental Estimates 2013	Australian Bureau of Statistics	February 2013
National Greenhouse Gas Inventory 2015	Australian Department of Environment and Energy	June 2016
National Greenhouse Gas Inventory 2013	Australian Department of Environment and Energy	June 2014
National Greenhouse Accounting Factors 2018	Department of Environment and Energy	July 2018
National Greenhouse Accounting Factors 2015	Australian Department of Environment and Energy	August 2015
2016 Australian Energy Statistics Update	Department of Industry, Innovation and Science	October 2016
2017/18 Residential electricity usage data supplied by Powercor, via Shire of Strathbogie	NA	October 2018
Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories	Intergovernmental Panel on Climate Change	2006
ABS Agricultural Commodities by SA2	Australian Bureau of Statistics	2016

Name	Author	Publication date
Mass of Nitrogen by state	Fertilizer Industry Federation of Australia	2016

7.2 Greenhouse Gas Emissions Factors

Emission factors convert activity data into a mass of GHG emissions; tonnes of CO_2 released per kilometre travelled, for example, or the ratio of CH_4 emissions produced to amount of waste landfilled. According to the GPC, emission factors should be relevant to the profile boundary, specific to the activity being measured, and sourced from credible government, industry, or academic sources[2]. The following tables outline the GHG emission factors used in the development of this profile.

Table 7: Grid supplied electricity emissions factors (Source: National Greenhouse Accounting Factors 2018)

Grid supplied electricity emissions factors				
State	Financial Year	Equivalent year	Scope 2 EF (kg CO_2-e/kWh)	Scope 3 EF (kg CO_2-e/kWh)
Victoria	Latest Estimate	2015.5	1.08	0.1

Table 8: Grid supplied gas emissions (Source: National Greenhouse Accounting Factors 2018, Table 2)

Emission factors for the consumption of natural gas					
Fuel combusted	Energy content factor (GJ/m^3 unless otherwise indicated)	Emission factor (kg CO_2-e/GJ) (relevant oxidation factors incorporated)			
		CO_2	CH_4	N_2O	Total
Natural gas distributed in a pipeline	39.3×10^{-3}	51.4	0.1	0.03	51.53

Table 9: Natural gas leakage factors (Source: National Greenhouse Accounting Factors 2018, Table 16)

Natural gas leakage factors			
State	Unaccounted for gas (%UAG)	Natural gas composition factor (tonnes CO_2-e/TJ)	
	UAG	CO_2	CH_4
Victoria	3	0.9	388

[2] If no local, regional, or country-specific sources are available, councils can use IPCC default factors or data from the Emission Factor Database (EFDB) or other standard values from international bodies that reflect national circumstances.

Table 10: Distribution losses (Source: Electricity and Gas Australia 2015, Table 3.5)

Distribution losses	
Data year	2013.5
State	Victoria
Loss	4.6%

Table 11: Waste emission factors (Source: National Greenhouse Accounting Factors 2015)

Waste – Emissions Factors				
	CO_2	CH_4	N_2O	Total CO_2 -e
Proportion of total CO_2-e	0.27%	96.08%	3.65%	100%

Table 12: Waste emission factors for total waste disposed to landfill (Source: National Greenhouse Accounting Factors 2018)

Waste emission factors for total waste disposed to landfill by broad waste stream category			
Waste types	Municipal solid waste	Commercial and industrial waste	Construction / demolition waste
	A	B	C
Emission factor (t CO_2-e/t waste)	1.4	1.2	0.2

Table 13: Transport fuels emission coefficients (Source: National Greenhouse Accounting Factors 2018, Table 4)

Fuel combustion emission factors - fuels used for transport energy purposes				
Fuel combusted	Energy content factor (GJ/kL unless otherwise indicated)	Emission factor (kg CO_2-e/GJ) (relevant oxidation factors incorporated)		
		CO_2	CH_4	N_2O
Pre-2004 vehicles				
Gasoline (other than for use as fuel in an aircraft)	34.2	67.4	0.5	1.8
Diesel oil	38.6	69.9	0.1	0.5
Liquefied petroleum gas	26.2	60.2	0.6	0.7
Ethanol for use as fuel in an internal combustion engine	23.4	0	0.7	1.9
Post-2004 vehicles				
Gasoline (other than for use as fuel in an aircraft)	34.2	67.4	0.02	0.2
Diesel oil	38.6	69.9	0.01	0.6
Liquefied petroleum gas	26.2	60.2	0.4	0.3
Ethanol for use as fuel in an internal combustion engine	23.4	0	0.2	0.2

Table 14: Emission breakdown by fuel type (Source: National Greenhouse Accounting Factors 2018)

Emissions breakdown by fuel type							
Data year	2017.5						
Fuel type	CO_2 emissions factors (kg CO_2-e/GJ)				Proportion of emissions		
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O
Hydro	0.00	0.00	0.00	0.00	0.0000	0.0000	0.0000
Biofuels	0	0.07	0.2	0.27	0.0000	0.2593	0.7407
Black coal	90	0.03	0.2	90.23	0.9975	0.0003	0.0022
Brown coal	93.50	0.02	0.40	93.92	0.9955	0.0002	0.0043
Coal seam methane	51.4	0.2	0.03	51.63	0.9955	0.0039	0.0006
Natural gas	51.40	0.10	0.03	51.53	0.9975	0.0019	0.0006
Oil products	69.8	0	0.2	70.00	0.9971	0.0000	0.0029
Solar	0	0	0	0.00	0.0000	0.0000	0.0000
Wind	0.00	0.00	0.00	0.00	0.0000	0.0000	0.0000
Total (kg CO_2-e/GJ)	81.08	0.02	0.34	81.44	0.9956	0.0003	0.0042
Total (kg CO_2-e/MWh)	22.52	0.01	0.09	22.62	0.9956	0.0003	0.0042
	99.555%	0.029%	0.415%	1.00			

Table 15: Global warming potentials of greenhouse gases (Source: National Greenhouse Accounting Factors 2018, Appendix 1)

Global Warming Potentials		
Gas	Chemical formula	Global Warming Potential
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous oxide	N_2O	298

Table 16: Electricity generation fuel mixes by state (Source: 2016 Australian Energy Statistics Update, Table O)

Electricity generation fuel mixes		
Data year	2013.5	
State	Victoria	
Generation source	Value (GWh)	Proportion
Hydro	1,103.0	2%
Biofuels	898.8	2%
Black coal		0%
Brown coal	43,977.7	83%
Coal seam methane		0%
Natural gas	3,239.3	6%
Oil products	145.8	0%
Solar	755.6	1%
Wind	2,771.9	5%
Total (kg CO_2-e/GJ)	**52,892.1**	**100%**
Fossil Fuels	47,362.8	90%
Nuclear	0	0%
Renewables	5,529.3	10%

Table 17: Emissions factors for N_2O emissions (Source: Intergovernmental Panel on Climate Change, 2006)

Emissions factors for N_2O emissions	
Emission Factor	Value
EF1 (default emissions factor for direct N_2O emissions)	0.0125 (kg N_2O-N/kg N)
F_{GASF}	0.1 kg (NH3-N + NOx-N)/kg fertilizer

Table 18: Enteric fermentation emissions factors for livestock (Source: Intergovernmental Panel on Climate Change, 2006)

Enteric Fermentation Emissions Factors for livestock			
Zone	Category	Emission Factor (kg/head/yr)	Notes
Oceania	Dairy Cattle	68	
	Non-Dairy Cattle	53	Includes beef cows, bulls, and young.
	Sheep	8	
	Pigs	1.5	

Table 19: Manure management emissions factors (Source: Intergovernmental Panel on Climate Change, 2006)

Manure management emissions factors			
Category	Emissions Factor (kg CO2e/head)		
	Cool	Temp	Warm
Sheep	0.19	0.28	0.37
Dairy Cattle	31	32	33
Non-Dairy Cattle	5	6	7
Pigs	20	20	20

8. Appendix 2: Policy Context

International/Federal

Globally, a number of countries, states and cities are making significant changes to the way they live and work to reduce their contribution to human induced climate change. In some countries, such as Australia, it has been cities and communities that are leading the way with policies and programs to seize the opportunity of sustainability.

Australia has seen significant policy uncertainty through the introduction and repeal of policies such as the carbon tax and the protracted review of the Renewable Energy Target. We've also seen the drafting of initiatives, such as the Emissions Intensity Scheme (2016), the Clean Energy Target (2017) and the National Energy Guarantee (2018), that have all failed to be realised. Nationally, uncertainty regarding energy policy continues to stifle investment in large-scale renewable energy to the detriment of consumer prices.

The second major Federal policy influencing Council decision-making is the Emission Reduction Fund (ERF). The methodologies and abatement pricing structures announced in the first round of the Fund provide limited opportunities for councils to participate, however the second round may provide some limited opportunity. The Australian Renewable Energy Agency and Clean Energy Finance Corporation are still attempting to fund innovation and tailored project finance to support the development of the industry irrespective of limited political support.

Australia is a signatory to the Paris Climate Agreement which pledges to reduce carbon emissions and limit global warming to "well below 2°C above pre-industrial levels". The Australian Government has set a target of 26-28% emissions reduction on 2005 levels by 2030.

State

The Victorian Government has established a climate change framework and enshrined in legislation a goal to achieve net zero emissions by the year 2050, beginning with a reduction of 15-20% on 2005 levels by the year 2020. In addition, they aim to increase renewable energy generation to 25% by the year 2020.

A key strategy to reducing emissions is the Take 2 Pledge delivered by Sustainability Victoria - a commitment to keeping global temperature increases under 2 degrees Celsius that can be signed by individuals, families, businesses or governments.

Recently, the Victorian Climate Change Adaptation Plan 2017-2020 was released, outlining key government actions to meet its GHG reduction targets.

Local

At the local level, a number of councils across Australia have shown strong leadership in climate action and derived great benefits by reducing their operational costs, carbon exposure and improving productivity. In addition, this has provided a great basis for community engagement and leadership.