

Local Energy and Emissions Monitor:

Scope and Methodology

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B.1 About the Local Energy and Emissions Monitor

The Local Energy and Emissions Monitor is a database of carbon equivalent emissions for each Local Government Area in Australia. The regional accounts reproduce Australia's National and State and Territory Greenhouse Gas Inventories for each LGA in Australia for 86 ANZSIC subdivisions plus residential from 2000-01 to 2023-24.

The Local Energy and Emissions Monitor uses an **economy and industry focused** methodological approach to model regional emissions that benchmark emissions on industrial input-output flows. Regional activity indicators for each carbon sector are integrated into the model. The results are reconciled to Australia's National Greenhouse Gas Inventory.

B.1.1 Local Government Area

The main regional unit of interest is the Local Government Area, of which there are 543 LGAs modelled that cover all areas of Australia. A summary of the number of LGAs and region types is contained in B.1.

Table B.1 Summary of Local Government Areas by State					
State		Count of LGAs number	Region Type		
			Metropolitan per cent	Regional per cent	Rural per cent
1	New South Wales	129	25.6	17.8	56.6
2	Victoria	80	38.8	10.0	51.3
3	Queensland	78	6.4	12.8	80.8
4	South Australia	71	26.8	2.8	70.4
5	Western Australia	137	22.6	3.6	73.7
6	Tasmania	29	0.0	17.2	82.8
7	Northern Territory	18	0.0	22.2	77.8
8	Australian Capital Territory	1	0.0	100.0	0.0

B.1.2 ANZSIC Industries

The following tables shows the industry structure used within each carbon sector model. All sectoral results are presented for 86 ANZSIC industry subdivisions and the residential sector.

Table B.2 ANZSIC Industries – page 1 of 3 (A to E)				
Industry Division		Industry Subdivision		
Code	Name	Code	Industry Name	Class
A	Agriculture, Forestry and Fishing	1	Agriculture	Industrial
		2	Aquaculture	Industrial
		3	Forestry and Logging	Industrial
		4	Fishing, Hunting and Trapping	Industrial
		5	Agriculture, Forestry and Fishing Support Services	Industrial
B	Mining	6	Coal Mining	Industrial
		7	Oil and Gas Extraction	Industrial
		8	Metal Ore Mining	Industrial
		9	Non-Metallic Mineral Mining and Quarrying	Industrial
		10	Exploration and Other Mining Support Services	Industrial
C	Manufacturing	11	Food Product Manufacturing	Industrial
		12	Beverage and Tobacco Product Manufacturing	Industrial
		13	Textile, Leather, Clothing and Footwear Manufacturing	Industrial
		14	Wood Product Manufacturing	Industrial
		15	Pulp, Paper and Converted Paper Product Manufacturing	Industrial
		16	Printing (including the Reproduction of Recorded Media)	Industrial
		17	Petroleum and Coal Product Manufacturing	Industrial
		18	Basic Chemical and Chemical Product Manufacturing	Industrial
		19	Polymer Product and Rubber Product Manufacturing	Industrial
		20	Non-Metallic Mineral Product Manufacturing	Industrial
		21	Primary Metal and Metal Product Manufacturing	Industrial
		22	Fabricated Metal Product Manufacturing	Industrial
		23	Transport Equipment Manufacturing	Industrial
		24	Machinery and Equipment Manufacturing	Industrial
		25	Furniture and Other Manufacturing	Industrial
D	Electricity, Gas, Water and Waste Services	26	Electricity Supply	Industrial
		27	Gas Supply	Industrial
		28	Water Supply, Sewerage and Drainage Services	Industrial
		29	Waste Collection, Treatment and Disposal Services	Industrial
E	Construction	30	Building Construction	Industrial
		31	Heavy and Civil Engineering Construction	Industrial
		32	Construction Services	Industrial

Table B.2 ANZSIC Industries – page 2 of 3 (F to K)

Industry Division		Industry Subdivision		
Code	Name	Code	Industry Name	Class
F	Wholesale Trade	33	Basic Material Wholesaling	Commercial
		34	Machinery and Equipment Wholesaling	Commercial
		35	Motor Vehicle and Motor Vehicle Parts Wholesaling	Commercial
		36	Grocery, Liquor and Tobacco Product Wholesaling	Commercial
		37	Other Goods Wholesaling	Commercial
		38	Commission-Based Wholesaling	Commercial
G	Retail Trade	39	Motor Vehicle and Motor Vehicle Parts Retailing	Commercial
		40	Fuel Retailing	Commercial
		41	Food Retailing	Commercial
		42	Other Store-Based Retailing	Commercial
		43	Non-Store Retailing and Retail Commission Based Buying	Commercial
H	Accommodation and Food Services	44	Accommodation	Commercial
		45	Food and Beverage Services	Commercial
I	Transport, Postal and Warehousing	46	Road Transport	Commercial
		47	Rail Transport	Commercial
		48	Water Transport	Commercial
		49	Air and Space Transport	Commercial
		50	Other Transport	Commercial
		51	Postal and Courier Pick-up and Delivery Services	Commercial
		52	Transport Support Services	Commercial
		53	Warehousing and Storage Services	Commercial
		54	Publishing (except Internet and Music Publishing)	Commercial
J	Information Media and Telecommunications	55	Motion Picture and Sound Recording Activities	Commercial
		56	Broadcasting (except Internet)	Commercial
		57	Internet Publishing and Broadcasting	Commercial
		58	Telecommunications Services	Commercial
		59	Internet Service Providers, Web Search Portals and Data Processing Services	Commercial
		60	Library and Other Information Services	Commercial
K	Financial and Insurance Services	62	Finance	Commercial
		63	Insurance and Superannuation Funds	Commercial
		64	Auxiliary Finance and Insurance Services	Commercial

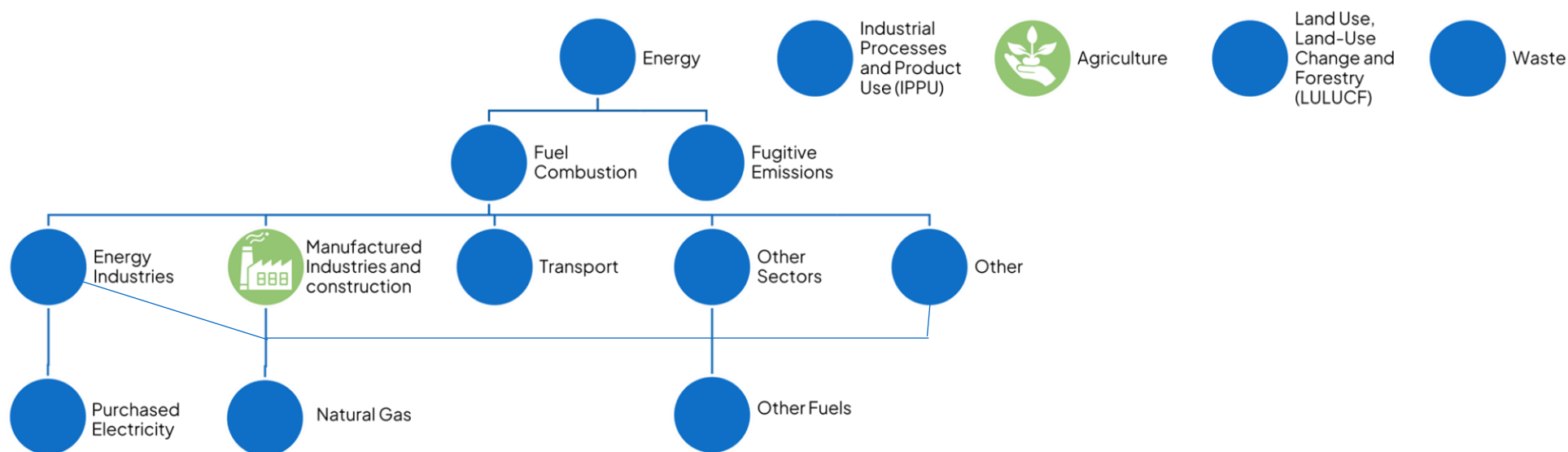
Table B.2 ANZSIC Industries – page 3 of 3 (L to S)				
Industry Division		Industry Subdivision		
Code	Name	Code	Industry Name	Class
L	Rental, Hiring and Real Estate Services	66	Rental and Hiring Services (except Real Estate)	Commercial
		67	Property Operators and Real Estate Services	Commercial
M	Professional, Scientific and Technical Services	69	Professional, Scientific and Technical Services (Except Computer System Design and Related Services)	Commercial
		70	Computer System Design and Related Services	Commercial
N	Administrative and Support Services	72	Administrative Services	Commercial
		73	Building Cleaning, Pest Control and Other Support Services	Commercial
O	Public Administration and Safety	75	Public Administration	Commercial
		76	Defence	Commercial
		77	Public Order, Safety and Regulatory Services	Commercial
P	Education and Training	80	Preschool and School Education	Commercial
		81	Tertiary Education	Commercial
		82	Adult, Community and Other Education	Commercial
Q	Health Care and Social Assistance	84	Hospitals	Commercial
		85	Medical and Other Health Care Services	Commercial
		86	Residential Care Services	Commercial
		87	Social Assistance Services	Commercial
R	Arts and Recreation Services	89	Heritage Activities	Commercial
		90	Creative and Performing Arts Activities	Commercial
		91	Sports and Recreation Activities	Commercial
		92	Gambling Activities	Commercial
S	Other Services	94	Repair and Maintenance	Commercial
	Households			Residential

B.1.3 UNFCCC Carbon Sectors

The LGA carbon accounts are reconciled with Australia's latest National Greenhouse Gas Accounts. Australia's National Greenhouse Gas Accounts are prepared under the United Nations Framework Convention on Climate Change (UNFCCC) classification system. The National inventory is used to track Australia's progress toward the Paris Agreement and toward local emissions targets.

NIEIR's regional model is structured around the main climate accounts as outlined in Figure B.1. The stationary fuel combustion sector has been segmented by energy fuel type (electricity, natural gas and other fuels). While Transport and Fugitive Emissions from the energy sector have been modelled separately. Industrial Process and Product Use (IPPU), Agriculture, Land Use, Land-Use Change and Forestry and Waste sectors are also modelled separately.

Figure B.1 UNFCCC carbon sectors and model structure



B.1.4 Scope of Emissions

The scope of emissions classifies greenhouse gas emissions into three categories. Scope 1 emissions are direct, while Scope 2 and Scope 3 emissions are indirect classifications.

Scope 1: Direct emissions from sources directly controlled or owned by site/location.

Scope 2: Indirect emissions from purchased energy that are not necessarily generated on site/location, but are as a consequence of site/locations activities. For example, this includes electricity generated off site/location, but purchased for use on site/location.

Scope 3: Indirect emissions in site/locations from upstream and downstream site/locations supply chain from sources outside the control of location/site. Can include goods and services purchased, employee commuting, etc.

The scope of emissions for the Local Energy and Emissions Monitor varies with the scope of each sector outlined in Table B.3.

Table B.3 Scope of emissions by sector		
Sector		Scope
Energy	Purchased Electricity	Scope 2
	Natural Gas	Scope 2
	Other Fuel Combustion	Scope 2
	Fugitive Emissions	Scope 1
	Transport	Scope 1
Non-Energy	Industrial Processes and Product Use	Scope 1
	Agriculture	Scope 1
	Waste	Scope 3
Land	Land Use, Land Use Change and Forestry	n/a
Total Emissions	Total Emissions	Sum of regional components

B.1.5 Data Series

The Local Energy and Emissions Monitor standard data package summarises the results for the main categories only for UNFCCC carbon accounts for each LGA across industry subdivisions. The series that are contained in the Excel data tables are presented in table B.4.

Table B.5 presents the complete set of data series that are estimated within the Local Energy and Emissions Monitor, including additional sub-categories and series that are available upon request (non-standard).

In general, data series are available from 2000-01 to 2023-24 at the Local Government Area level for 86 ANZSIC industry subdivisions on a financial year basis. NIEIR have also modelled carbon subsectors and supporting data series at the regional level that are available upon request.

Data can also be provided on a quarterly or calendar year basis. The data may also be supplied on a regional aggregation basis upon request.

Each of series that are presented in kt CO₂-e may also derived on a per capita or economic emissions intensity basis.

Table B.4 LEEM – Standard data series list

Data series	Industry level	Scope	Description and units
Total Emissions	Total	Total of components	LGA total emissions in CO ₂ -e kt, CO ₂ -e per capita and kg per \$ of GRP
Summary by carbon sector	Total	Total of components	Summary of emissions by UNFCCC/IPCC carbon sector in CO ₂ -e kt
Total Emissions	A1 plus residential	Total of components	Total emissions for each ANZSIC division and residential sector in CO ₂ -e kt. Total includes the sum of each carbon sector.
Purchased Electricity	A1 plus residential	Scope 2	Purchased electricity emissions by ANZSIC division and residential sector in CO ₂ -e kt.
Natural Gas	A1 plus residential	Scope 2	Natural Gas emissions by ANZSIC division and residential sector in CO ₂ -e kt.
Other Fuel Combustion	A1 plus residential	Scope 2	Other Fuel Combustion emissions by ANZSIC division and residential sector in CO ₂ -e kt.
Fugitive Emissions	A1 plus residential	Scope 1	Fugitive emissions by ANZSIC division and residential sector in CO ₂ -e kt.
Transport	A1 plus residential	Scope 1	Transport by ANZSIC division and residential sector in CO ₂ -e kt.
Industrial Processes and Product Use	A1 plus residential	Scope 1	Industrial Processes and Product Use emissions by ANZSIC division and residential sector in CO ₂ -e kt.
Agriculture	A1 plus residential	Scope 1	Agriculture emissions by ANZSIC division and residential sector in CO ₂ -e kt.
Waste	A1 plus residential	Scope 3	Waste emissions by ANZSIC division and residential sector in CO ₂ -e kt.
Total Emissions	A2 plus residential	Total of components	Total emissions for each ANZSIC subdivision and residential sector in CO ₂ -e kt. Total includes the sum of each carbon sector.
Purchased Electricity	A2 plus residential	Scope 2	Purchased electricity emissions by ANZSIC subdivision and residential sector in CO ₂ -e kt.
Natural Gas	A2 plus residential	Scope 2	Natural Gas emissions by ANZSIC subdivision and residential sector in CO ₂ -e kt.
Other Fuel Combustion	A2 plus residential	Scope 2	Other Fuel Combustion emissions by ANZSIC subdivision and residential sector in CO ₂ -e kt.
Fugitive Emissions	A2 plus residential	Scope 1	Fugitive emissions by ANZSIC subdivision and residential sector in CO ₂ -e kt.
Transport	A2 plus residential	Scope 1	Transport emissions by ANZSIC subdivision and residential sector in CO ₂ -e kt.
Industrial Processes and Product Use	A2 plus residential	Scope 1	Industrial Processes and Product Use emissions by ANZSIC subdivision and residential sector in CO ₂ -e kt.
Agriculture	A2 plus residential	Scope 1	Agriculture emissions by ANZSIC subdivision and residential sector in CO ₂ -e kt.
Waste	A2 plus residential	Scope 3	Waste emissions by ANZSIC subdivision and residential sector in CO ₂ -e kt.
Land Use, Land-Use Change and Forestry	Total	Scope 1	Total net emissions from the Land Use, Land-Use Change and Forestry sector in CO ₂ -e kt
Economic Emissions Intensity	A1	Total of components	Total carbon sector emissions divided by Value added for each industry division.
Economic Emissions Intensity	A2	Total of components	Total carbon sector emissions divided by Value added for each industry subdivision.

Table B.5 LEEM – Complete data series list – page 1 of 3

Data Series	Units	Region	Industry level	Comment
Total				
Total Emissions	kt CO ₂ -e	LGA	A2 plus residential	
Total Emissions per capita	t CO ₂ -e per capita	LGA	A2 plus residential	
Economic Emissions Intensity	kg CO ₂ -e per \$	LGA	A2 plus residential	Denominated by either GRP or industry specific value-added
Purchased Electricity				
Purchased Electricity Emissions	kt CO ₂ -e	LGA	A2 plus residential	
Electricity Consumption	MWh or PJ	LGA	A2 plus residential	
Small-scale solar capacity	MW	LGA	total	
Large-scale solar capacity	MW	LGA	total	
Small-scale solar generation	MWh or PJ	LGA	A2 plus residential	
Small-scale solar energy consumption	MWh or PJ	LGA	A2 plus residential	
Small-scale solar exports	MWh or PJ	LGA	A2 plus residential	
Large-scale solar generation	MWh or PJ	LGA	A2 plus residential	
Large-scale solar energy consumption	MWh or PJ	LGA	A2 plus residential	
Large-scale solar exports	MWh or PJ	LGA	A2 plus residential	
Total PV energy consumption	MWh or PJ	LGA	A2 plus residential	
Natural Gas				
Natural Gas Emissions	kt CO ₂ -e	LGA	A2 plus residential	
Natural Gas Consumption	PJ	LGA	A2 plus residential	
Other Fuel Combustion				
Other Fuel Combustion Emissions	kt CO ₂ -e	LGA	A2 plus residential	
Other Fuel Consumption	PJ	LGA	A2 plus residential	Includes all other fuels for non-transport combustion, excluding fuels used for electricity generation and natural gas (e.g. diesel)
Fugitive Emissions				
Fugitive Emissions	kt CO ₂ -e	LGA	A2 plus residential	
Transport				
Transport Emissions	kt CO ₂ -e	LGA	A2 plus residential	

Table B.5 LEEM – Complete data series list – page 2 of 3

Data Series	Units	Region	Industry level	Comment
Industrial Processes and Product Use				
Industrial Processes and Product Use Emissions	kt CO ₂ -e	LGA	A2 plus residential	
Heavy Industry total	kt CO ₂ -e	LGA	A2	Non-metallic minerals, chemical, metals and other industry
Mineral industry	kt CO ₂ -e	LGA	A2	
Chemical industry	kt CO ₂ -e	LGA	A2	
Metal industry	kt CO ₂ -e	LGA	A2	
Other Industry	kt CO ₂ -e	LGA	A2	
Ozone Depleting Substitutes (ODS) total	kt CO ₂ -e	LGA	A2 plus residential	
ODS – Commercial and Industrial Refrigeration	kt CO ₂ -e	LGA	A2	
ODS – Domestic Refrigeration	kt CO ₂ -e	LGA	Residential	
ODS – Transport Refrigeration	kt CO ₂ -e	LGA	A2	
ODS – Mobile air-conditioners	kt CO ₂ -e	LGA	A2 plus residential	
ODS – Stationary air-conditioners	kt CO ₂ -e	LGA	A2 plus residential	
ODS – Residual	kt CO ₂ -e	LGA	A2 plus residential	
Non-energy products from fuels and solvent use	kt CO ₂ -e	LGA	A2 plus residential	
Agriculture				
Agriculture emissions	kt CO ₂ -e	LGA	A2	
Land Use, Land Use Change and Forestry				
Land Use, Land Use Change and Forestry Net Emissions	kt CO ₂ -e	LGA	total	
Forest Land	kt CO ₂ -e	LGA	Total	
Forest land remaining forest land	kt CO ₂ -e	LGA	Total	
Land converted to forest land	kt CO ₂ -e	LGA	Total	
Cropland	kt CO ₂ -e	LGA	Total	
Cropland remaining cropland	kt CO ₂ -e	LGA	Total	
Land converted to cropland	kt CO ₂ -e	LGA	Total	
Grassland	kt CO ₂ -e	LGA	Total	
Grassland remaining grassland	kt CO ₂ -e	LGA	Total	
Land converted to grassland	kt CO ₂ -e	LGA	Total	
Wetland	kt CO ₂ -e	LGA	Total	
Wetland remaining wetland	kt CO ₂ -e	LGA	Total	
Land converted to wetland	kt CO ₂ -e	LGA	Total	
Settlements	kt CO ₂ -e	LGA	Total	
Settlements remaining settlements	kt CO ₂ -e	LGA	Total	
Land converted to settlements	kt CO ₂ -e	LGA	Total	
Harvested Wood Products	kt CO ₂ -e	LGA	Total	

Table B.5 LEEM – Complete data series list – page 3 of 3

Data Series	Units	Region	Industry level	Comment
Waste				
Waste Emissions	kt CO ₂ -e	LGA	A2 plus residential	
Solid Waste Disposal total	kt CO ₂ -e	LGA	A2 plus residential	MSW, C&D and C&I
Municipal Waste (MSW)	kt CO ₂ -e	LGA	A2 plus residential	
Construction and Demolition Waste (C&D)	kt CO ₂ -e	LGA	A2	
Commercial and Industrial Waste (C&I)	kt CO ₂ -e	LGA	A2	
Waste water treatment and discharge	kt CO ₂ -e	LGA	A2	
Other Waste	kt CO ₂ -e	LGA	A2	

Note: A2 = ANZSIC industry subdivision.

B.2 Methodology and Approach

B.2.1 General Approach

The general approach to modelling each carbon sector can be summarised in three steps. However, depending on the sector and availability of regional and state data, there are some deviations from this approach.

- (1) Industry input-output flows are used in the first stage in the model to estimate the initial distribution of carbon emissions between industries and regions.
- (2) Any available regional data and/or carbon specific sector modelling is used to improve the accuracy of the initial estimates. Regional data is typically activity based (e.g. vehicles on the road.)
- (3) Improved regional estimates from (2) are constrained to the state and territory carbon accounts.

B.2.2 Industry Input–Output Flows

The first pass of the model benchmarks emissions on the relevant input requirements for each industry within each LGA. The key input into this stage is NIEIR’s regional economic database, which is on over 300 LGA websites around Australia through ID. The economic and demographic database includes regional LGA for industry outputs, value added, and final demand allocations for the 86 2-digit ANZSIC subdivision industries as listed in Table B.2. The regional data extends from 1990–91 to 2023–24 and is updated annually by NIEIR.

The database includes estimates of input-output flows for each of the 86 industries for each quarter/year. This means that the input requirements for each industry within each LGA can be estimated using this database. This enables a first pass or default emission estimate by industry and emission type, if no other information is available. The starting point is the basic input-output identity for each of the 86 industries for each LGA. The identity is:

$$a_{i,1,k}x_{1,k} + \dots + a_{i,86,k}x_{86,k} + h_{i,k} + rex_{i,k} + iex_{i,k} + other_{i,k} = s_{i,k} \quad (B.1)$$

where:

- $a_{i,j,k}$ = proportion of output of industry j from all sources (local LGA, other LGAs in Australia, foreign countries) used by industry i in LGA k ;
- $x_{j,k}$ = gross output of industry j in LGA k in \$cvm million;
- $h_{i,k}$ = household demand for industry i output in \$cvm million;
- $rex_{i,k}$ = exports of industry i output in LGA k exported to other LGAs in Australia or interregional exports \$cvm million;
- $iex_{i,k}$ = exports of industry i output in LGA k exported to other countries or international exports \$cvm million;

$other_{i,k}$ = other elements of final demand for industry i in LGA k (government expenditure, investment, etc.) \$cvm million; and

$s_{i,k}$ = total supply industry i in LGA k \$cvm million.

Equation B.1 refers to a period t , which in the case of the framework of this Report is a fiscal year.

The default model can be illustrated with the case of purchased electricity. For any year, at the State level, using a combination of data sources the coefficient for CO₂ emissions in '000 tonnes per \$cvm million expenditure on electricity can be calculated. Let $peec_m$ represent this coefficient, where m refers to one of the eight Australian States and Territories.

From Table B.4 the sales of commercial purchased electricity sales are to ANZSIC industries 33 to 94. Accordingly, the first step in applying the default model is to add up the $peec_m * a_{i,26,k} x_{i,k}$ from i equals 33 to 94 given that LGA k is in State/Territory m . Industry 26 is the purchased electricity sector. Thus, $peec_m * a_{i,26,k} x_{i,k}$ represents the emissions from purchased commercial electricity from industry i in LGA k for period t . The next step is to aggregate this sum across all LGAs in State/Territory m . The final step is to distribute the total commercial electricity emission estimate for State/Territory m from the emission accounts for fiscal year t to LGA k in accordance with its share in the State/Territory sum across the relevant LGAs for the input-output based estimates of electricity consumption. It is a simple extension to apply the same model for industrial and household electricity demand and emissions.

If there were no other sources of data then the default model would become the source of final estimates. However, this is not the case for electricity. Firstly, estimates of on-site electricity production are available (e.g. embedded solar PV). This would have to be taken into account since it would alter the outcome for purchased electricity compared to the input-output estimate of electricity consumption. Secondly, regional purchased electricity consumption data is available, on a substation basis, where regions consist of one or more LGAs. If the regional estimates consist of more than one LGA, and the regional weighting of the data is unknown, then the results from the default model are used to allocate the data to the appropriate LGAs.

There are emission categories where only the default model is available. The notable categories here are for petroleum products, agriculture emissions, industrial emissions, fugitive emissions and non-residential waste. However, for petroleum products there is considerable additionality to the basic default input-output model. For household petroleum demand the stock of motor vehicles by LGA is used. Further, for petroleum products the analysis has to be extended beyond the standard input-output identity to take into account trade flows.

The first emissions which have to be added to the basis input-output identity estimates are the transport emissions associated with the import of product from other LGAs in Australia. The NIEIR data base contain estimates of all interregional trade flows. That is, for LGA k its imports for industry i from each of the other LGAs in Australia in Australia. Given this data and the distance between LGAs it is a straight forward to estimate the transport costs and then the emissions from interregional trade to be assigned to each LGA to correctly assign scope 1 emissions. This methodology would also capture the assignment of aviation emission for household and business back to the LGA of origin. The same methodology is applied to assign scope 1 emissions for petroleum and other

transport emissions for international exports from the LGA to ports back to the LGA of origin.

The key to the application of the default model is a reasonable assignment between the emission sources of Table B.3 and the 86 industries of Table B.2. The industries from Table B.2 relevant in this assignment are by ANZSIC industry number.

1. Agriculture;
6. Coal;
7. Oil and gas;
17. Petroleum products;
- 11-25. Manufacturing products
26. Electricity;
27. Gas distribution;
29. Waste distribution;
46. Road transport;
47. Rail transport;
48. Water transport;
49. Air transport; and
50. Other transport.

The assignment of industries to emission sources is largely transparent and where this is not the case this is outlined below.

B.2.3 Summary approach by carbon sector

The following sections outline the specific approach taken for each of the nine main carbon accounts. At this stage, regional activity drivers for each of the carbon accounts are integrated into the regional estimates.

B.2.3.1 Purchased electricity

The Purchased electricity sector is estimated as scope 2 emissions, which represent the greenhouse gas emissions embodied within electricity purchased by businesses and consumers. This is in contrast to scope 1 emissions, which summarise emissions at the point of electricity supply (where the power station is located). This places the responsibility of electricity source emissions on the consumer.

The carbon intensity of electricity consumption depends on the generation mix of supply to each Local Government Area. This will vary depending on state grid supply adjusted for local embedded generation. Due to the interaction of grid supply and local supply, the carbon intensity per unit of electricity typically varies between Local Government Areas.

The approach for Purchased electricity follows the general approach. The initial estimate for regional and industrial electricity activity is based on input from the Electricity Supply industry to all other industries.

The specific sector modelling is supported by regional data (where available) and a set of supporting models that build a complete picture of regional electricity consumption. Total electricity consumption for each LGA for residential and non-residential sectors is estimated by reconciling:

- distribution network data;
- modelled large customer loads;
- consumption from small and large-PV systems;
- interpolated data for any gaps; and
- ANZSIC subdivision estimates from the initial estimates.

LGA electricity consumption is applied to the first estimates, and constrained to the National Greenhouse Gas Inventory scope 2 data by state to get the final carbon emission equivalent estimates.

Distribution Network

The primary source of regional data is from regulated electricity distribution networks operating within the National Electricity Market. This includes:

- zone substation network interval data; and
- annual electricity consumption by region and customer class.

Distributors are required to publish zone substation (ZSS) data annually for their network. Zone substations receive higher voltage electricity from transmission networks and convert electricity to lower voltages. Electricity is then converted to even lower voltages along feeder lines, which is suitable for home and business consumption. Electricity passing through the zone substation is measured in aggregate intervals for the distribution region of the zone substation.

Zone substation distribution areas have been weighted and reconciled to Local Government Area boundaries by NIEIR. In regional and rural areas, the distribution area for zone substations is likely similar to or contained within LGA boundaries as both capture and service the larger population centres. In metropolitan regions, reconciliation requires more work. GIS data for LGA boundaries and available GIS data for zone substation service areas were used as the starting point before weighting for customer loads.

Some Distributors also elect to voluntarily publish regional electricity consumption data. This data is usually based on individual customer usage, which may be summarised from smart meter or billed data. Data is classified by tariff class or an aggregation of tariff class (e.g. residential, commercial, industrial).

However, Distributors may elect to omit data for privacy concerns. For example, some large customers have their own zone substation and publication of this data would uniquely identify the customers electricity use.

As such, NIEIR have separately modelled each large industrial and commercial customer's electricity consumption. Annual consumption profiles are based on available information for production, electricity use, and economic activity.

Embedded Generation

Traditionally, electricity networks have had centralised supply of electricity from large power stations that distribute electricity from higher voltages to lower voltages along transmission and distribution networks. This model has been challenged over the past 15 years by the prevalence of solar PV, where generation has been embedded at the customer level in the network, particularly for small-scale systems (<100kW capacity).

Depending on the network, consumption from embedded PV systems may be captured in annual consumption data. However, generation and consumption from embedded PV systems will not be measured at the zone substation level.

To provide consistency, NIEIR have used a separate model for small-scale (0 to 100kW) and large-scale (100kW +) solar PV. This is based on installed capacity, solar irradiation, and operational efficiency in systems. Generation, consumption and exports are separately estimated. Large-scale systems have been separately industry coded to ANZSIC subdivision, while small-scale solar consumption is proportioned for residential and non-residential customers.

Off-Grid and Other Gaps

Where data is unavailable, data is interpolated for missing years and regions based on customer average consumption and NIEIR's economic databases. For example, number of dwellings multiplied by state average household consumption. Non-residential electricity consumption may be filled with relevant output benchmarks.

B.2.3.2 Natural Gas and Other Fuels

The Natural Gas and Other Fuel Combustion sectors are modelled separately, but are required to be considered together when reconciling with the National Greenhouse Gas Inventory. Both of these regional LGA accounts are presented as scope 2 emissions, which summarise carbon equivalent emissions from those that are purchasing and consuming the fuels, rather than the supplier of fuels.

The fuel combustion sector within the Energy sector in Australia's greenhouse gas accounts includes energy used for stationary combustion, such as electricity, natural gas and diesel. The sector also includes mobile fuel combustion (transport). Both electricity and transport are covered in other sections.

The remaining fuel combustion sector groups together fuels used directly on site such as Natural Gas and Diesel. These fuels are reported in aggregate for each of:

- Manufacturing (by manufacturing sub-industry);
- Construction;
- Agriculture;
- Commercial; and
- Residential.

Carbon emissions from each of the industry sectors listed above are segmented into Natural Gas and all Other Fuel Consumption at the state level by reconciling carbon emissions by industry with Australian Energy Statistics by industry and fuel type. This gives state-level constraints by sub-sector for each of Natural Gas and Other fuels.

The initial input flows for Natural Gas for 86 ANZSIC subdivisions are estimated using the Gas Supply industry. Other Fuels input flows are estimated using Petroleum Product Manufacturing.

LGA-level data for both Natural Gas and other fuels are limited. However, regional data for Natural Gas consumption that has been used in the model, this includes gas distribution data for NSW. The service boundaries of the gas distribution network have also been reconciled with LGA areas to ensure that only areas that have access to natural gas have emissions. Information from AEMO's Gas Bulletin Board (GBB) has also been used to define the gas network.

B.2.3.3 Fugitive Emissions

Fugitive emissions are unintended leaks, releases or losses of greenhouse gases from fuel industries. Fugitive emissions can come from coal mining, fuel transformation and oil and natural gas industries. This includes fugitive emissions arising from all points of the supply chain for oil and natural gas, including exploration, production, processing, storage and distribution. Fugitive emissions in the Local Energy and Emissions Monitor are presented as scope 1. This means that the leaks, releases and losses from fuel industries are assigned to those industries, rather than the consumer of the fuels. This is important, given that a large amount of Australia's fuel production is exported overseas (e.g. LNG and coal).

Fugitive emissions have a relatively narrow industrial base (4 out of 86 industry subdivisions). Regional activity data has not been used for each LGA. Industry output, with adjustment, is a sufficient indicator of regional fugitive emissions, which means the larger producers are assigned a high amount of Fugitive Emissions.

The first estimate regional is constrained for each state's annual Fugitive Emissions.

B.2.3.4 Transport

Transport emissions are from the combustion of fuel used in vehicles for private and non-private purposes. This includes road transport, domestic aviation and railways. The road transport segment makes up around 85 per cent of total annual transport emissions in Australia. The Local Emission Monitor presents Transport source emissions as scope 1 emissions. This means that emissions are assigned to transport industries and to the residential sector, or those that operate the vehicles. These accounts do not consider Transport on a scope 3 emissions basis, which would assign non-residential transport emissions to the purchaser of the transport service (e.g. the supermarket getting goods delivered by freight).

The first estimate of emissions from the transport industry assigns activity based on imports of Petroleum products.

LGA estimates of motor vehicle use by motive power and fuel type are also used to adjust the profile for carbon emissions. This data is drawn from the ABS Motor Vehicle Census and the most recent years from Bureau of Infrastructure and Transport Research Economics (BITRE).

Garaged and registered motor vehicle types at the LGA level include:

- passenger vehicles;
- light commercial vehicles;
- light buses;
- heavy buses;
- light rigid trucks;
- articulated trucks;
- heavy rigid trucks;
- campervans;
- motorcycles; and
- non-freight-carrying vehicles.

These motor vehicle types are segmented by motive power for the following:

- petrol;
- diesel;
- dual fuel;
- hybrid electric;
- battery/fuel-cell electric; and
- other.

Average travel kilometres and fuel usage for each vehicle type by motive power is used to estimate petroleum usage within each LGA and the deviation from state averages. These estimates are used to adjust the initial industry input estimates.

The final estimates for emissions by LGA are constrained by Transport sector emissions from the National Greenhouse Gas Inventory for each state.

B.2.3.5 Industrial Processes and Product Use

Industrial Processes and Product Use (IPPU) are greenhouse gas emissions generated from non-energy sources in industrial processes or the direct use of greenhouse gases in products. Industrial processes may release greenhouse gases as a byproduct of chemical reactions, such as within the smelting of metals and chemical manufacturing. Product use can include leakage from refrigeration and air-conditioning, which have both become an increasingly proportion of IPPU sector emissions in Australia over the past 20 years.

The IPPU sector contains a variety of sources of emissions. Industrial Processes are derived from manufacturing industry, while product use is mostly dependent on appliance and equipment use from Ozone Depleting Substitutes (ODS).

Each of the detailed IPPU UNFCCC carbon sectors were mapped to ANZSIC subdivisions. Relevant industrial activity from NIEIRs databases was used to allocate Industrial Processes. While product use from refrigeration and air-conditioners is dependent on outputs from the Purchased Electricity and Transport carbon models.

The following UNFCCC carbon sectors were mapped to specific or specific groups of ANZSIC subdivisions:

- Mineral industry;
- Chemical industry;
- Metal industry;
- Electronic industry; and
- Other product manufacture and use/Other.

The *Non-energy products from fuels and solvent use* sector are more widely used by industry and represents use of non-energy products and such lubricants and solvents.

The following sectors were modelled from the *Product uses as ODS substitutes* category:

- Commercial refrigeration;
- Domestic refrigeration;
- Industrial refrigeration;
- Mobile air-conditioning;
- Stationary air-conditioning;
- Transport refrigeration; and
- Product uses as ODS substitutes residual.

Stationary air-conditioning and refrigeration were allocated according to electricity consumption within the relevant industries (or residential sector). While mobile air-conditioning is allocated according to transport activity, and transport refrigeration is allocated to road transport and delivery services.

B.2.3.6 Agriculture

Agriculture sector emissions include direct emissions from livestock and farm management practices, such as from agricultural soils, the application of fertilisers and manure management. This sector excludes Land Use, Land-Use Change and Forestry.

The Agriculture carbon sector has a narrow ANZSIC industry allocation with both crop and livestock farming within the “Agriculture” industry subdivision. While there are still potential Agriculture carbon sector emissions from the other Agricultural industries, most are within the first industry. As such, the main regional activity indicator is industry output by LGA, which is constrained to the state accounts from the National Greenhouse Gas inventory.

B.2.3.7 Land Use, Land-Use Change and Forestry

The Land Use, Land-Use Change and Forestry sector measures the net impact on emission from activities affecting land and vegetation. This sector could either be a source of emissions, or it could act as a land sink by removing emissions from the atmosphere. Land use changes, such as clearing land and harvesting forests, increase emissions. Protecting and restoring natural vegetation acts as a carbon sink that reduces emissions in the atmosphere.

The Land Use, Land-Use Change and Forestry carbon sector is based on analysis of Australian satellite imagery over the past 25 years from Digital Earth Australia (DEA) Land Cover (otherwise known as Landsat). The satellite images display the composition of land within each area across Australia on an annual basis.

Australian land is classified into the following main categories of land use:

- Cultivated Terrestrial Vegetated;
- Natural Terrestrial Vegetated;
- Natural Aquatic Vegetated;
- Artificial Surface;
- Natural Surface; and
- Water.

The density and type of cover for each of natural and cultivated terrestrial surface is also classified into woody or herbaceous cover with densities within the following categories:

- Closed (> 65 %);
- Open (40 to 65 %);
- Open (15 to 40 %);
- Sparse (4 to 15 %); and
- Scattered (1 to 4 %).

Each of the Landsat categories are assigned a carbon weight by type and density. The Landsat categories are then reconciled with the UNFCCC carbon accounts categories.

- Forest Land;
- Cropland;
- Grassland;
- Wetland;
- Settlements; and
- Harvested Wood Products.

The stock of each type of land is summarised for each LGA for each year. The change between years is also calculated. These regional estimates are constrained to state and national greenhouse gas inventories.

B.2.3.8 Waste

Waste source emissions are primarily from the decomposition of solid waste materials that have been disposed of in landfill. This sector also includes emissions from waste water treatment, and other minor waste sectors such as incineration, open burning of waste and the biological treatment of solid waste. The Waste sector is presented as scope 3 emissions in the Local Energy and Emissions Monitor. This means that the businesses and consumers generating the waste are assigned responsibility for the emissions, rather than landfill sites or wastewater treatment plants.

The first stage of the waste model estimates waste generation by industry input from the Waste Collection, Treatment and Disposal Services industry. In the absence of any other data, this provides the regional and industrial distribution for waste.

The first stage estimates are then improved through a regional model and data for Waste. The regional model for waste is segmented into the following areas for Solid Waste Disposal:

- **Municipal Waste (MSW)** – typically the responsibility of council, and includes collection of waste from households and in some instances, business;
- **Construction and Demolition (C&D)** – construction waste materials from construction, renovation and demolition activities; and
- **Commercial and Industrial (C&I)** – any commercial and industrial waste collected from businesses outside of municipal waste collection services.

The main concern for solid waste is landfill waste tonnage, rather than any recycled waste, which is diverted from landfill and reduces emissions from the sector. Where available, data for Municipal Waste disposal by Local Government Area was integrated into the model which cover most states. The National waste database was also used to calibrate regional estimates for each sector.

The following Waste sectors were also modelled:

- **Other waste** – this category is relatively minor and includes the biological treatment of solid waste, and incineration and open burning of waste; and
- **Wastewater treatment and disposal** – local population and waste water treatment infrastructure determine greenhouse gas emissions.

The waste subsectors are constrained to National and State Greenhouse Gas Inventories to the relevant categories.

B.2.4 National Greenhouse Gas Inventory

The Department of Climate Change, Energy and Environment and Water publish Australia's official greenhouse gas inventories, which include inventories that are used to track Australia's progress toward meeting its commitments to the Paris Agreement and UNFCCC. The annual greenhouse gas inventories are currently published with National, state and territory data from 1989-90 to 2022-23. NIEIR have used these National and State accounts as the main constraint for the regional estimates. Data sources include:

- The UNFCCC/Paris Agreement inventory from <https://www.greenhouseaccounts.climatechange.gov.au/>;
- Australia's National Greenhouse Accounts: Data tables for the State and Territory Greenhouse Gas Inventories 2023; and
- Scope 2 Purchased electricity emissions by industry and state.

Australia also publishes National updates on a quarterly basis with the latest quarterly update published to March 2025. The annual state accounts have been updated by NIEIR using the National quarterly updates alongside relevant economic and activity indicators by state and territory to cover the 2023-24 year.

B.2.5 Data Sources

B.2.5.1 NIEIR's Regional Economic Database

NIEIR has developed an extensive regional database currently used by over 300 Australian Local Governments on their websites. At the core of the database is the quarterly Local Government Area (LGA) database with consistent series from the June quarter 1991 to June quarter 2023-24 which in regional summary form appears in the ALGA "State of the Regions" report. The database is based on the 86 industry 2-digit ANZSIC industry classification for 543 LGAs with each industry having time series indicators for:

- Gross Regional Product (GRP);
- Employment (by 2-Digit Industry and Usual Resident/Place of Work);
- Hours (by 2-Digit Industry and Usual Resident/Place of Work); Income (by 2-Digit Industry and Usual Resident/Place of Work);
- Value Added (by 2-Digit Industry);
- Dollar per hour by place of work and place of residence;
- Sales (by 2-Digit Industry);
- Exports (by 2-Digit Industry and International/Interregional);
- Imports (by 2-Digit Industry and International/Interregional);
- Consumption expenditures by industry by households in an LGA;

- Final demand estimates for equipment investment, construction and current government expenditures;
- Flow of Funds Series (Wages, Business Income etc.);
- Population; and
- Households.

Household income and expenditures by LGA is structured in accordance with the National and State Household Income Formation in the Australian Bureau of Statistics' Australian National Accounts.

The NIEIR LGA databases are available in the public domain on the .id supported websites for nearly 200 LGAs. The data is also available at the 67 regional level for the NIEIR “*State of the Regions*” report.

Annual databases have been developed with many of the LGA series broken down into estimates from 2000-01 to 2023-24 for the SA2 region level and for employment by place of work and place of resident employment at the 1-digit ANZSIC industry level at the SAI level.

The databases have been used to construct a powerful quarterly integrated LGA regional modelling system based around:

- automatically updated input-output relationships for each LGA;
- inter-regional trade flow relationships between a given industry in a given LGA and all other;
- LGAs in Australia; and
- investment formation and capacity expansion functions estimated for historical data for installed floor space capacity, infrastructure capital stock estimates and major individual investments time series.

B.2.5.2 Other Data Sources

The following table contains a summary of data sources that have been used in each of the sector specific models to estimate regional carbon emissions. This list is non-exhaustive, but contains the main data catalogues used in modelling.

Table B.6 Data sources for climate modelling – page 1 of 2

Description	Source	Timing
NIEIR Regional Economic database – inc. output, employment, population.	NIEIR	1991.3 to 2024.2
Daily climate observations at Australian weather stations	Bureau of Meteorology	All available history
UNFCCC/Paris Agreement inventory	Department of Climate Change, Energy, the Environment and Water	1989-90 to 2022-23
National Inventory by Economic Sector 2023	Department of Climate Change, Energy, the Environment and Water	1989-90 to 2022-23
Quarterly Update of Australia's National Greenhouse Gas Inventory	Department of Climate Change, Energy, the Environment and Water	2004.3 to 2024.4
Australia's National Greenhouse Accounts 2023: Data tables for the State and Territory Greenhouse Gas Inventories 2023	Department of Climate Change, Energy, the Environment and Water	1989-90 to 2022-23
Australian National Greenhouse Accounts Factors	Department of Climate Change, Energy, the Environment and Water	2024
General Energy		
Australian Energy Statistics, August 2025, including Tables O and F	Department of Climate Change, Energy, the Environment and Water	1973-74 to 2023-24
Electricity		
Operational Demand interval data	AEMO	2004.3 to 2025.2
Company reports and publications reporting on large customers	Various	n/a
RIN Responses, various networks	Australian Energy Regulator	2005-06 to 2023-24
Scheduled generation interval data	AEMO	2014 to 2025
Non-scheduled generation interval data	AEMO	2005 to 2025
Small-scale installation postcode data	Clean Energy Regulator	2000-01 to 2023-24
Large-scale renewable energy data	Clean Energy Regulator	2000-01 to 2023-24
ENERGEX zone substation data	ENERGEX	2004 to 2024
Ergon zone substation data	Ergon	2011 to 2024
Jemena zone substation data	Jemena	2007 to 2024
United Energy zone substation data	United Energy	2010 to 2023
Citipower zone substation data	Citipower	2005 to 2023
Powercor zone substation data	Powercor	2004 to 2023
Ausnet Services zone substation data	Ausnet Services	2011 to 2025
Essential Energy zone substation data	Essential Energy	2012 to 2024
Endeavour Energy zone substation data	Endeavour Energy	2007 to 2023
Ausgrid zone substation data	Ausgrid	2008 to 2024
SA Power zone substation data	SA Power	2007 to 2024
TasNetworks zone substation data	TasNetworks	2004 to 2024
ENERGEX annual energy consumption	ENERGEX	2020 to 2024
Ergon annual energy consumption	Ergon	2020 to 2024

Table B.6 Data sources for climate modelling – page 2 of 2

Description	Source	Timing
United Energy annual energy consumption	United Energy	2019 to 2024
Citipower annual energy consumption	Citipower	2016 to 2024
Powercor annual energy consumption	Powercor	2016 to 2024
Ausnet Services annual energy consumption	Ausnet Services	2021-22
Essential Energy annual energy consumption	Essential Energy	2014 to 2023
Ausgrid annual energy consumption	Ausgrid	2009 to 2024
Transport		
Survey of Motor Vehicle Use, Australia	ABS	2001 to 2020
Road vehicles, Australia	Bureau of Infrastructure and Transport Research Economics	2021 to 2024
Motor Vehicle Census, Australia	ABS	2015 to 2020
Green Vehicle Guide	Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts	n/a
Natural Gas		
RIN Responses, various networks	Australian Energy Regulator	2005-06 to 2023-24
Gas Bulletin Board (GBB)	AEMO	2019 to 2025
WA Gas Bulletin Board (WA GBB)	AEMO	2013 to 2025
Jemena gas consumption – LGA level (NSW)	Jemena Gas	2010 to 2022
Gas distribution maps	various networks	n/a
Company reports and publications reporting on large customers	Various	n/a
Land Use, Land-Use Change and Forestry		
Digital Earth Australia (DEA) Land Cover (LANDSAT)	Digital Earth Australia	2000-01 to 2022-23
Waste		
Local council waste and resource recovery data (NSW)	NSW EPA	2014-15 to 2022-23
Queensland Local Government Comparative Information	Department of State Development, Infrastructure, Local Government and Planning	2014-15 to 2022-23
Recycling Victoria – Victorian Local Government Annual Waste Services Survey data release	Recycling Victoria	2001-02 to 2023-24
LG waste services 2019 to June 2024	Department of Water and Environmental Regulation (DWER)	2018-19 to 2023-24
National Waste and Resource Recovery Database	Department of Climate Change, Energy, the Environment and Water	2006-07 to 2022-23

B.3 Local Energy and Emissions Monitor Outputs

B.3.1 Energy and Emissions Data

The process to develop the energy and emissions data for each Local Government Area and ANZSIC industry have been outlined above. The process combines the best data available at the local and industry level with NIEIR's economic and energy models, which have been developed over decades of research and development.

The sectoral and industry emissions data is included in a Microsoft Excel workbook.

Generative AI models or Large-language Models (LLM) **are not** queried to generate energy and emissions results. All data and inputs are parsed through NIEIRs proprietary models to estimate local energy and climate emissions.

B.3.2 LGA Reports

NIEIR have created automated reports for each of the 543 Local Government Areas covering all of Australia. These reports summarise the energy and emissions data from 2001 to the most recent year available in report format templated in Microsoft Word and published as a PDF.

The reports are structured using a word template developed by NIEIR that is standard across all LGA reports.

The automated reports are designed to present insights into NIEIR's energy and emissions data and also include supporting information.

Figure B.2 contains an overview of the workflow to generate each report with is managed by a series of scripts written by NIEIR. Each word template is built around three basic components:

- (1) tables;
- (2) charts and other figures; and
- (3) text.

Tables

All tables are read directly from NIEIR's database and other external sources and transformed and inserted into the word template.

Charts and Other Figures

All charts and figures are created using data from NIEIR's databases and other external sources. The charts and saved as image files and inserted into place in the word template.

Text

The text within the report is written and developed through several different methods. Each of the text replacement methods (items b to d) generates a customised piece of text and searches and replaces the word template for the correct placeholder.

- (a) Constant or template text;
- (b) Basic text replacement;
- (c) Scripted logic text replacement; or
- (d) AI-generated responses.

Constant or template text is written directly into the template and is the same across all reports.

Basic text replacement does not require any extensive logic. An example of basic text replacement is the name of the Local Government Area or simple statistics/numbers drawn from the data.

Scripted logic text replacement uses conditional statements (e.g. if-then-else) to customised the text based on logic. A simple example of this could be a different insight based on whether emissions have increased, decreased or stayed the same compared to the previous year.

AI-generated responses are used for more customised or complex insights into NIEIR's energy and emissions results that are not practical to complete through **scripted logic** alone. NIEIR prompts AI models through an API, which return a response. The response is then inserted into place within the report.

The prompts to the AI models typically include a limited set of results from NIEIR's databases (or other source) and instructions to provide insights based on this data. Data could include report tables or data behind the charts. NIEIR endeavours to minimise any potential hallucinations or inaccuracies from AI model responses.

Figure B.2 Overview of process for automated reports

