

Air Emissions Inventory for the Greater Metropolitan Region in New South Wales

2013 Calendar Year

Consolidated Natural and Human-Made Emissions: Executive Summary

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ISBN 978 1 925987 28 7
EPA 2019P1918
October 2019

Acknowledgements

This study was performed with the help of organisations and individuals who should be recognised for their efforts.

We gratefully acknowledge the 3,533 residential households and 1,117 EPA-licensed premises that participated in the domestic and industrial surveys conducted by Taverner Research and Umwelt Pty Ltd, respectively, in conjunction with the NSW Environment Protection Authority. Their input has enabled a thorough evaluation of domestic and industrial sources of air emissions.

Essential to completion of this study were the data provided by other government departments and service providers, including Airservices Australia; Australian Asphalt Pavement Association; Australian Bureau of Agricultural and Resource Economics and Sciences; Australian Bureau of Statistics; Australian Energy Market Operator; Australian Paint Manufacturers Federation Inc.; Australian Rail Track Corporation; Bureau of Infrastructure, Transport and Regional Economics; Bureau of Resources and Energy Economics; Bureau of Transport Statistics; Commonwealth Scientific and Industrial Research Organisation; Department of Resources, Energy and Tourism; Duskhail Pty Ltd; GfK; IBISWorld; IHS Global Pte Ltd; Informark; International Fertilizer Industry Association; Jemena Gas Networks (NSW) Ltd; Lloyds Register Group Ltd; NSW Department of Health; NSW Maritime; NSW Registry of Births, Deaths and Marriages; NSW Roads and Maritime Services; NSW Rural Fire Service; NSW Trade and Investment; Newcastle Buses and Ferries; Newcastle Port Corporation; Office of Environment and Heritage; Outboard Engine Distributors Association; Pacific National; Port Kembla Port Corporation; Primary Industries Division of the Department of Trade and Investment; RailCorp; Regional Infrastructure and Services; Sydney Ports Corporation; Transport for NSW; United States Department of Agriculture; Winemakers' Federation of Australia and Winetitles Pty Ltd.

The work of a number of individuals is acknowledged – including the late Nick Agapides, Manager Major Air Projects; Gareth Jones, Principal Policy and Programs Officer; Daniel Helm, Technical Policy Advisor; and Greg Cooper, Senior Technical Policy Advisor – for their efforts in project scoping and management, developing emission estimation methodologies, collecting activity data, developing databases, estimating emissions and preparing this report.

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Executive summary

The NSW Environment Protection Authority (EPA) has produced an air emissions inventory (the 'inventory') for natural and human-made sources in NSW. The base year of the inventory represents activities that took place during the 2013 calendar year. The area included in the inventory covers the greater Sydney, Newcastle and Wollongong regions, known collectively as the Greater Metropolitan Region (GMR).

The inventory region defined as the GMR measures 210km (east–west) by 273km (north–south). The GMR and the three urban subregions defined in the inventory are presented in Table ES-1 and shown in Figure ES-1.

Table ES-1: Definition of Greater Metropolitan, Sydney, Newcastle and Wollongong regions

Region	South-west corner MGA ¹ coordinates		North-east corner MGA coordinates	
	Easting (km)	Northing (km)	Easting (km)	Northing (km)
Greater Metropolitan	210	6159	420	6432
Sydney	261	6201	360	6300
Newcastle	360	6348	408	6372
Wollongong	279	6174	318	6201

The air emissions inventory includes emissions from biogenic (natural living organisms), geogenic (natural non-living) and anthropogenic (human-made) sources, grouped into six modules as follows:

- **Natural** – biogenic and geogenic (e.g. bushfires, marine aerosol and vegetation)
- **Commercial** – non-EPA licensed² premises (e.g. printers, quarries and service stations)
- **Domestic-Commercial** – domestic activities (e.g. residential lawn mowing, wood heaters and portable fuel containers) and non-premises based commercial activities (e.g. public open space lawn mowing)
- **Industrial** – EPA-licensed³ premises (e.g. coal mines, oil refineries and power stations)
- **Off-Road Mobile** – unregistered non-road vehicles and equipment (e.g. dump trucks, bulldozers, locomotives and marine vessels)
- **On-Road Mobile** – road registered vehicles (e.g. registered cars, trucks and buses).

¹ Map Grid of Australia (MGA) based on the Geocentric Datum of Australia 1994 (GDA94) (ICSM, 2014).

² Not a scheduled activity or scheduled development work as defined in the *Protection of the Environment (Operations) Act 1997* (PCO, 2010a).

³ An activity listed in Schedule 1 of the *Protection of the Environment (Operations) Act 1997* (PCO, 2010a).



Figure ES-1: Definition of Greater Metropolitan, Sydney, Newcastle and Wollongong regions

The pollutants inventoried include criteria pollutants specified in the Ambient Air Quality National Environment Protection Measure (NEPM) (NEPC, 2016), air toxics associated with the National Pollutant Inventory NEPM (NEPC, 2008) and the Air Toxics NEPM (NEPC, 2004), and any other pollutants associated with state-specific programs, i.e. Load Based Licensing (Protection of the Environment Operations (General) Regulation 2009 (PCO, 2010b)) and the Protection of the Environment Operations (Clean Air) Regulation 2010 (PCO, 2011). More than 1,000 pollutants are included in the 2013 inventory.

This report presents emissions of criteria pollutants referred to in the Ambient Air Quality (AAQ) NEPM (NEPC, 2016), including⁴:

- carbon monoxide (CO)
- oxides of nitrogen (NO_x)
- particulate matter ≤ 10µm (PM₁₀)
- particulate matter ≤ 2.5µm (PM_{2.5})
- sulfur dioxide (SO₂)
- total volatile organic compounds (VOC).

The emission estimation methodologies used for the 2013 inventory are largely consistent with those developed and implemented for the 2008 inventory. Refer to the 2008 inventory reports for further information (EPA, 2012a; EPA, 2012b; EPA, 2012c; EPA, 2012d; EPA, 2012e; and EPA, 2012f). Section 2.7 of the accompanying main report lists key differences in emission estimation methodologies implemented for this inventory.

Emissions for 17 pollutants, including those listed above, are available to a higher spatial resolution (postcode level) in the [Air Emissions in My Community web tool](#)⁵. Data for the 2003 and 2008 air emissions inventories are also available in the web tool.

⁴ VOC is not included in the AAQ NEPM but is included in this report due to its importance as a precursor to the formation of secondary pollution in the atmosphere. Lead is an AAQ NEPM pollutant but is not included in this report as monitoring for lead ceased in 2005 with NSW annual average ambient levels having fallen to less than 10% of the NEPM standard (OEH, 2019).

⁵ <https://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-my-community/air-emissions-in-my-community-tool>.

Table ES-2 presents total estimated annual emissions of criteria pollutants from natural and human-made sources in the Sydney, Newcastle and Wollongong regions, and the whole GMR. Total estimated annual emissions are also presented for the region defined as Non-urban. This region is the area of the GMR minus the combined areas of the Sydney, Newcastle and Wollongong regions.

Table ES-2: Total estimated annual emissions from natural and human-made sources in each region

Substance	Region ⁶	Emissions (tonnes/year)		
		Human-made	Natural	Total ⁶
Carbon monoxide	Sydney	210,291	42,008	252,299
	Newcastle	60,789	20,261	81,050
	Wollongong	114,170	1,083	115,253
	Non-urban	82,829	810,795	893,625
	GMR	468,079	874,147	1,342,226
Oxides of nitrogen	Sydney	58,676	2,605	61,282
	Newcastle	9,133	739	9,872
	Wollongong	9,863	110	9,973
	Non-urban	191,334	32,466	223,800
	GMR	269,007	35,920	304,927
Particulate matter ≤ 10µm	Sydney	15,415	5,786	21,200
	Newcastle	4,969	2,300	7,269
	Wollongong	1,790	239	2,029
	Non-urban	79,038	95,222	174,260
	GMR	101,211	103,547	204,758
Particulate matter ≤ 2.5µm	Sydney	9,945	3,816	13,761
	Newcastle	2,093	1,769	3,862
	Wollongong	942	111	1,054
	Non-urban	16,248	71,269	87,517
	GMR	29,228	76,965	106,194
Sulfur dioxide	Sydney	10,148	382	10,530
	Newcastle	9,988	184	10,172
	Wollongong	4,840	9.85	4,850
	Non-urban	200,376	7,378	207,754
	GMR	225,351	7,955	233,306
Total volatile organic compounds	Sydney	96,521	31,785	128,306
	Newcastle	7,653	4,376	12,029
	Wollongong	4,300	3,055	7,355
	Non-urban	25,734	165,805	191,539
	GMR	134,209	205,021	339,230

⁶ The totals may differ from the sum of the addends due to rounding.

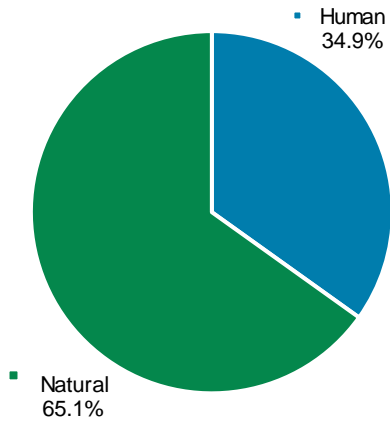
Table ES-3 presents the proportions of total estimated annual emissions of criteria pollutants from natural and human-made sources in the Sydney, Newcastle, Wollongong and Non-urban regions, and the whole GMR.

Table ES-3: Proportions of total estimated annual emissions from natural and human-made sources in each region

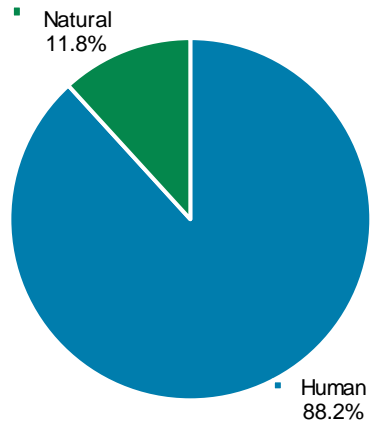
Substance	Region	Proportion (%)	
		Human-made	Natural
Carbon monoxide	Sydney	83.3	16.7
	Newcastle	75.0	25.0
	Wollongong	99.1	0.94
	Non-urban	9.27	90.7
	GMR	34.9	65.1
Oxides of nitrogen	Sydney	95.7	4.25
	Newcastle	92.5	7.49
	Wollongong	98.9	1.11
	Non-urban	85.5	14.5
	GMR	88.2	11.8
Particulate matter $\leq 10\mu\text{m}$	Sydney	72.7	27.3
	Newcastle	68.4	31.6
	Wollongong	88.2	11.8
	Non-urban	45.4	54.6
	GMR	49.4	50.6
Particulate matter $\leq 2.5\mu\text{m}$	Sydney	72.3	27.7
	Newcastle	54.2	45.8
	Wollongong	89.4	10.6
	Non-urban	18.6	81.4
	GMR	27.5	72.5
Sulfur dioxide	Sydney	96.4	3.63
	Newcastle	98.2	1.81
	Wollongong	99.8	0.20
	Non-urban	96.4	3.55
	GMR	96.6	3.41
Total volatile organic compounds	Sydney	75.2	24.8
	Newcastle	63.6	36.4
	Wollongong	58.5	41.5
	Non-urban	13.4	86.6
	GMR	39.6	60.4

Figure ES-2, Figure ES-3, Figure ES-4, Figure ES-5 and Figure ES-6 show the proportions of total estimated annual emissions of criteria pollutants from natural and human-made sources in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

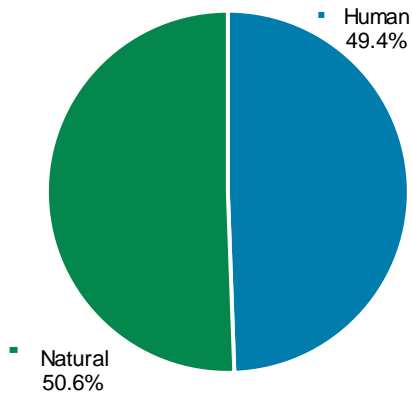
Carbon monoxide



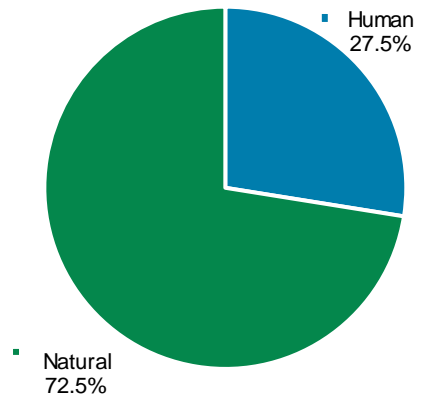
Oxides of nitrogen



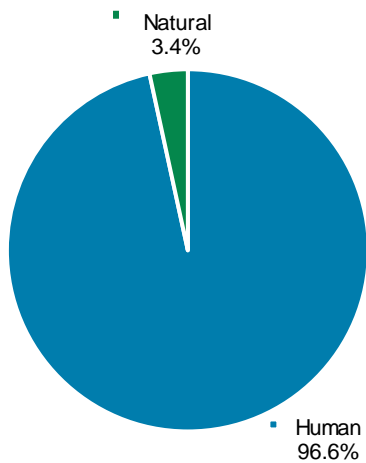
Particulate matter 10µm



Particulate matter 2.5µm



Sulfur dioxide



Total VOC

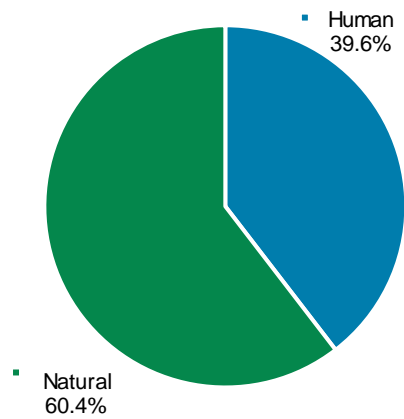


Figure ES-2: GMR: proportion of total estimated annual emissions from natural and human-made sources

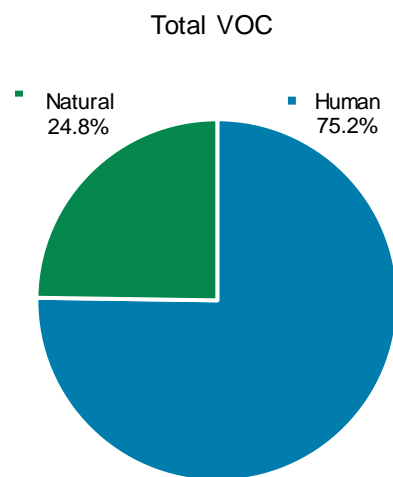
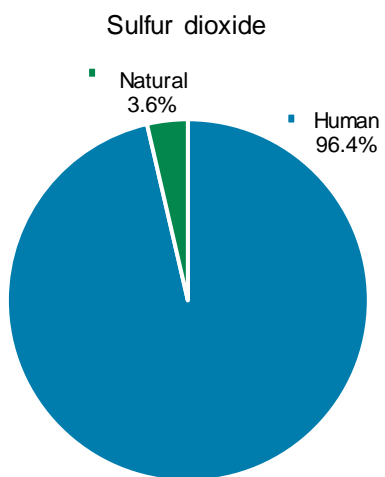
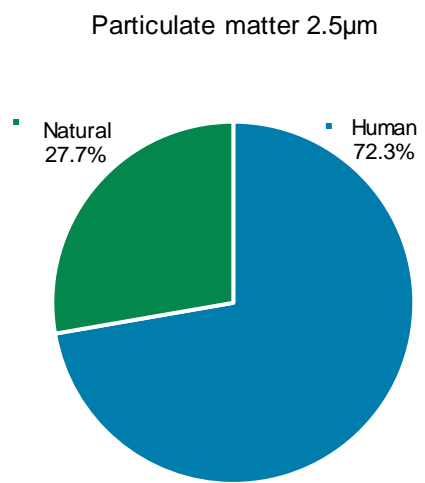
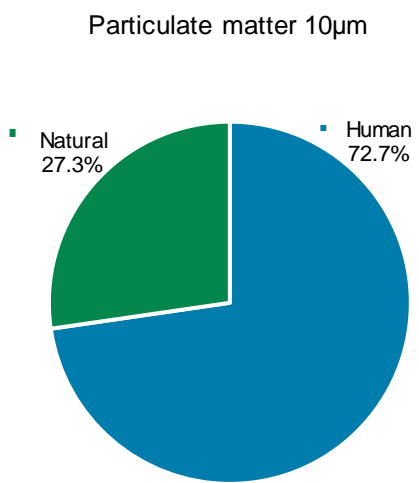
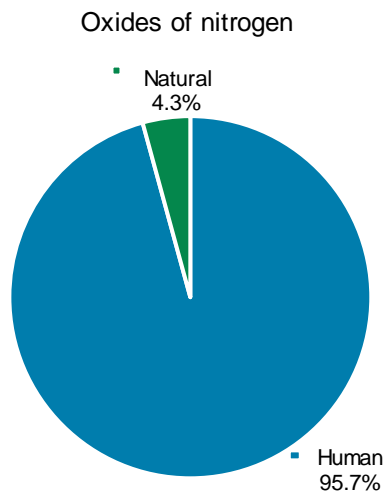
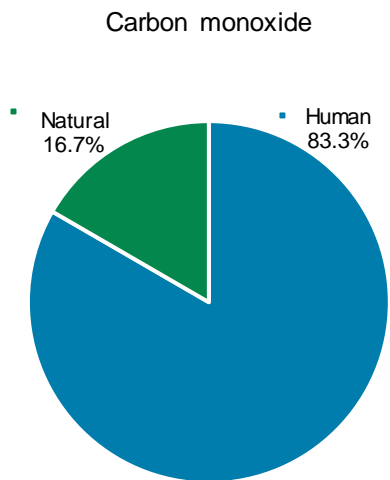


Figure ES-3: Sydney region: proportions of total estimated annual emissions from natural and human-made sources

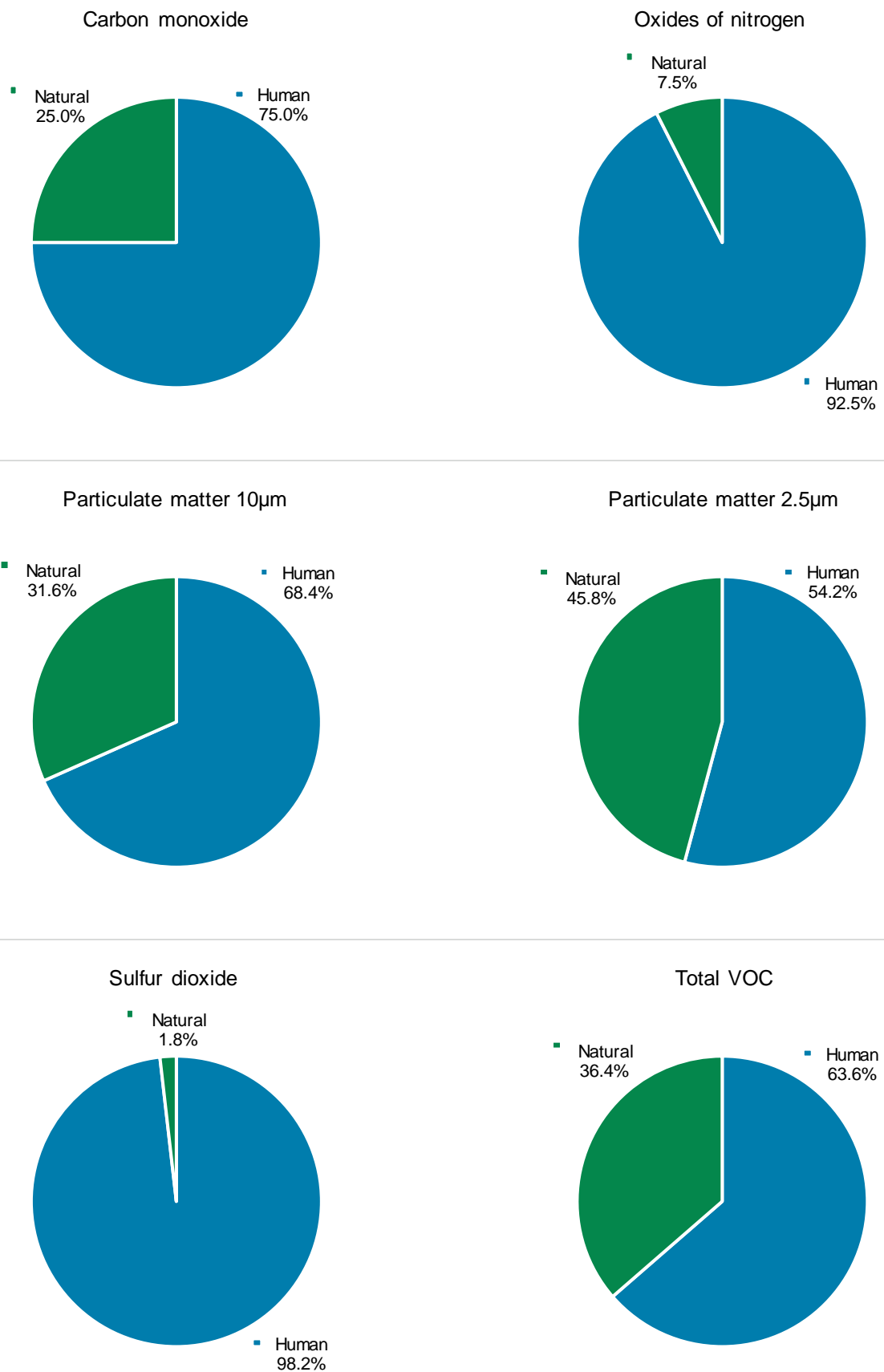


Figure ES-4: Newcastle region: proportions of total estimated annual emissions from natural and human-made sources

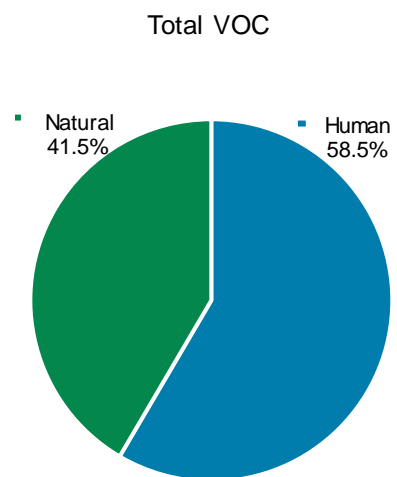
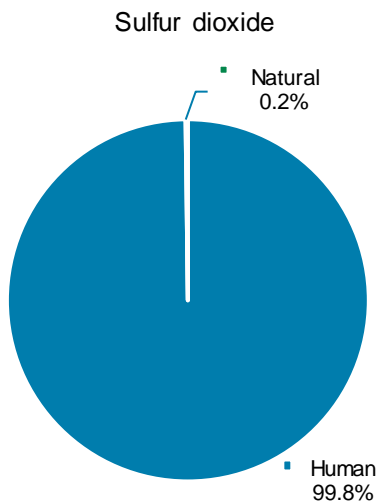
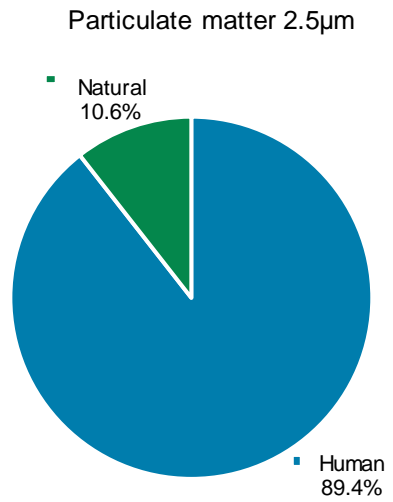
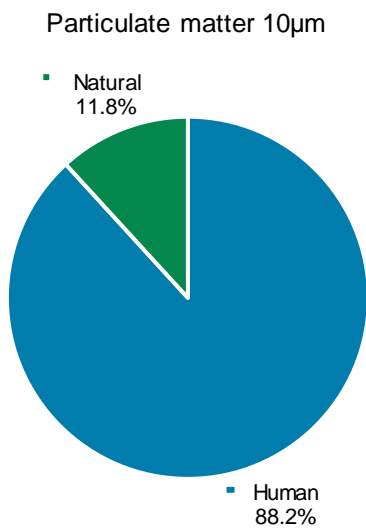
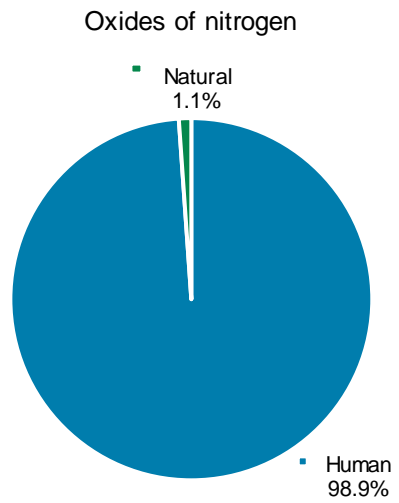
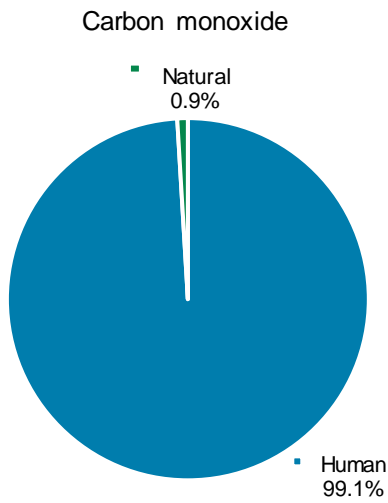
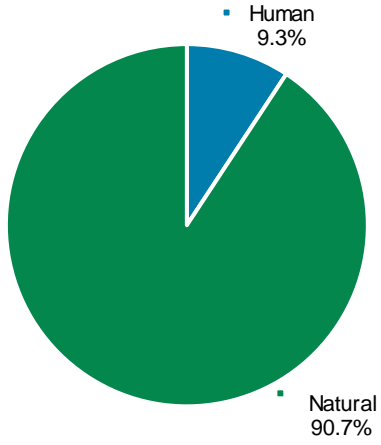
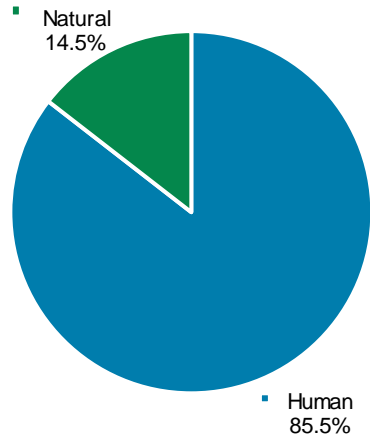


Figure ES-5: Wollongong region: proportions of total estimated annual emissions from natural and human-made sources

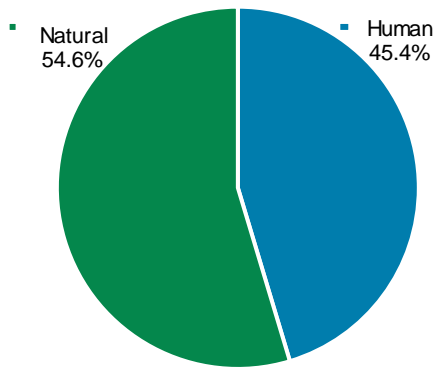
Carbon monoxide



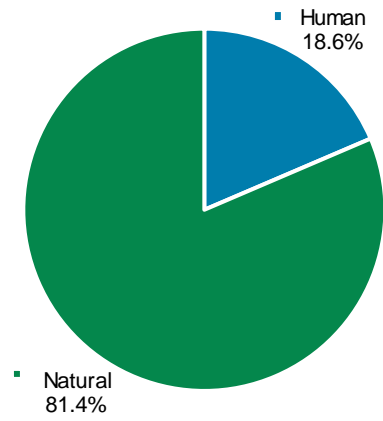
Oxides of nitrogen



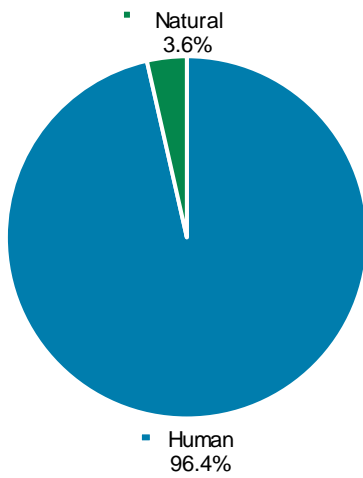
Particulate matter 10µm



Particulate matter 2.5µm



Sulfur dioxide



Total VOC

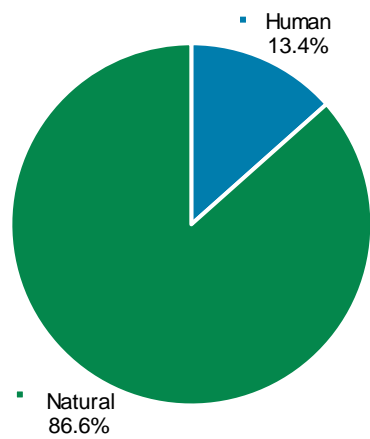


Figure ES-6: Non-urban region: proportions of total estimated annual emissions from natural and human-made sources

Table ES-4 presents total estimated annual emissions of criteria pollutants by human-made source type in the Sydney, Newcastle, Wollongong and Non-urban regions, and the whole GMR.

Table ES-4: Total estimated annual emissions by human-made source type in each region

Substance	Region	Emissions (tonnes/year)					Total ⁷
		Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile	
Carbon monoxide	Sydney	320	90,299	5,968	22,465	91,239	210,291
	Newcastle	9.68	6,838	43,489	3,802	6,649	60,789
	Wollongong	16.69	4,456	104,510	1,640	3,547	114,170
	Non-urban	31.26	18,072	17,179	33,720	13,827	82,829
	GMR ⁷	378	119,664	171,147	61,628	115,262	468,079
Oxides of nitrogen	Sydney	359	2,701	7,387	15,734	32,496	58,676
	Newcastle	38.13	187	2,016	4,104	2,788	9,133
	Wollongong	11.12	129	6,166	1,946	1,610	9,863
	Non-urban	154	457	145,396	37,136	8,191	191,334
	GMR	562	3,473	160,966	58,920	45,085	269,007
Particulate matter ≤ 10µm	Sydney	682	5,744	6,040	1,111	1,838	15,415
	Newcastle	82.44	432	4,016	283	156	4,969
	Wollongong	30.41	262	1,280	133	85.34	1,790
	Non-urban	492	1,296	75,087	1,736	427	79,038
	GMR	1,287	7,734	86,422	3,263	2,505	101,211
Particulate matter ≤ 2.5µm	Sydney	291	5,517	1,824	1,034	1,279	9,945
	Newcastle	19.28	415	1,289	263	107	2,093
	Wollongong	10.03	251	497	125	59.43	942
	Non-urban	112	1,245	12,921	1,665	305	16,248
	GMR	433	7,429	16,530	3,086	1,750	29,228
Sulfur dioxide	Sydney	78.95	124	3,057	6,790	97.36	10,148
	Newcastle	1.76	9.12	8,261	1,709	7.12	9,988
	Wollongong	0.74	5.75	4,190	640	4.06	4,840
	Non-urban	110	25.81	198,604	1,618	17.43	200,376
	GMR	192	165	214,112	10,757	126	225,351
Total volatile organic compounds	Sydney	9,561	57,399	9,369	7,552	12,641	96,521
	Newcastle	108	3,933	1,194	1,466	952	7,653
	Wollongong	79.91	2,750	362	612	497	4,300
	Non-urban	580	9,746	1,703	11,670	2,034	25,734
	GMR	10,330	73,828	12,628	21,300	16,124	134,209

⁷ The totals may differ from the sum of the addends due to rounding.

Table ES-5 presents the proportions of total estimated annual emissions of criteria pollutants by human-made source type in the Sydney, Newcastle, Wollongong and Non-urban regions, and the whole GMR.

Table ES-5: Proportions of total estimated annual emissions by human-made source type in each region

Substance	Region	Proportion (%) ⁸				
		Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile
Carbon monoxide	Sydney	0.15	42.9	2.84	10.7	43.4
	Newcastle	1.59×10 ⁻²	11.2	71.5	6.26	10.9
	Wollongong	1.46×10 ⁻²	3.90	91.5	1.44	3.11
	Non-urban	3.77×10 ⁻²	21.8	20.7	40.7	16.7
	GMR	8.08×10 ⁻²	25.6	36.6	13.2	24.6
Oxides of nitrogen	Sydney	0.61	4.60	12.6	26.8	55.4
	Newcastle	0.42	2.04	22.1	44.9	30.5
	Wollongong	0.11	1.31	62.5	19.7	16.3
	Non-urban	8.06×10 ⁻²	0.24	76.0	19.4	4.28
	GMR	0.21	1.29	59.8	21.9	16.8
Particulate matter ≤ 10µm	Sydney	4.43	37.3	39.2	7.21	11.9
	Newcastle	1.66	8.70	80.8	5.70	3.13
	Wollongong	1.70	14.6	71.5	7.44	4.77
	Non-urban	0.62	1.64	95.0	2.20	0.54
	GMR	1.27	7.64	85.4	3.22	2.48
Particulate matter ≤ 2.5µm	Sydney	2.93	55.5	18.3	10.4	12.9
	Newcastle	0.92	19.8	61.6	12.5	5.12
	Wollongong	1.06	26.6	52.7	13.2	6.31
	Non-urban	0.69	7.66	79.5	10.2	1.88
	GMR	1.48	25.4	56.6	10.6	5.99
Sulfur dioxide	Sydney	0.78	1.22	30.1	66.9	0.96
	Newcastle	1.76×10 ⁻²	9.13×10 ⁻²	82.7	17.1	7.13×10 ⁻²
	Wollongong	1.53×10 ⁻²	0.12	86.6	13.2	8.38×10 ⁻²
	Non-urban	5.50×10 ⁻²	1.29×10 ⁻²	99.1	0.81	8.70×10 ⁻³
	GMR	8.50×10 ⁻²	7.31×10 ⁻²	95.0	4.77	5.59×10 ⁻²
Total volatile organic compounds	Sydney	9.91	59.5	9.71	7.82	13.1
	Newcastle	1.41	51.4	15.6	19.2	12.4
	Wollongong	1.86	63.9	8.41	14.2	11.6
	Non-urban	2.25	37.9	6.62	45.3	7.90
	GMR	7.70	55.0	9.41	15.9	12.0

⁸ Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g. 9.46×10⁻² = 0.0946).

Figure ES-7, Figure ES-8, Figure ES-9, Figure ES-10 and Figure ES-11 show the proportions of total estimated annual emissions of criteria pollutants by human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

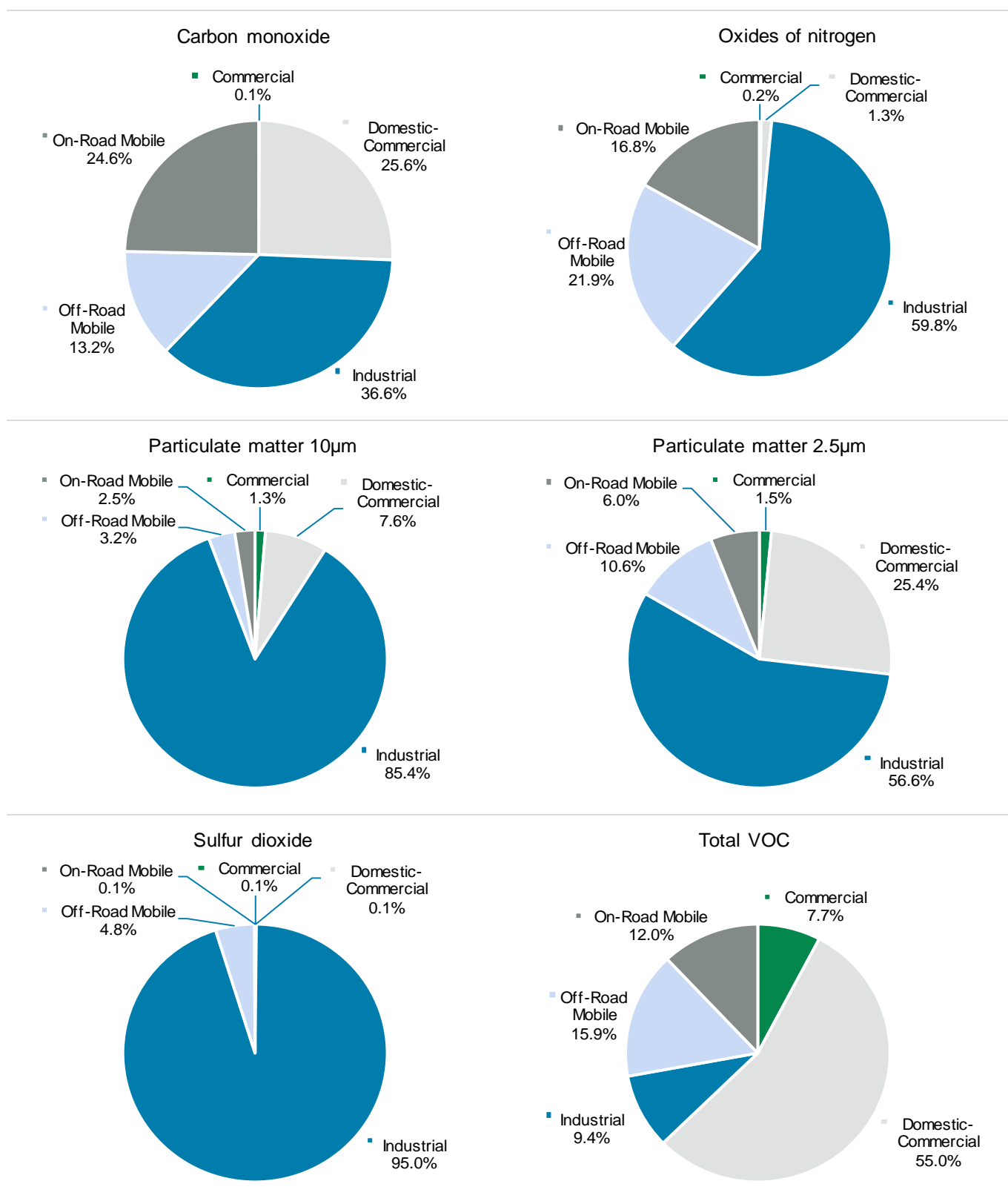


Figure ES-7: GMR: proportions of total estimated annual emissions by human-made source type

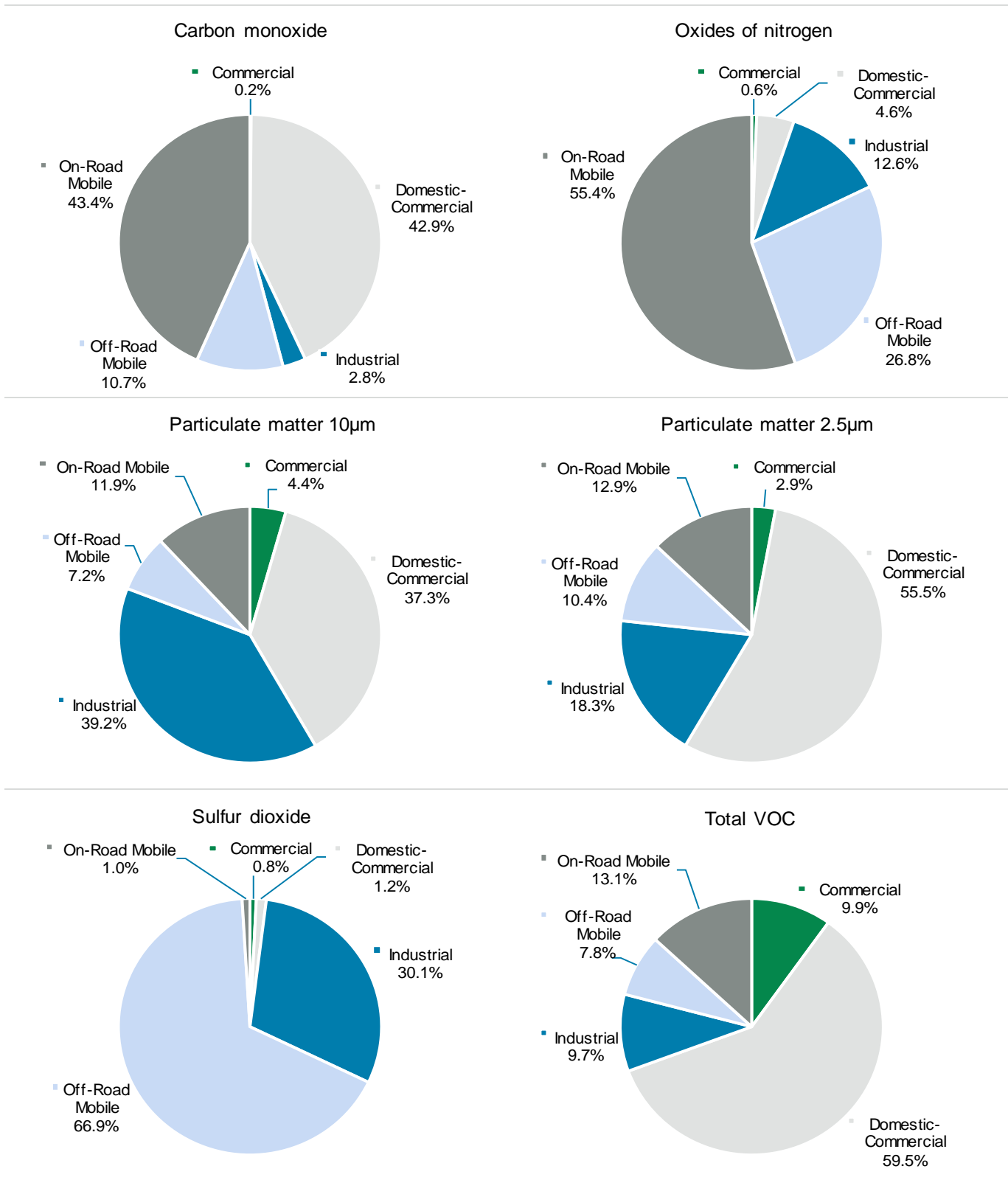


Figure ES-8: Sydney region: proportions of total estimated annual emissions by human-made source type

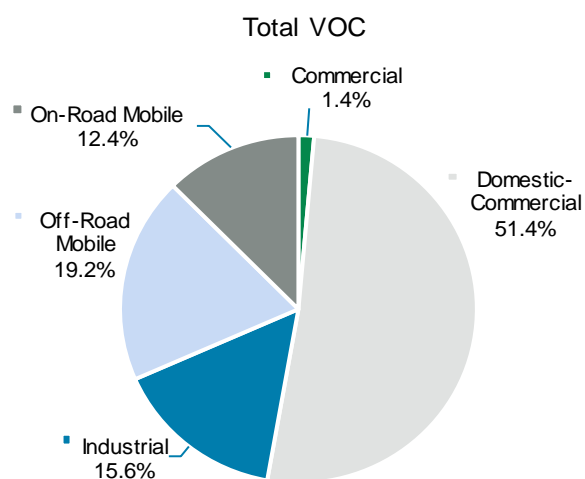
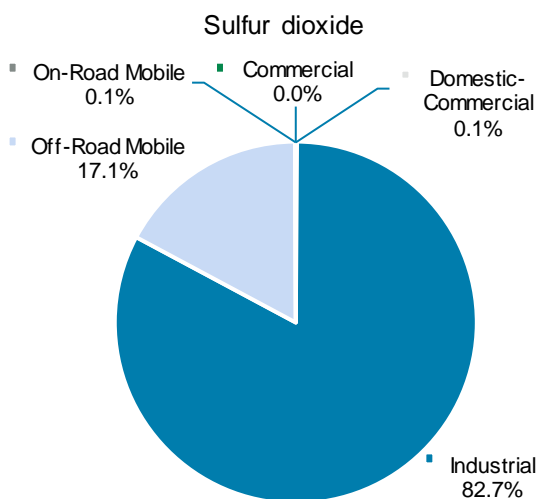
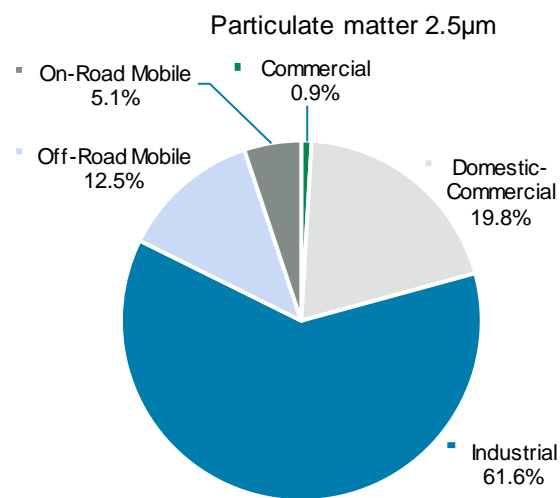
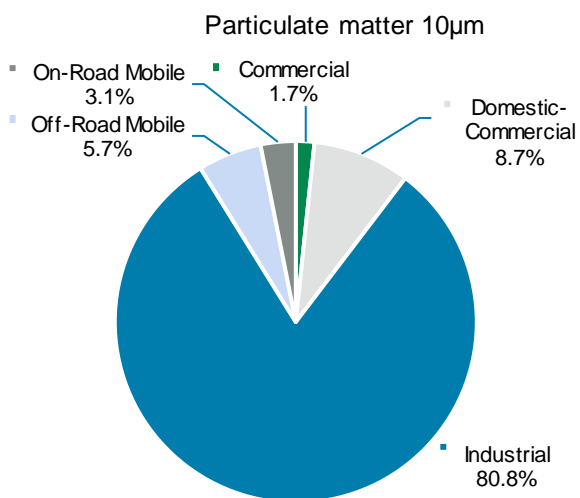
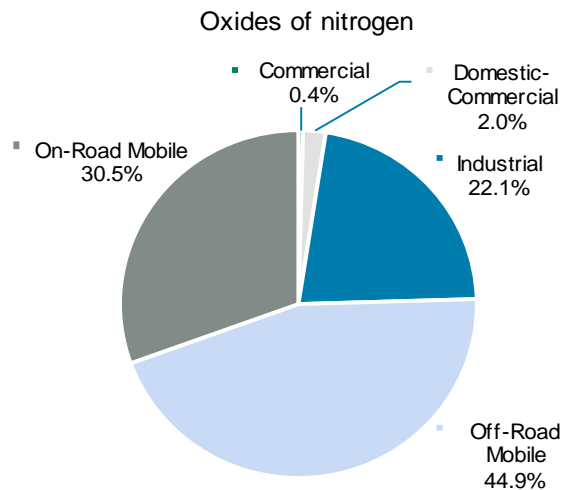
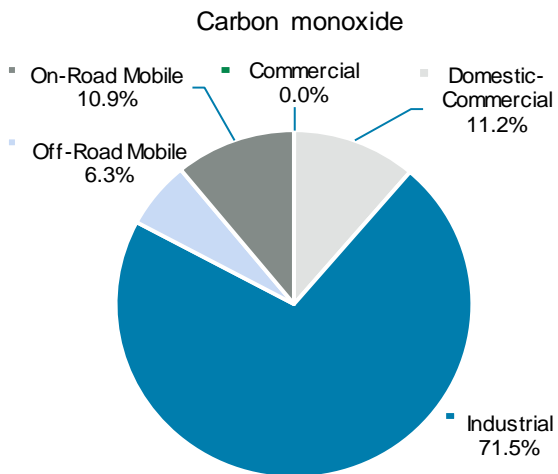


Figure ES-9: Newcastle region: proportions of total estimated annual emissions by human-made source type

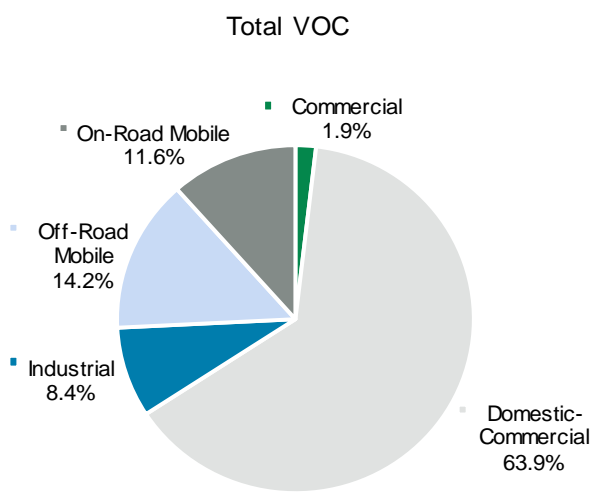
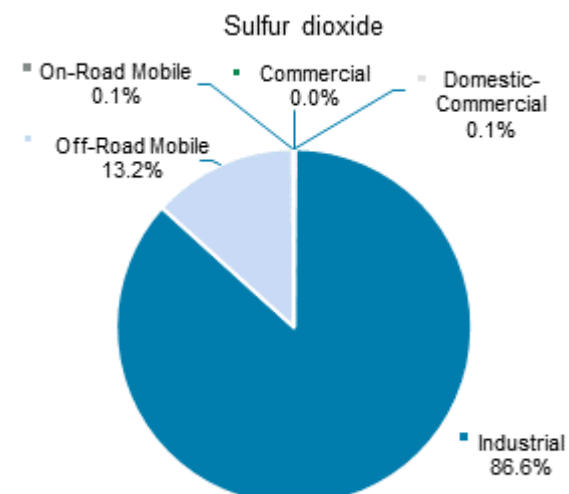
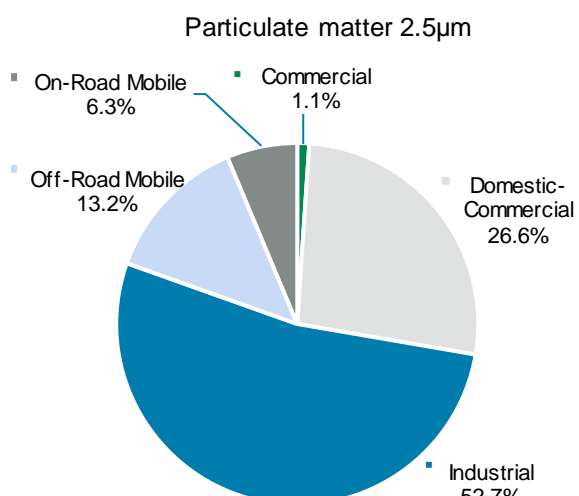
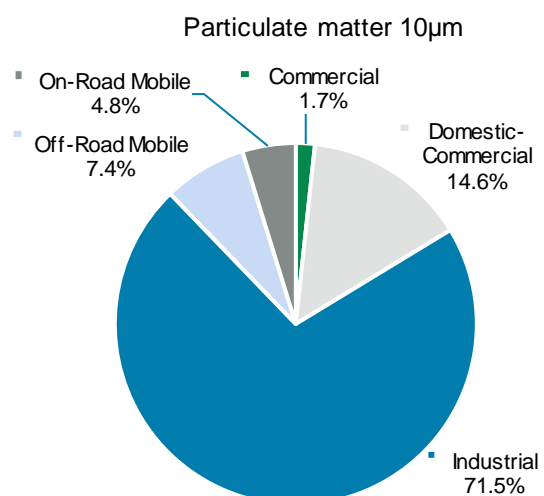
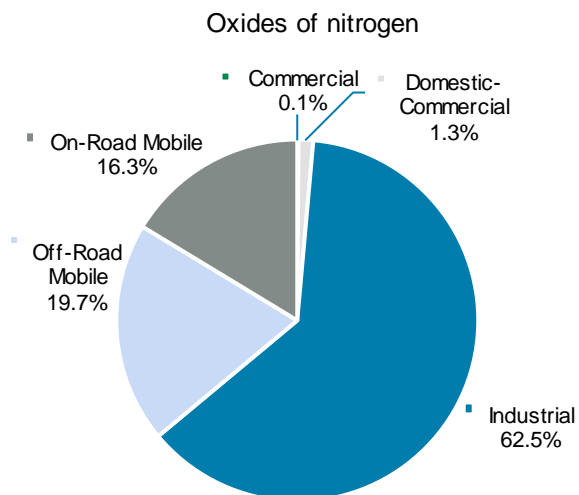
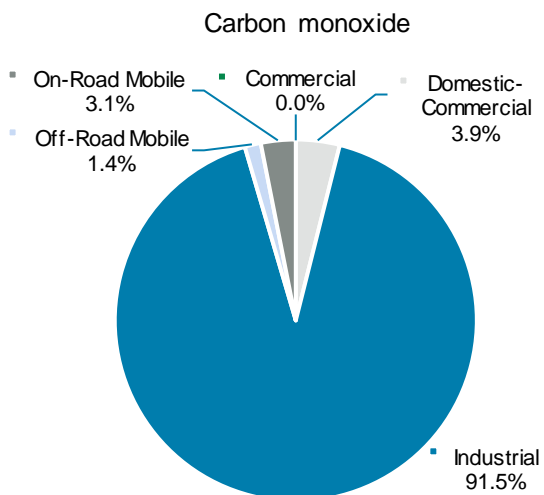


Figure ES-10: Wollongong region: proportions of total estimated annual emissions by human-made source type

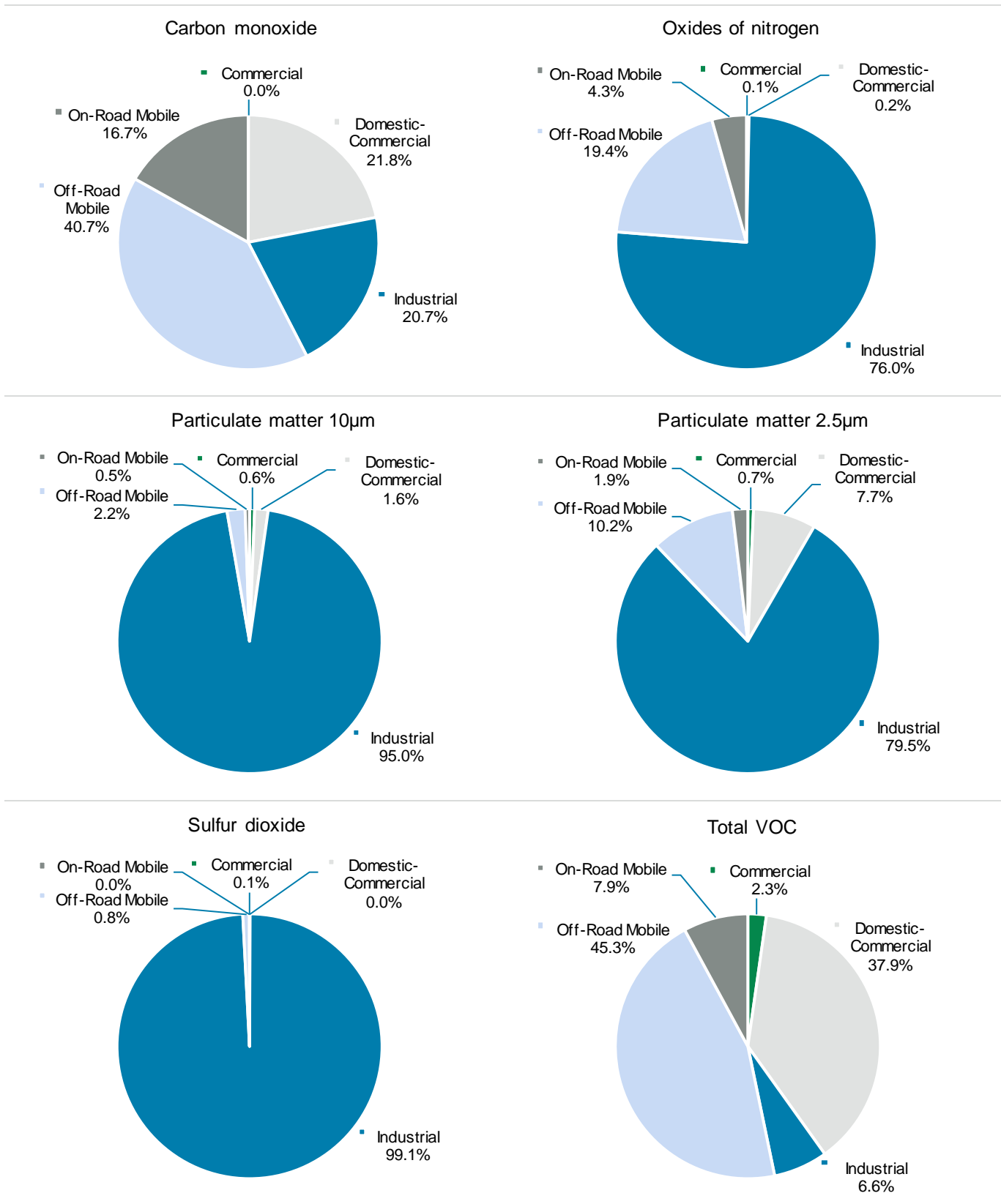


Figure ES-11: Non-urban region: proportions of total estimated annual emissions by human-made source type

Table ES-6 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of carbon monoxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table ES-6: Top 10 human-made sources of carbon monoxide in each region

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Top 10 human-made carbon monoxide sources in the GMR				
Industrial	Iron or steel production (iron ore)	103,354	22.1	22.1
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	79,074	16.9	39.0
Domestic-Commercial	Solid Fuel Burning (Domestic)	50,117	10.7	49.7
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	45,363	9.69	59.4
Industrial	Aluminium production (alumina)	40,709	8.70	68.1
Off-Road Mobile	Commercial Boats Exhaust	27,225	5.82	73.9
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	23,995	5.13	79.0
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	22,657	4.84	83.9
Off-Road Mobile	Recreational Boats Exhaust	16,490	3.52	87.4
Off-Road Mobile	Industrial Vehicles and Equipment	11,822	2.53	89.9
Human-made	Other	47,273	10.1	100.0
Top 10 human-made carbon monoxide sources in the Sydney region				
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	62,708	29.8	29.8
Domestic-Commercial	Solid Fuel Burning (Domestic)	37,063	17.6	47.4
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	33,868	16.1	63.5
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	19,688	9.36	72.9
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	18,161	8.64	81.5
Off-Road Mobile	Recreational Boats Exhaust	8,411	4.00	85.5
Off-Road Mobile	Commercial Boats Exhaust	7,616	3.62	89.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	3,706	1.76	90.9
Off-Road Mobile	Aircraft (Flight Operations)	2,936	1.40	92.3
On-Road Mobile	Others - Exhaust	2,897	1.38	93.7
Human-made	Other	13,236	6.29	100.0
Top 10 human-made carbon monoxide sources in the Newcastle region				
Industrial	Aluminium production (alumina)	40,709	67.0	67.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	4,776	7.86	74.8
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	2,840	4.67	79.5
Domestic-Commercial	Solid Fuel Burning (Domestic)	2,800	4.61	84.1
Off-Road Mobile	Commercial Boats Exhaust	2,560	4.21	88.3
Industrial	Iron or steel production (scrap metal)	2,038	3.35	91.7
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	1,126	1.85	93.5
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	1,116	1.84	95.4

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Off-Road Mobile	Recreational Boats Exhaust	736	1.21	96.6
Industrial	Ammonium nitrate production	411	0.68	97.2
Human-made	Other	1,674	2.75	100.0
Top 10 human-made carbon monoxide sources in the Wollongong region				
Industrial	Iron or steel production (iron ore)	103,354	90.5	90.5
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	2,541	2.23	92.8
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	1,899	1.66	94.4
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,668	1.46	95.9
Off-Road Mobile	Recreational Boats Exhaust	1,045	0.92	96.8
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	831	0.73	97.5
Industrial	Generation of electrical power from gas	820	0.72	98.2
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	586	0.51	98.8
Off-Road Mobile	Industrial Vehicles and Equipment	333	0.29	99.0
Industrial	Metal plating or coating	289	0.25	99.3
Human-made	Other	804	0.70	100.0
Top 10 human-made carbon monoxide sources in the Non-urban region				
Off-Road Mobile	Commercial Boats Exhaust	16,871	20.4	20.4
Off-Road Mobile	Industrial Vehicles and Equipment	9,309	11.2	31.6
Industrial	Mining for coal	9,122	11.0	42.6
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	9,050	10.9	53.5
Domestic-Commercial	Solid Fuel Burning (Domestic)	8,586	10.4	63.9
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	6,755	8.16	72.1
Off-Road Mobile	Recreational Boats Exhaust	6,298	7.60	79.7
Industrial	Generation of electrical power from coal	6,093	7.36	87.0
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	2,594	3.13	90.2
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	2,549	3.08	93.2
Human-made	Other	5,602	6.76	100.0

Figure ES-12, Figure ES-13, Figure ES-14, Figure ES-15 and Figure ES-16 show the proportions of total estimated annual emissions for the top 10 human-made sources of carbon monoxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

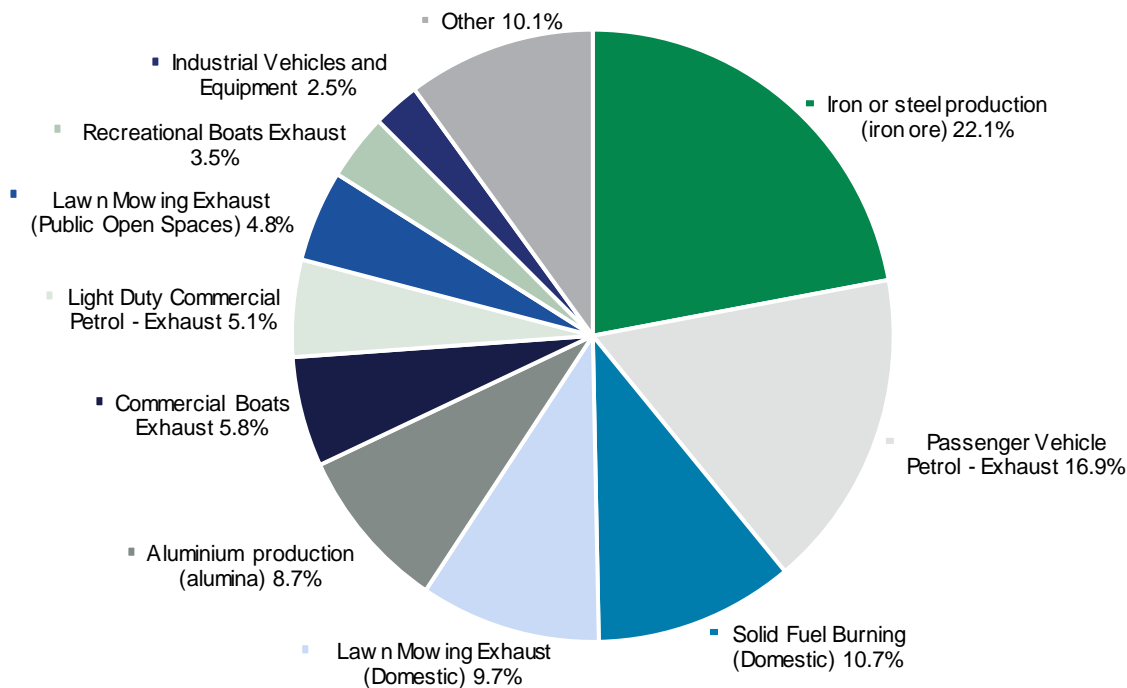


Figure ES-12: GMR: top 10 human-made sources of carbon monoxide

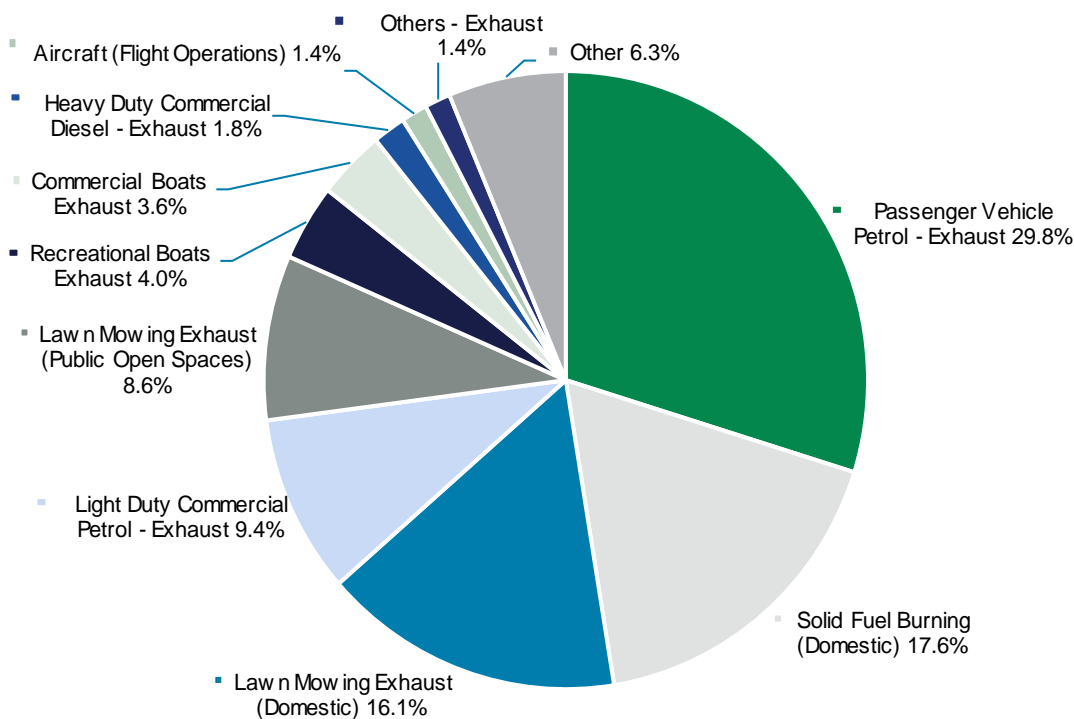


Figure ES-13: Sydney region: top 10 human-made sources of carbon monoxide

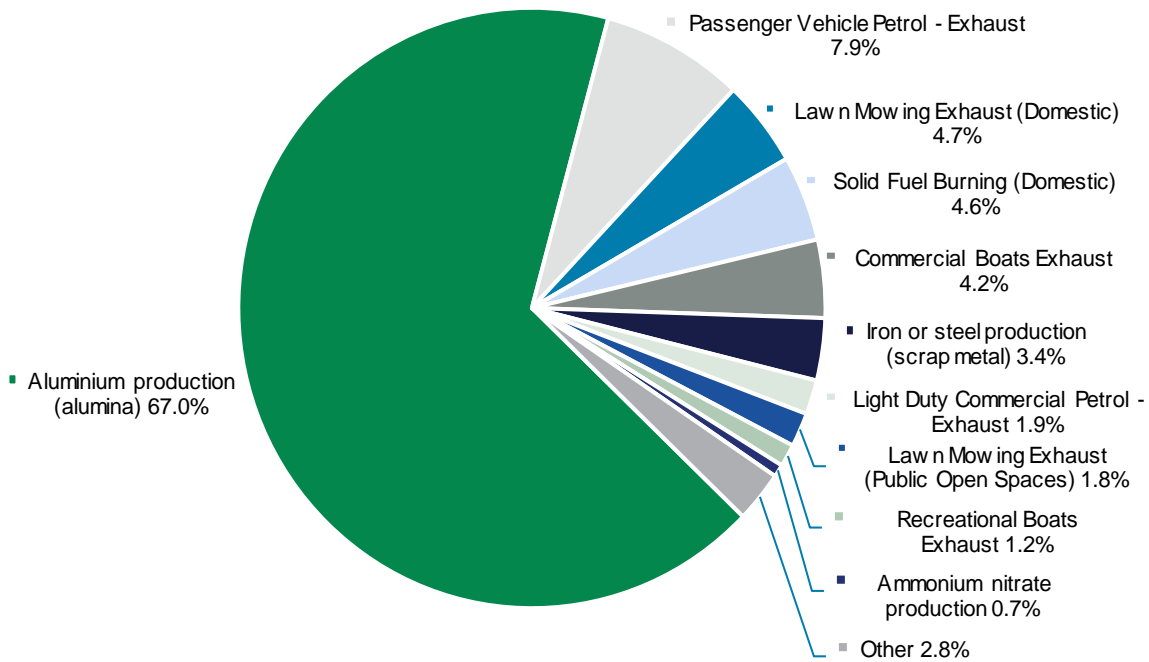


Figure ES-14: Newcastle region: top 10 human-made sources of carbon monoxide

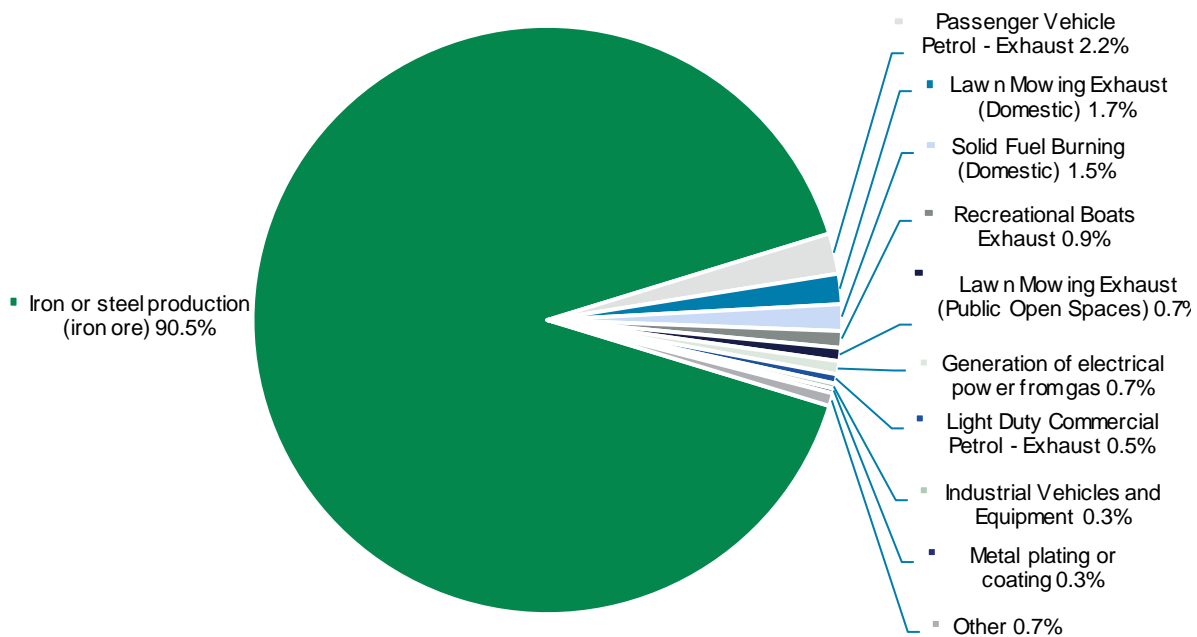


Figure ES-15: Wollongong region: top 10 human-made sources of carbon monoxide

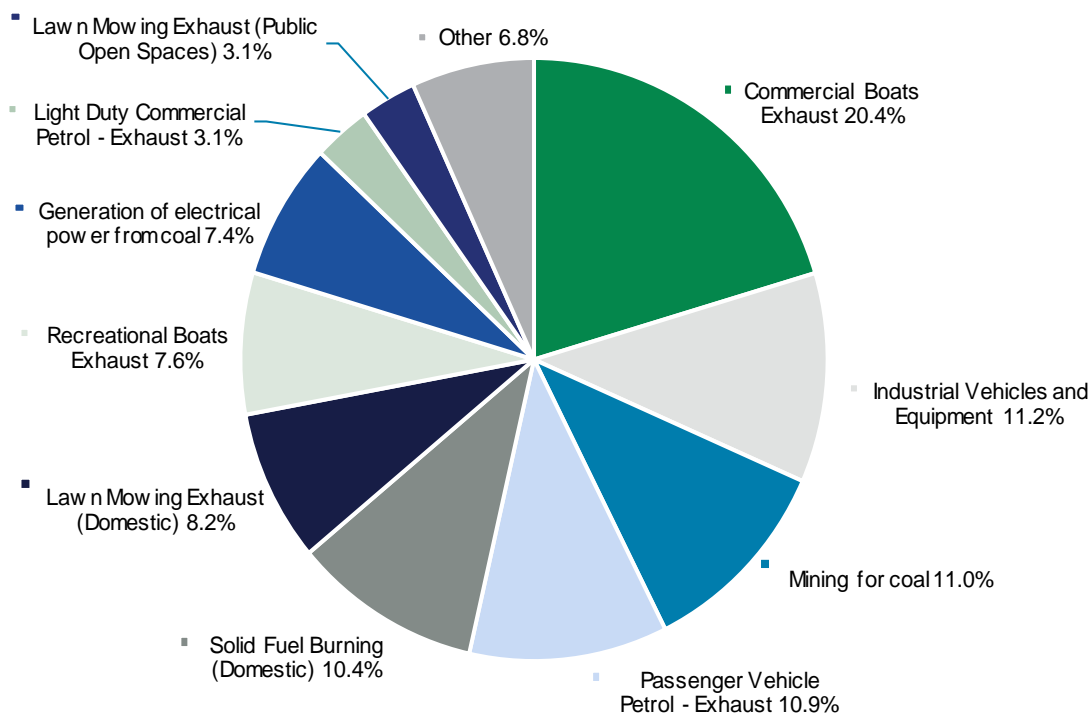


Figure ES-16: Non-urban region: top 10 human-made sources of carbon monoxide

Table ES-7 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of oxides of nitrogen in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table ES-7: Top 10 human-made sources of oxides of nitrogen in each region

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Top 10 human-made oxides of nitrogen sources in the GMR				
Industrial	Generation of electrical power from coal	139,246	51.8	51.8
Off-Road Mobile	Industrial Vehicles and Equipment	30,767	11.4	63.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	20,564	7.64	70.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	13,273	4.93	75.8
Off-Road Mobile	Ships	12,373	4.60	80.4
Off-Road Mobile	Locomotives	9,093	3.38	83.8
On-Road Mobile	Light Duty Diesel - Exhaust	6,631	2.47	86.2
Industrial	Iron or steel production (iron ore)	5,772	2.15	88.4
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	4,490	1.67	90.0
Industrial	Cement or lime production	3,985	1.48	91.5
Human-made	Other	22,812	8.48	100.0

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Top 10 human-made oxides of nitrogen sources in the Sydney region				
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	13,694	23.3	23.3
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	10,039	17.1	40.4
Off-Road Mobile	Ships	6,874	11.7	52.2
On-Road Mobile	Light Duty Diesel - Exhaust	5,230	8.91	61.1
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	3,443	5.87	66.9
Off-Road Mobile	Industrial Vehicles and Equipment	2,840	4.84	71.8
Off-Road Mobile	Commercial Boats Exhaust	2,154	3.67	75.5
Off-Road Mobile	Aircraft (Flight Operations)	1,966	3.35	78.8
Industrial	Generation of electrical power from gas	1,905	3.25	82.1
Domestic-Commercial	Gaseous Fuel Burning	1,705	2.91	85.0
Human-made	Other	8,827	15.0	100.0
Top 10 human-made oxides of nitrogen sources in the Newcastle region				
Off-Road Mobile	Ships	2,293	25.1	25.1
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	1,339	14.7	39.8
Industrial	Ammonium nitrate production	1,301	14.2	54.0
Off-Road Mobile	Locomotives	1,115	12.2	66.2
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	857	9.38	75.6
Off-Road Mobile	Industrial Vehicles and Equipment	360	3.94	79.5
On-Road Mobile	Light Duty Diesel - Exhaust	344	3.77	83.3
Off-Road Mobile	Commercial Boats Exhaust	251	2.74	86.1
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	240	2.62	88.7
Industrial	Iron or steel production (scrap metal)	186	2.04	90.7
Human-made	Other	848	9.29	100.0
Top 10 human-made oxides of nitrogen sources in the Wollongong region				
Industrial	Iron or steel production (iron ore)	5,772	58.5	58.5
Off-Road Mobile	Industrial Vehicles and Equipment	935	9.48	68.0
Off-Road Mobile	Ships	781	7.92	75.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	774	7.85	83.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	504	5.11	88.9
Industrial	Generation of electrical power from gas	328	3.33	92.2
On-Road Mobile	Light Duty Diesel - Exhaust	190	1.93	94.1
Off-Road Mobile	Locomotives	163	1.65	95.8
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	136	1.38	97.2

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Domestic-Commercial	Gaseous Fuel Burning	82.22	0.83	98.0
Human-made	Other	197	1.99	100.0
Top 10 human-made oxides of nitrogen sources in the Non-urban region				
Industrial	Generation of electrical power from coal	139,246	72.8	72.8
Off-Road Mobile	Industrial Vehicles and Equipment	26,632	13.9	86.7
Off-Road Mobile	Locomotives	6,513	3.40	90.1
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	4,757	2.49	92.6
Industrial	Cement or lime production	3,104	1.62	94.2
Industrial	Mining for coal	2,481	1.30	95.5
Off-Road Mobile	Ships	2,425	1.27	96.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	1,874	0.98	97.8
Off-Road Mobile	Commercial Boats Exhaust	1,205	0.63	98.4
On-Road Mobile	Light Duty Diesel - Exhaust	867	0.45	98.8
Human-made	Other	2,231	1.17	100.0

Figure ES-17, Figure ES-18, Figure ES-19, Figure ES-20 and Figure ES-21 show the proportions of total estimated annual emissions for the top 10 human-made sources of oxides of nitrogen in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

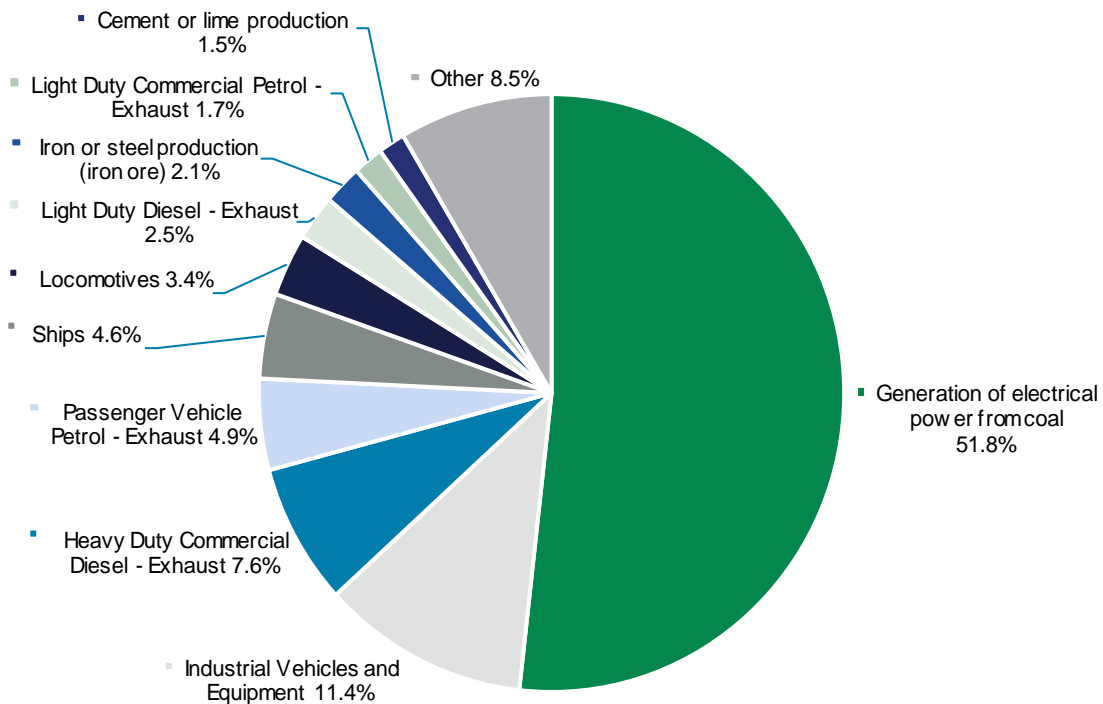


Figure ES-17: GMR: top 10 human-made sources of oxides of nitrogen

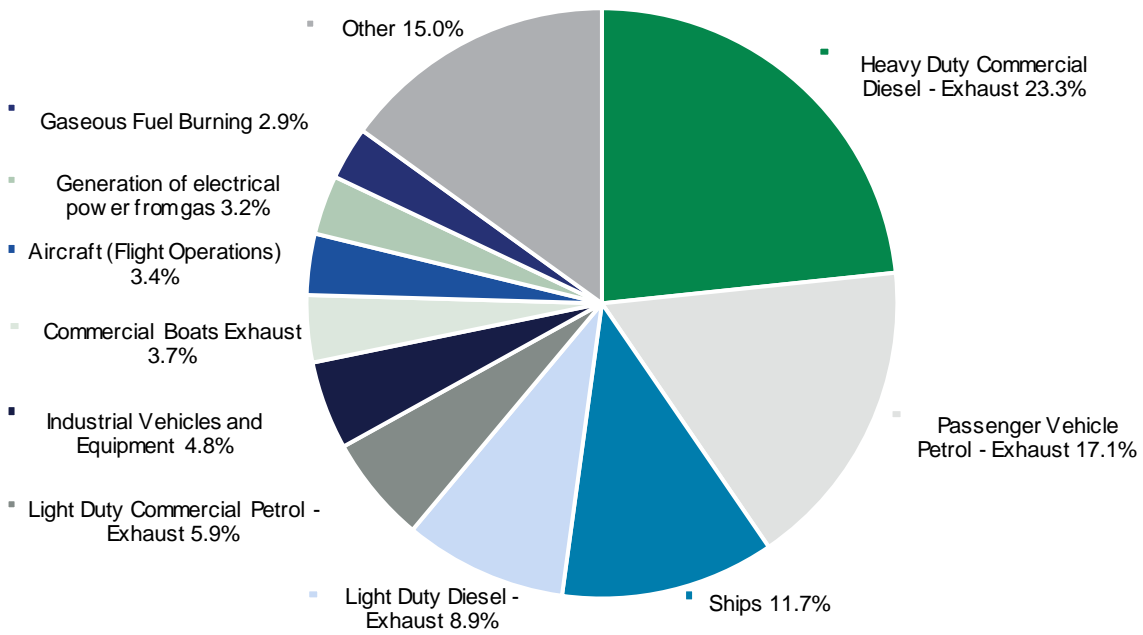


Figure ES-18: Sydney region: top 10 human-made sources of oxides of nitrogen

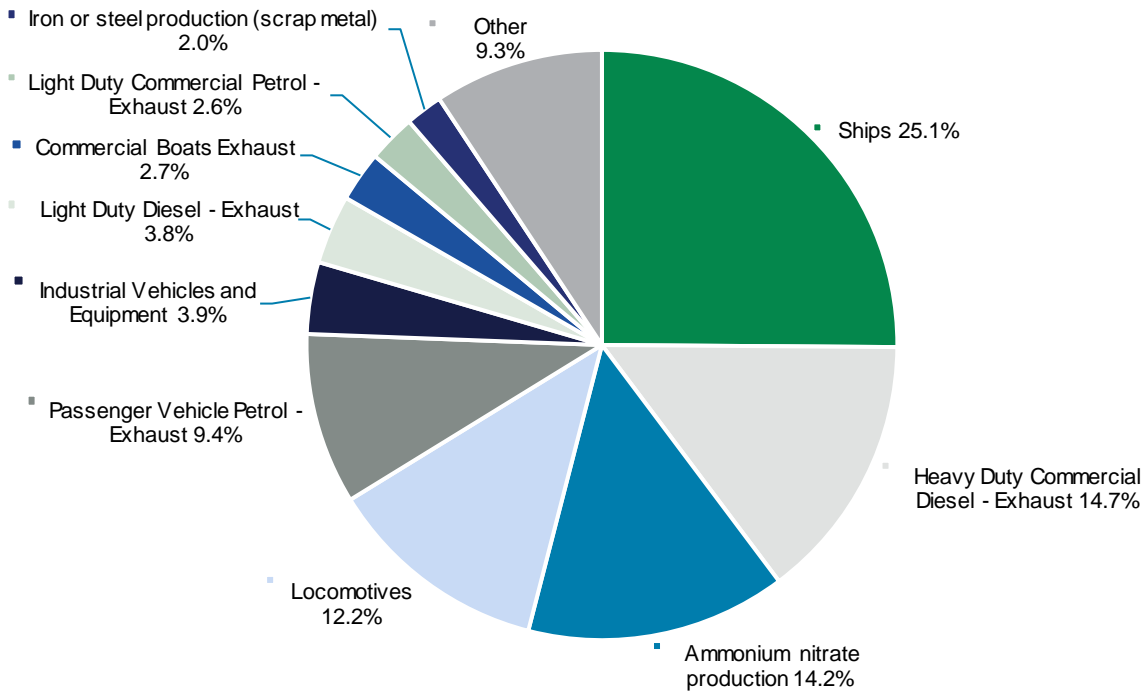


Figure ES-19: Newcastle region: top 10 human-made sources of oxides of nitrogen

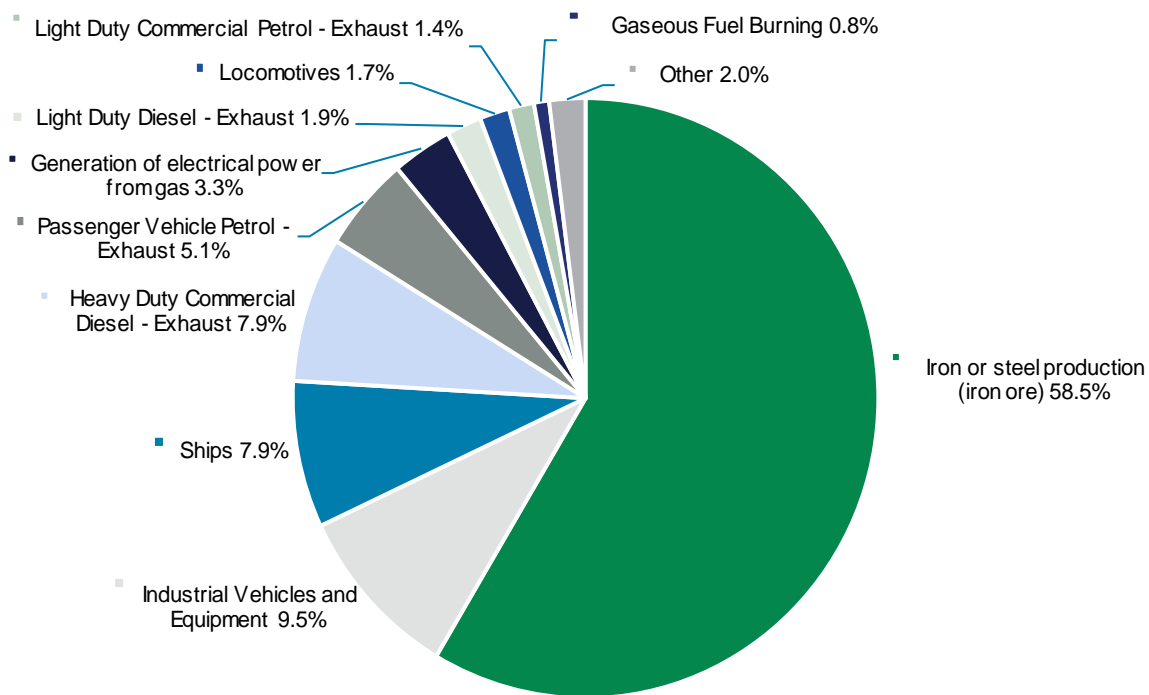


Figure ES-20: Wollongong region: top 10 human-made sources of oxides of nitrogen

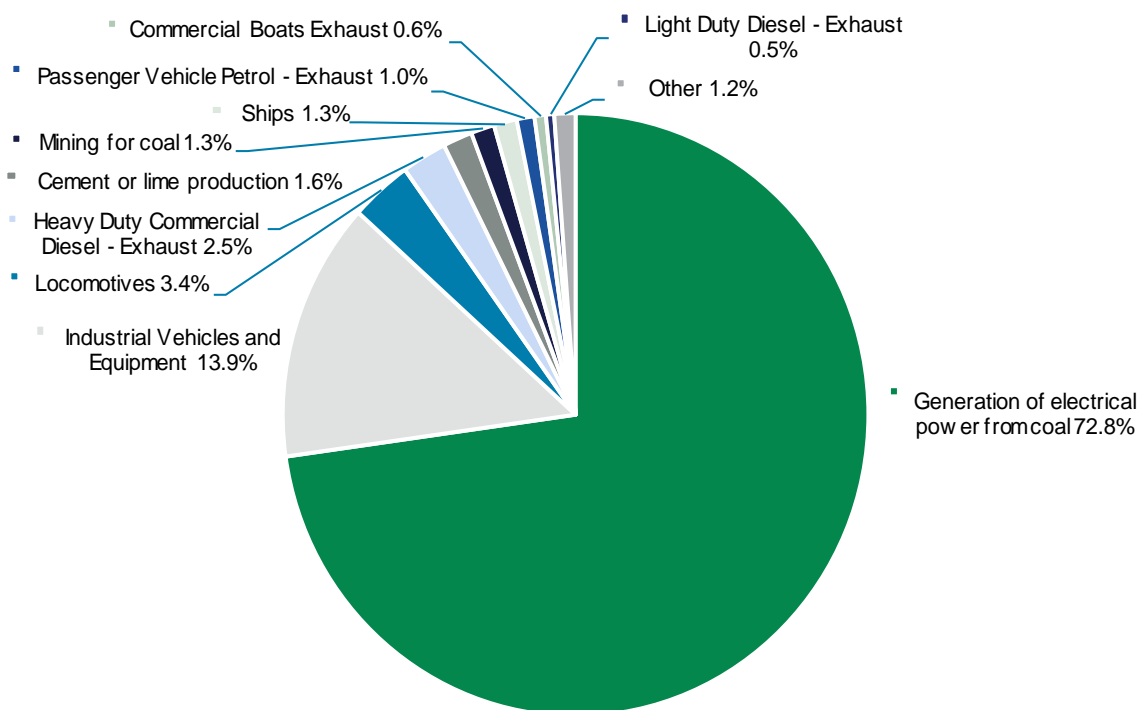


Figure ES-21: Non-urban region: top 10 human-made sources of oxides of nitrogen

Table ES-8 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$ in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table ES-8: Top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$ in each region

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Top 10 human-made particulate matter $\leq 10\mu\text{m}$ sources in the GMR				
Industrial	Mining for coal	68,020	67.2	67.2
Domestic-Commercial	Solid Fuel Burning (Domestic)	7,036	6.95	74.2
Industrial	Generation of electrical power from coal	3,623	3.58	77.7
Industrial	Land-based extractive activity	3,071	3.03	80.8
Industrial	Ceramics production	1,580	1.56	82.3
Industrial	Waste disposal (application to land)	1,563	1.54	83.9
On-Road Mobile	All - Non-Exhaust PM	1,548	1.53	85.4
Off-Road Mobile	Industrial Vehicles and Equipment	1,371	1.35	86.8
Off-Road Mobile	Ships	1,275	1.26	88.0
Industrial	Coal works	1,169	1.15	89.2
Human-made	Other	10,955	10.8	100.0
Top 10 human-made particulate matter $\leq 10\mu\text{m}$ sources in the Sydney region				
Domestic-Commercial	Solid Fuel Burning (Domestic)	5,203	33.8	33.8
Industrial	Waste disposal (application to land)	1,221	7.92	41.7
On-Road Mobile	All - Non-Exhaust PM	1,148	7.44	49.1
Industrial	Ceramics production	890	5.78	54.9
Off-Road Mobile	Ships	774	5.02	59.9
Industrial	Crushing, grinding or separating	666	4.32	64.2
Industrial	Mining for coal	479	3.11	67.3
Industrial	Land-based extractive activity	451	2.92	70.3
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	431	2.79	73.1
Commercial	Gravel and Sand Quarrying	342	2.22	75.3
Human-made	Other	3,810	24.7	100.0
Top 10 human-made particulate matter $\leq 10\mu\text{m}$ sources in the Newcastle region				
Industrial	Mining for coal	1,480	29.8	29.8
Industrial	Coal works	901	18.1	47.9
Industrial	Aluminium production (alumina)	506	10.2	58.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	393	7.91	66.0
Industrial	Ammonium nitrate production	328	6.61	72.6
Industrial	Land-based extractive activity	225	4.53	77.2
Off-Road Mobile	Ships	215	4.32	81.5
Industrial	Waste disposal (application to land)	121	2.43	83.9

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
On-Road Mobile	All - Non-Exhaust PM	99.69	2.01	85.9
Industrial	Non-thermal treatment of waste	87.42	1.76	87.7
Human-made	Other	612	12.3	100.0
Top 10 human-made particulate matter ≤ 10µm sources in the Wollongong region				
Industrial	Iron or steel production (iron ore)	915	51.1	51.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	234	13.1	64.2
Industrial	Coal works	131	7.30	71.5
Industrial	Mining for coal	113	6.32	77.8
Off-Road Mobile	Ships	78.06	4.36	82.2
Industrial	Generation of electrical power from gas	65.58	3.66	85.9
On-Road Mobile	All - Non-Exhaust PM	53.21	2.97	88.8
Off-Road Mobile	Industrial Vehicles and Equipment	41.95	2.34	91.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	22.13	1.24	92.4
Industrial	Waste disposal (application to land)	20.03	1.12	93.5
Human-made	Other	116	6.47	100.0
Top 10 human-made particulate matter ≤ 10µm sources in the Non-urban region				
Industrial	Mining for coal	65,948	83.4	83.4
Industrial	Generation of electrical power from coal	3,623	4.58	88.0
Industrial	Land-based extractive activity	2,395	3.03	91.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,205	1.53	92.6
Off-Road Mobile	Industrial Vehicles and Equipment	1,196	1.51	94.1
Industrial	Boat mooring and storage	945	1.20	95.3
Industrial	Ceramics production	689	0.87	96.2
Industrial	Cement or lime production	482	0.61	96.8
Commercial	Gravel and Sand Quarrying	336	0.43	97.2
On-Road Mobile	All - Non-Exhaust PM	248	0.31	97.5
Human-made	Other	1,969	2.49	100.0

Figure ES-22, Figure ES-23, Figure ES-24, Figure ES-25 and Figure ES-26 show the proportions of total estimated annual emissions for the top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$ in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

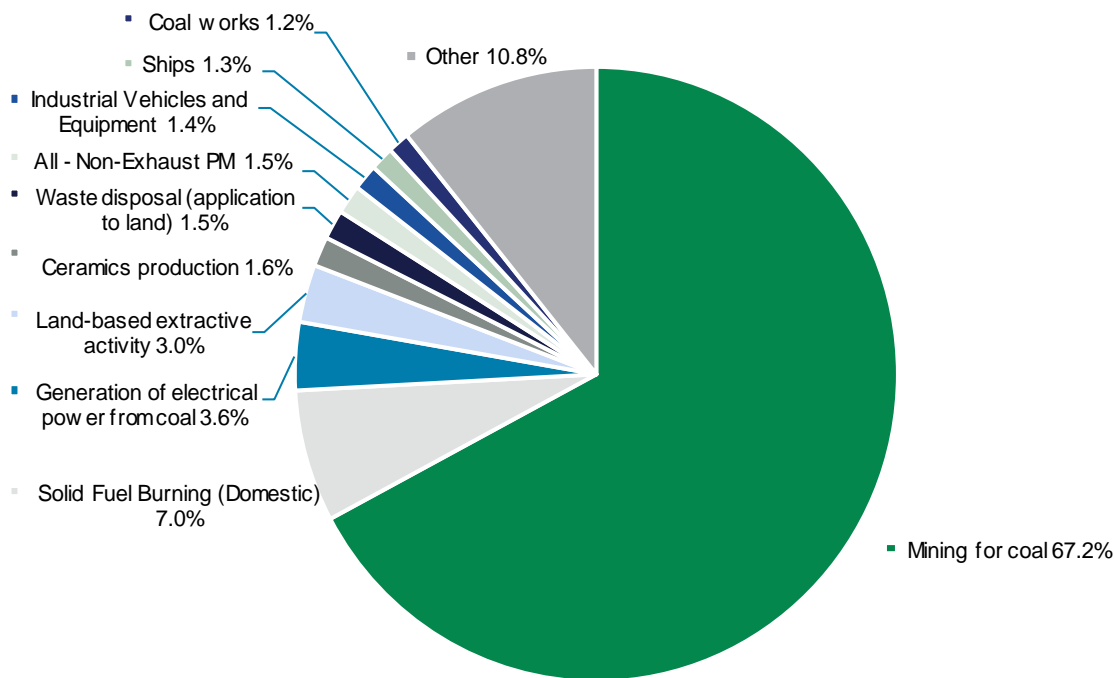


Figure ES-22: GMR: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$

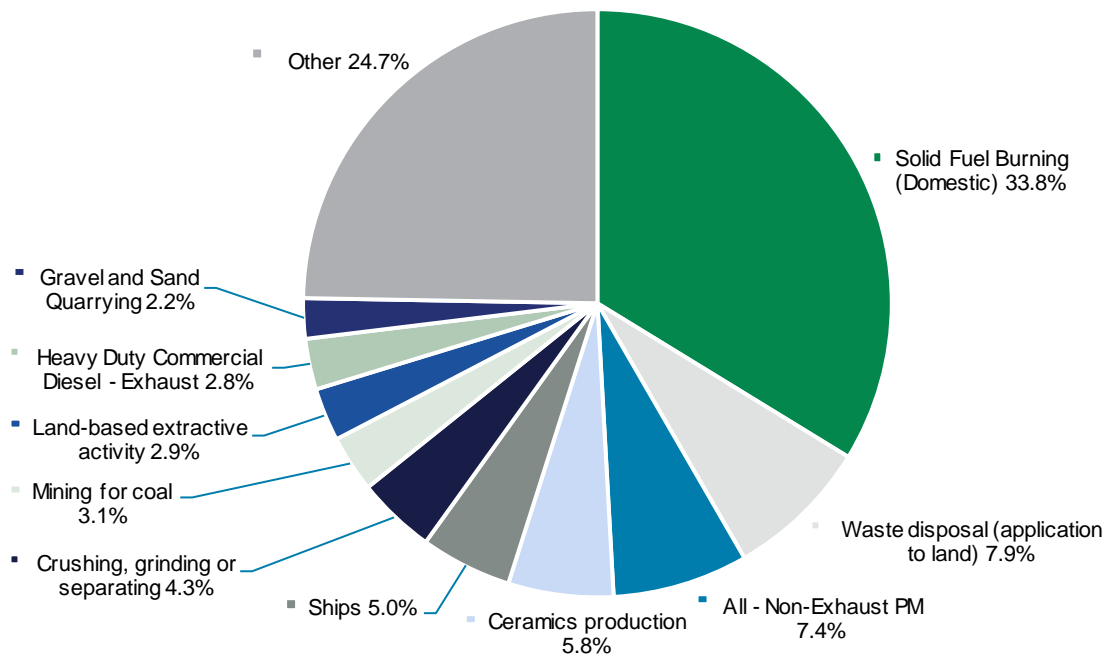


Figure ES-23: Sydney region: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$

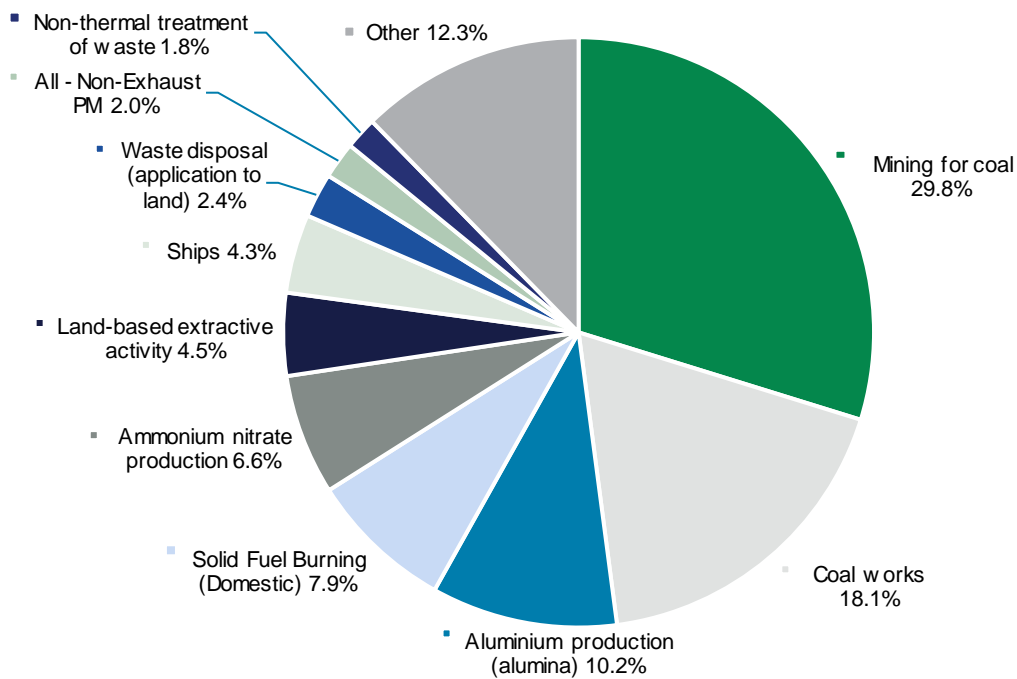


Figure ES-24: Newcastle region: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$

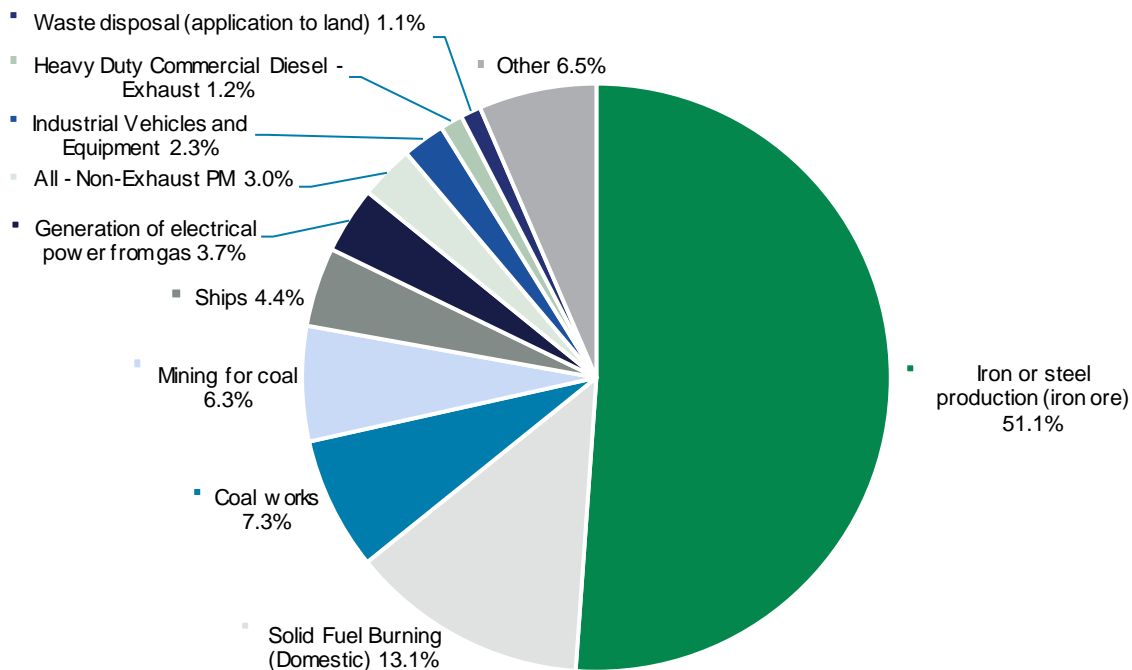


Figure ES-25: Wollongong region: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$

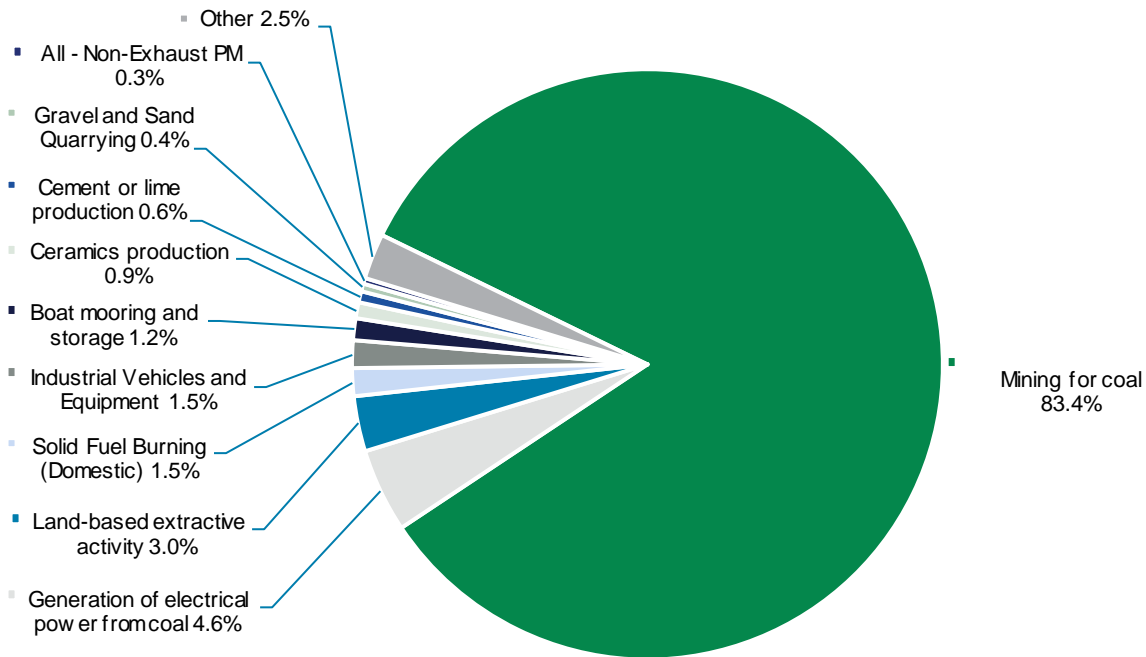


Figure ES-26: Non-urban region: top 10 human-made sources of particulate matter ≤ 10µm

Table ES-9 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of particulate matter ≤ 2.5µm in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table ES-9: Top 10 human-made sources of particulate matter ≤ 2.5µm in each region

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Top 10 human-made particulate matter ≤ 2.5µm sources in the GMR				
Industrial	Mining for coal	10,238	35.0	35.0
Domestic-Commercial	Solid Fuel Burning (Domestic)	6,773	23.2	58.2
Industrial	Generation of electrical power from coal	1,477	5.05	63.3
Off-Road Mobile	Industrial Vehicles and Equipment	1,330	4.55	67.8
Off-Road Mobile	Ships	1,173	4.01	71.8
Industrial	Land-based extractive activity	837	2.86	74.7
On-Road Mobile	All - Non-Exhaust PM	824	2.82	77.5
Industrial	Ceramics production	621	2.13	79.6
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	604	2.07	81.7
Industrial	Cement or lime production	392	1.34	83.0
Human-made	Other	4,960	17.0	100.0
Top 10 human-made particulate matter ≤ 2.5µm sources in the Sydney region				
Domestic-Commercial	Solid Fuel Burning (Domestic)	5,009	50.4	50.4
Off-Road Mobile	Ships	712	7.16	57.5

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
On-Road Mobile	All - Non-Exhaust PM	610	6.14	63.7
Industrial	Ceramics production	504	5.07	68.7
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	418	4.20	72.9
Industrial	Waste disposal (application to land)	232	2.33	75.3
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	200	2.01	77.3
On-Road Mobile	Light Duty Diesel - Exhaust	185	1.86	79.1
Industrial	Crushing, grinding or separating	149	1.50	80.6
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	142	1.43	82.1
Human-made	Other	1,784	17.9	100.0
Top 10 human-made particulate matter $\leq 2.5\mu\text{m}$ sources in the Newcastle region				
Domestic-Commercial	Solid Fuel Burning (Domestic)	378	18.1	18.1
Industrial	Aluminium production (alumina)	363	17.4	35.4
Industrial	Ammonium nitrate production	322	15.4	50.8
Industrial	Mining for coal	240	11.4	62.2
Off-Road Mobile	Ships	197	9.43	71.7
Industrial	Coal works	107	5.11	76.8
Industrial	Land-based extractive activity	61.02	2.92	79.7
On-Road Mobile	All - Non-Exhaust PM	53.04	2.53	82.2
Industrial	Iron or steel production (scrap metal)	44.28	2.12	84.4
Industrial	Agricultural fertiliser (phosphate) production	40.87	1.95	86.3
Human-made	Other	287	13.7	100.0
Top 10 human-made particulate matter $\leq 2.5\mu\text{m}$ sources in the Wollongong region				
Industrial	Iron or steel production (iron ore)	378	40.1	40.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	225	23.9	64.0
Off-Road Mobile	Ships	71.81	7.62	71.6
Industrial	Generation of electrical power from gas	65.58	6.96	78.6
Off-Road Mobile	Industrial Vehicles and Equipment	40.69	4.32	82.9
On-Road Mobile	All - Non-Exhaust PM	28.31	3.00	85.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	21.47	2.28	88.2
Industrial	Coal works	20.52	2.18	90.4
Industrial	Mining for coal	16.02	1.70	92.1
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	11.20	1.19	93.3
Human-made	Other	63.55	6.74	100.0
Top 10 human-made particulate matter $\leq 2.5\mu\text{m}$ sources in the Non-urban region				
Industrial	Mining for coal	9,898	60.9	60.9
Industrial	Generation of electrical power from coal	1,477	9.09	70.0
Off-Road Mobile	Industrial Vehicles and Equipment	1,160	7.14	77.2

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,160	7.14	84.3
Industrial	Land-based extractive activity	683	4.20	88.5
Industrial	Cement or lime production	337	2.08	90.6
Off-Road Mobile	Ships	192	1.18	91.8
Industrial	Boat mooring and storage	183	1.12	92.9
Off-Road Mobile	Commercial Boats Exhaust	138	0.85	93.7
On-Road Mobile	All - Non-Exhaust PM	132	0.81	94.5
Human-made	Other	887	5.46	100.0

Figure ES-27, Figure ES-28, Figure ES-29, Figure ES-30 and Figure ES-31 show the proportions of total estimated annual emissions for the top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$ in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

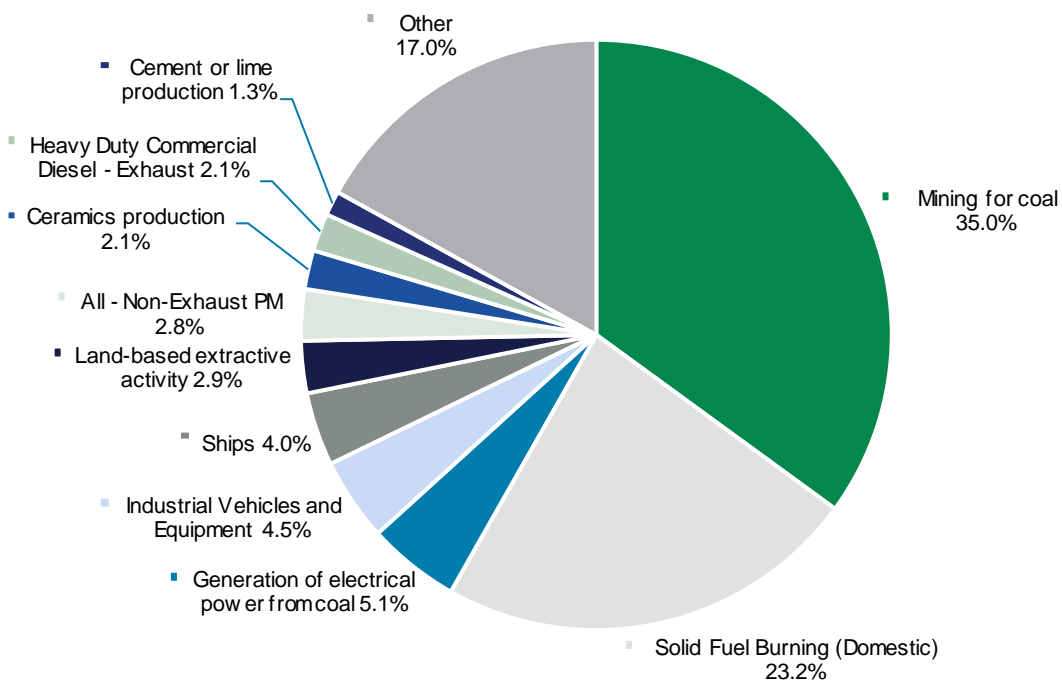


Figure ES-27: GMR: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$

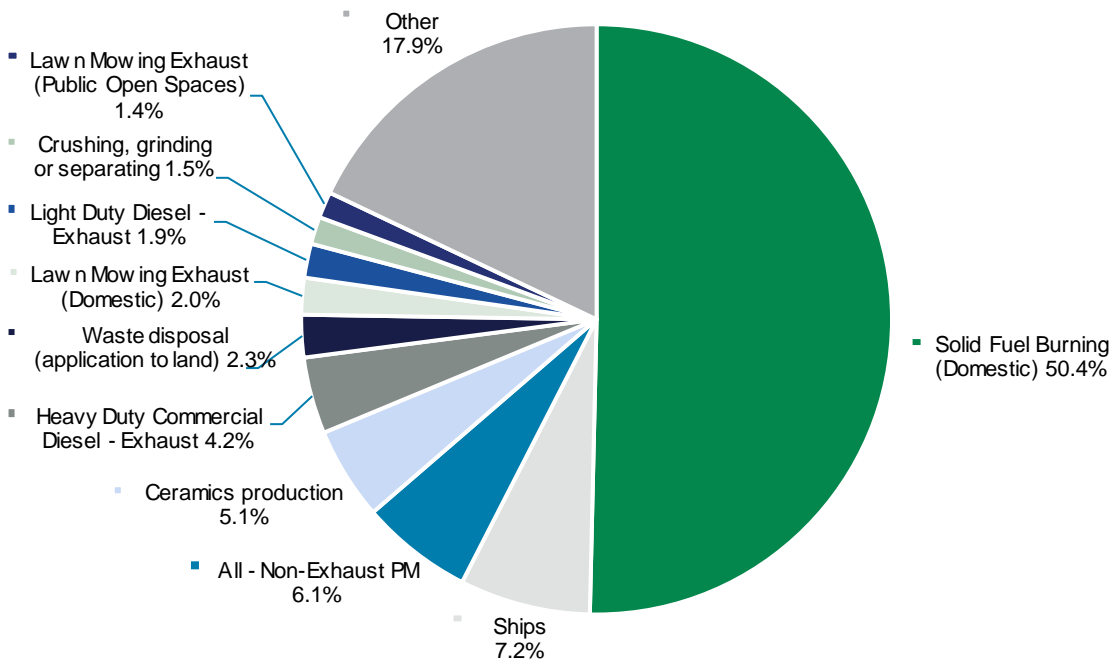


Figure ES-28: Sydney region: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$

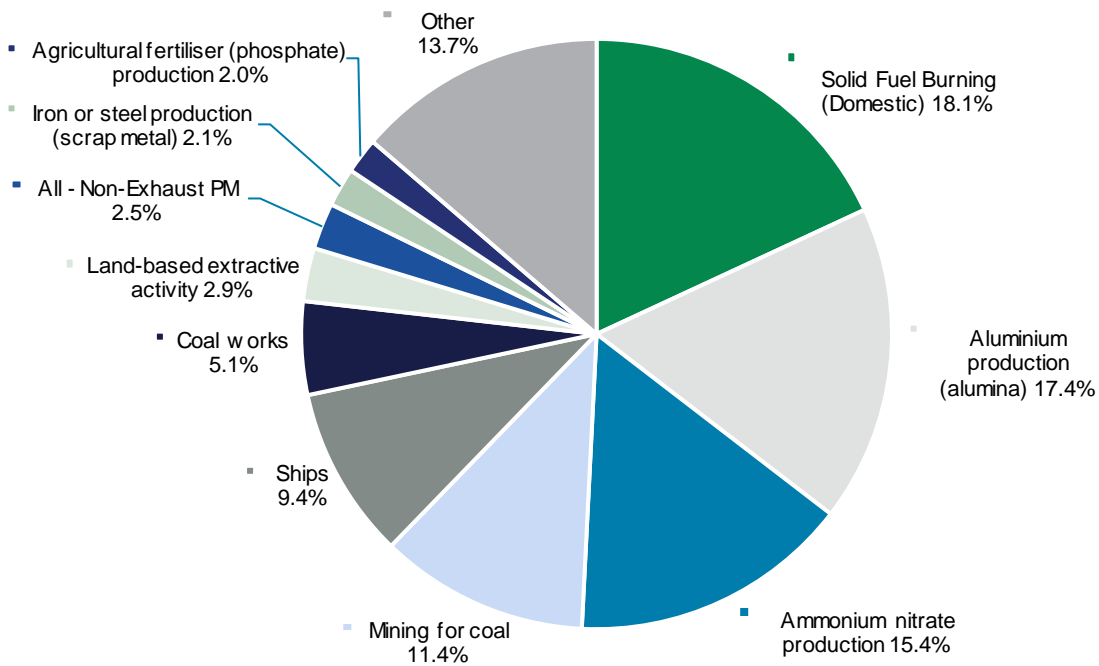


Figure ES-29: Newcastle region: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$

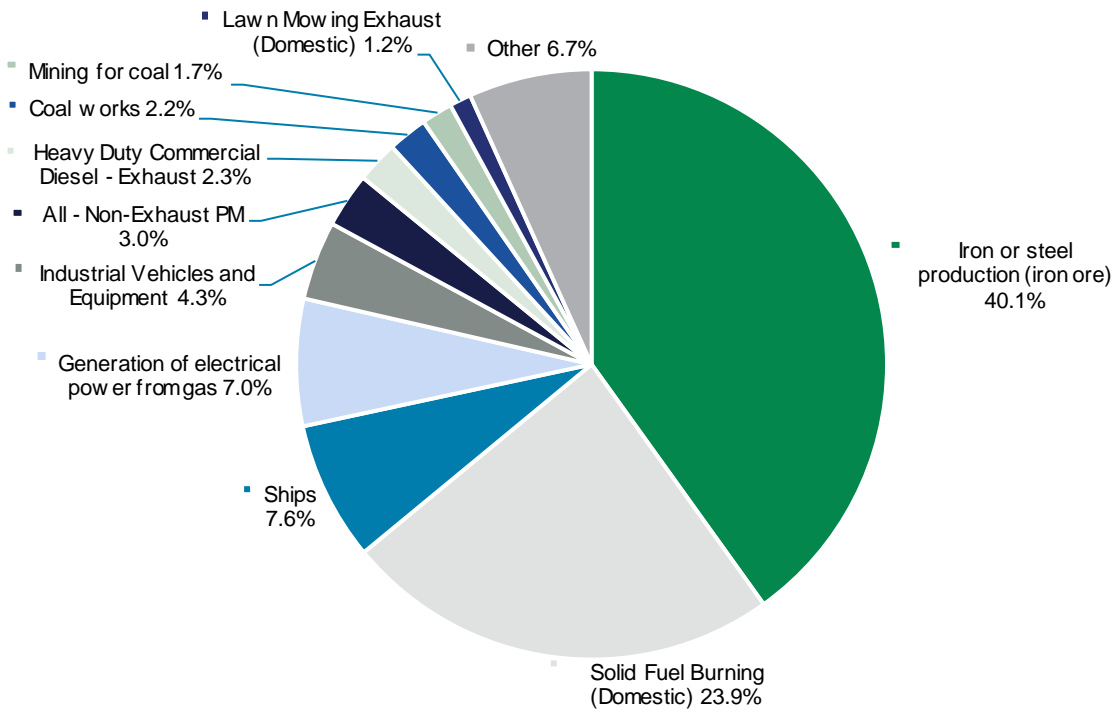


Figure ES-30: Wollongong region: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$

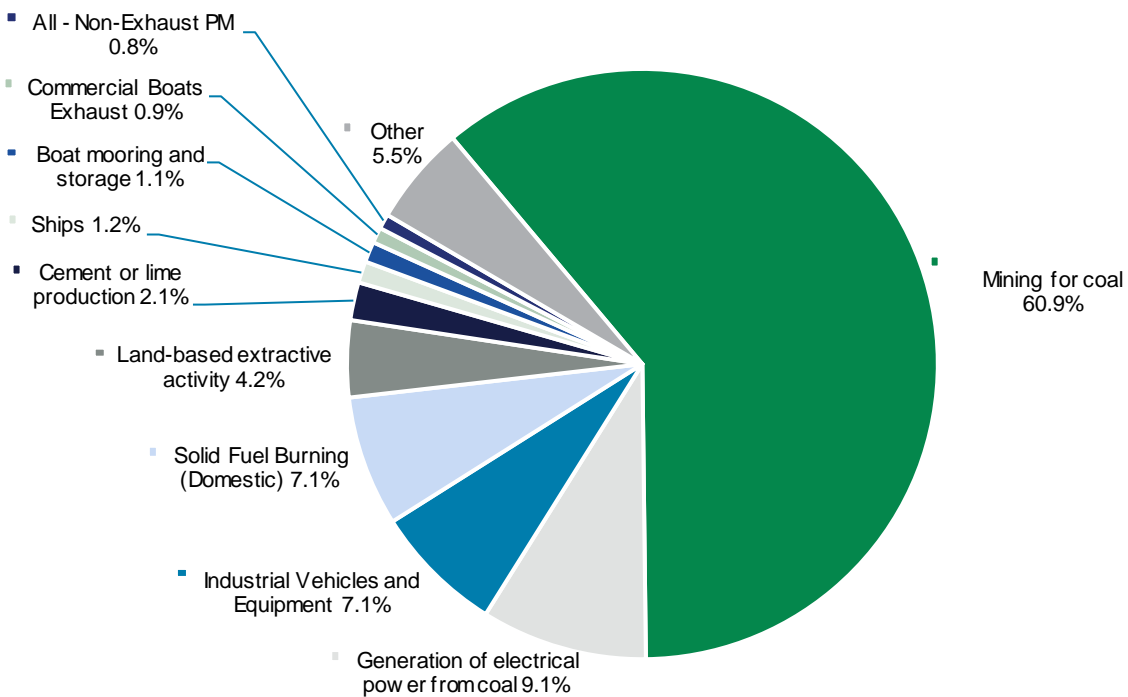


Figure ES-31: Non-urban region: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$

Table ES-10 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of sulfur dioxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table ES-10: Top 10 human-made sources of sulfur dioxide in each region

Module	Activity ⁹	Emissions (tonnes/year)	Proportion ¹⁰ (%)	Cumulative proportion (%)
Top 10 human-made sulfur dioxide sources in the GMR				
Industrial	Generation of electrical power from coal	198,191	87.9	87.9
Off-Road Mobile	Ships	10,536	4.68	92.6
Industrial	Aluminium production (alumina)	8,168	3.62	96.2
Industrial	Iron or steel production (iron ore)	4,176	1.85	98.1
Industrial	Petroleum products and fuel	1,841	0.82	98.9
Industrial	Ceramics production	477	0.21	99.1
Industrial	Petrochemical production	473	0.21	99.3
Industrial	Mining for coal	264	0.12	99.5
Industrial	Glass production (container)	213	9.46×10 ⁻²	99.6
Off-Road Mobile	Aircraft (Flight Operations)	180	7.97×10 ⁻²	99.6
Human-made	Other	833	0.37	100.0
Top 10 human-made sulfur dioxide sources in the Sydney region				
Off-Road Mobile	Ships	6,606	65.1	65.1
Industrial	Petroleum products and fuel	1,840	18.1	83.2
Industrial	Petrochemical production	473	4.67	87.9
Industrial	Ceramics production	458	4.52	92.4
Industrial	Glass production (container)	213	2.10	94.5
Off-Road Mobile	Aircraft (Flight Operations)	173	1.70	96.2
Domestic-Commercial	Solid Fuel Burning (Domestic)	84.16	0.83	97.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	70.01	0.69	97.7
Commercial	Ceramic Product Manufacturing	36.80	0.36	98.1
Industrial	Generation of electrical power from gas	23.07	0.23	98.3
Human-made	Other	169	1.67	100.0
Top 10 human-made sulfur dioxide sources in the Newcastle region				
Industrial	Aluminium production (alumina)	8,168	81.8	81.8
Off-Road Mobile	Ships	1,703	17.1	98.8
Industrial	Chemical production	64.36	0.64	99.5
Industrial	Slaughtering or processing of animals	9.32	9.33×10 ⁻²	99.6
Industrial	Iron or steel production (scrap metal)	9.06	9.07×10 ⁻²	99.7
Domestic-Commercial	Solid Fuel Burning (Domestic)	6.36	6.37×10 ⁻²	99.7

⁹ n.e.c. in the activity stands for not elsewhere classified, a general industry code in the Australia and New Zealand Standard Industrial Classification (ABS, 2006)

¹⁰ Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g. 9.46×10⁻² = 0.0946).

Module	Activity ⁹	Emissions (tonnes/year)	Proportion ¹⁰ (%)	Cumulative proportion (%)
Industrial	Bitumen mixing	6.04	6.04×10 ⁻²	99.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	5.03	5.04×10 ⁻²	99.8
Off-Road Mobile	Aircraft (Flight Operations)	3.41	3.41×10 ⁻²	99.9
Industrial	Generation of electrical power not coal, diesel or gas	2.17	2.17×10 ⁻²	99.9
Human-made	Other	11.01	0.11	100.0
Top 10 human-made sulfur dioxide sources in the Wollongong region				
Industrial	Iron or steel production (iron ore)	4,176	86.3	86.3
Off-Road Mobile	Ships	639	13.2	99.5
Industrial	Metal plating or coating	8.09	0.17	99.6
Industrial	Generation of electrical power from gas	5.09	0.11	99.8
Domestic-Commercial	Solid Fuel Burning (Domestic)	3.79	7.82×10 ⁻²	99.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	2.89	5.98×10 ⁻²	99.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	0.56	1.15×10 ⁻²	99.9
Domestic-Commercial	Gaseous Fuel Burning	0.53	1.10×10 ⁻²	99.9
Commercial	Funeral Directors, Crematoria and Cemeteries	0.53	1.09×10 ⁻²	99.9
Off-Road Mobile	Recreational Boats Exhaust	0.51	1.05×10 ⁻²	99.9
Human-made	Other	3.23	6.67×10 ⁻²	100.0
Top 10 human-made sulfur dioxide sources in the Non-urban region				
Industrial	Generation of electrical power from coal	198,191	98.9	98.9
Off-Road Mobile	Ships	1,589	0.79	99.7
Industrial	Mining for coal	263	0.13	99.8
Industrial	Cement or lime production	121	6.04×10 ⁻²	99.9
Commercial	Log Sawmilling	69.71	3.48×10 ⁻²	99.9
Commercial	Food Manufacturing n.e.c.	37.47	1.87×10 ⁻²	99.9
Domestic-Commercial	Solid Fuel Burning (Domestic)	19.50	9.73×10 ⁻³	100.0
Industrial	Ceramics production	18.19	9.08×10 ⁻³	100.0
Off-Road Mobile	Industrial Vehicles and Equipment	13.99	6.98×10 ⁻³	100.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	11.22	5.60×10 ⁻³	100.0
Human-made	Other	41.82	2.09×10 ⁻²	100.0

Figure ES-32, Figure ES-33, Figure ES-34, Figure ES-35 and Figure ES-36 show the proportions of total estimated annual emissions for the top 10 human-made sources of sulfur dioxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

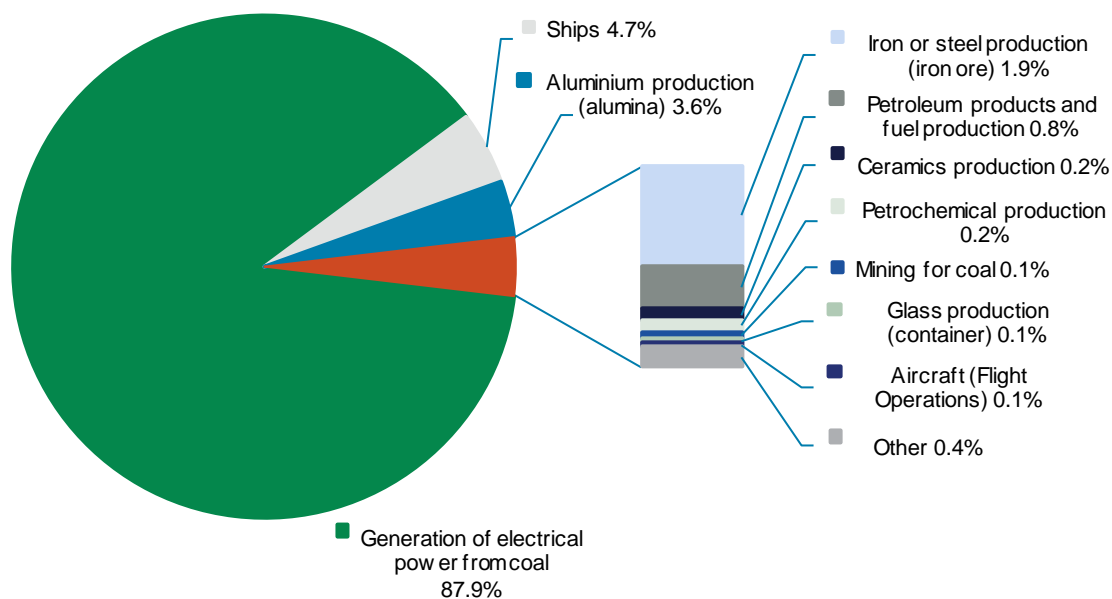


Figure ES-32: GMR: top 10 human-made sources of sulfur dioxide

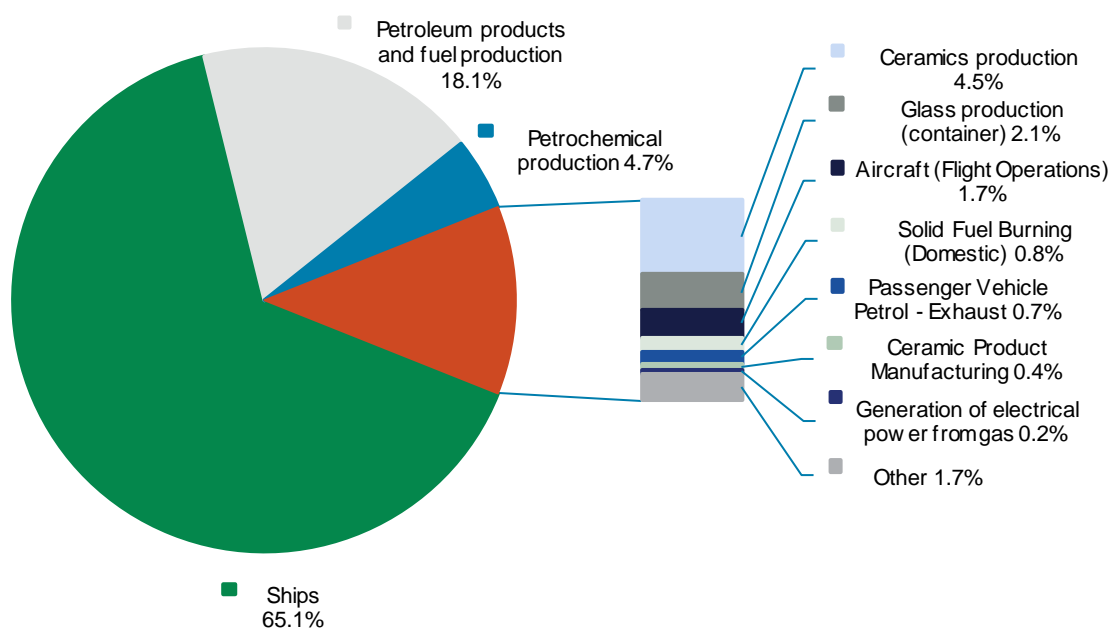


Figure ES-33: Sydney region: top 10 human-made sources of sulfur dioxide

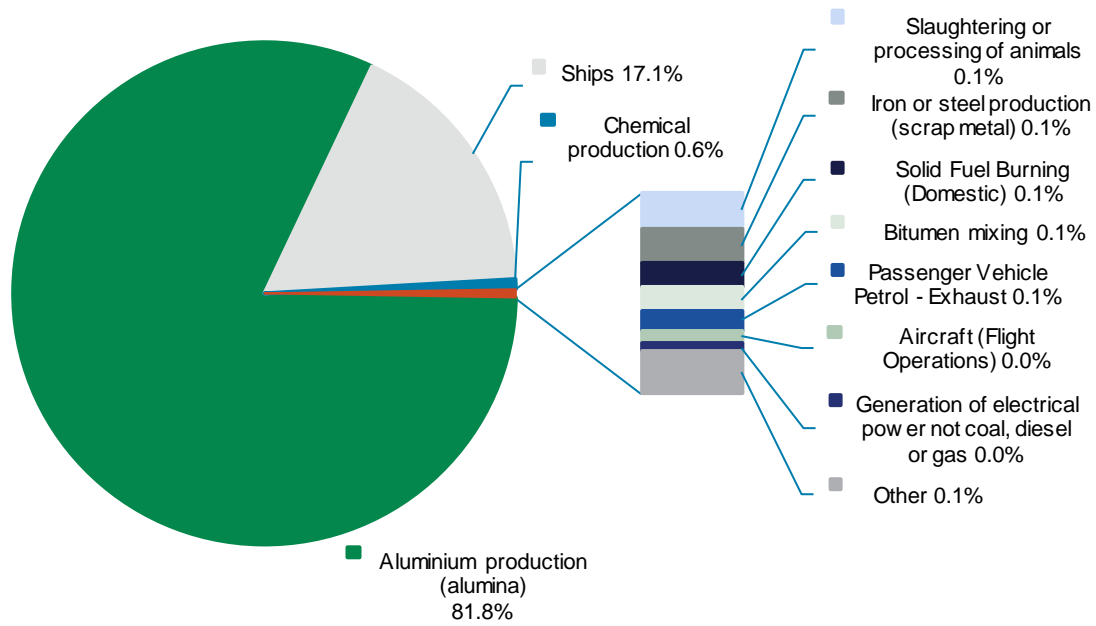


Figure ES-34: Newcastle region: top 10 human-made sources of sulfur dioxide

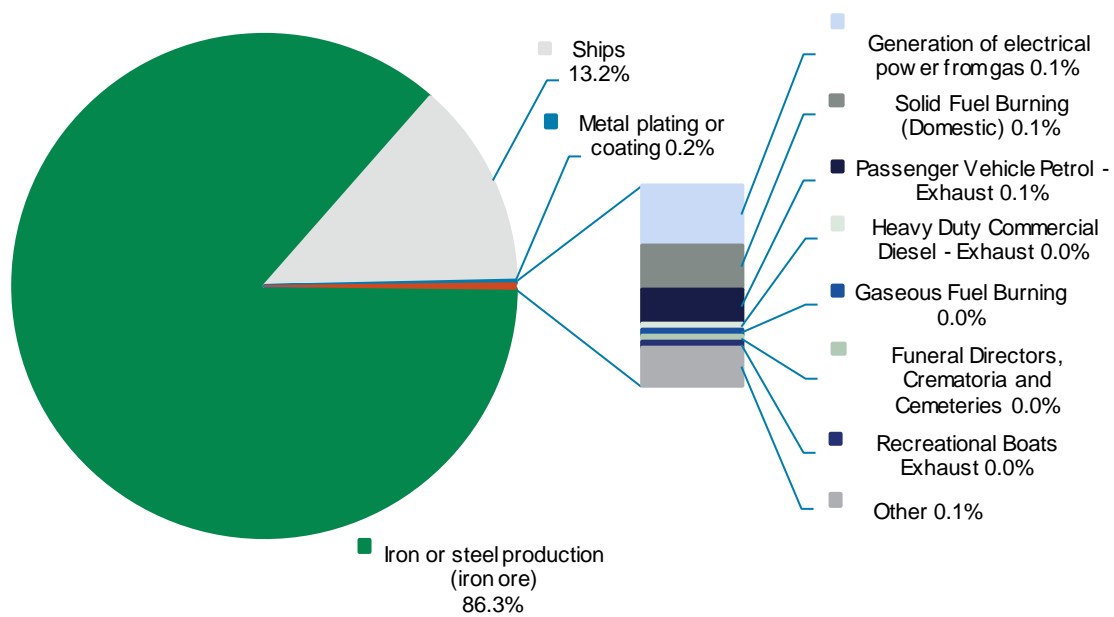


Figure ES-35: Wollongong region: top 10 human-made sources of sulfur dioxide

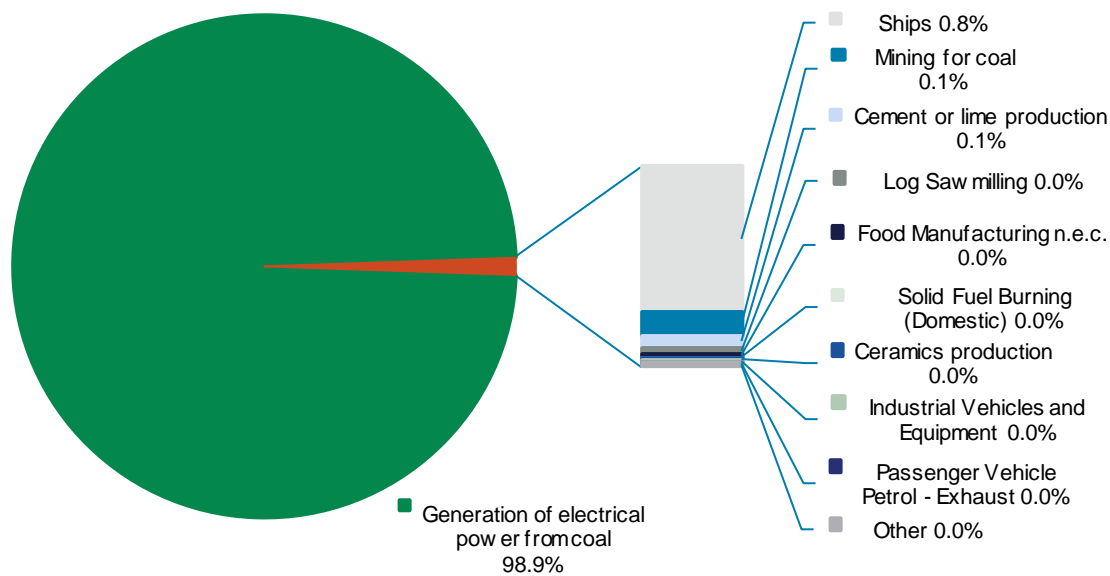


Figure ES-36: Non-urban region: top 10 human-made sources of sulfur dioxide

Table ES-11 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of VOC in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table ES-11: Top 10 human-made sources of VOC in each region

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Top 10 human-made total volatile organic compounds sources in the GMR				
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	27,715	20.7	20.7
Off-Road Mobile	Commercial Boats Exhaust	10,778	8.03	28.7
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	10,277	7.66	36.3
Domestic-Commercial	Surface Coatings	9,728	7.25	43.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	8,239	6.14	49.7
On-Road Mobile	All - Evaporative	6,956	5.18	54.9
Commercial	Automotive Fuel Retailing	6,646	4.95	59.9
Off-Road Mobile	Recreational Boats Exhaust	6,266	4.67	64.5
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	5,803	4.32	68.9
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	5,590	4.16	73.0
Human-made	Other	36,211	27.0	100.0

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Top 10 human-made total volatile organic compounds sources in the Sydney region				
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	21,929	22.7	22.7
Domestic-Commercial	Surface Coatings	7,682	7.96	30.7
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	7,673	7.95	38.6
Commercial	Automotive Fuel Retailing	6,646	6.89	45.5
Domestic-Commercial	Solid Fuel Burning (Domestic)	6,093	6.31	51.8
On-Road Mobile	All - Evaporative	5,289	5.48	57.3
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	4,652	4.82	62.1
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	4,492	4.65	66.8
Off-Road Mobile	Recreational Boats Exhaust	3,196	3.31	70.1
Domestic-Commercial	Lawn Mowing Evaporative (Domestic)	3,109	3.22	73.3
Human-made	Other	25,761	26.7	100.0
Top 10 human-made total volatile organic compounds sources in the Newcastle region				
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	1,364	17.8	17.8
Off-Road Mobile	Commercial Boats Exhaust	1,016	13.3	31.1
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	644	8.41	39.5
Industrial	Petroleum products storage	567	7.41	46.9
Domestic-Commercial	Surface Coatings	514	6.71	53.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	460	6.02	59.6
On-Road Mobile	All - Evaporative	446	5.83	65.5
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	325	4.25	69.7
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	286	3.74	73.5
Off-Road Mobile	Recreational Boats Exhaust	280	3.65	77.1
Human-made	Other	1,752	22.9	100.0
Top 10 human-made total volatile organic compounds sources in the Wollongong region				
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	997	23.2	23.2
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	430	10.0	33.2
Off-Road Mobile	Recreational Boats Exhaust	397	9.23	42.4
Domestic-Commercial	Surface Coatings	370	8.61	51.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	274	6.38	57.4
On-Road Mobile	All - Evaporative	235	5.46	62.9
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	213	4.95	67.8
Industrial	Waste disposal (application to land)	193	4.48	72.3
Domestic-Commercial	Lawn Mowing Evaporative (Domestic)	173	4.03	76.3

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	171	3.97	80.3
Human-made	Other	847	19.7	100.0
Top 10 human-made total volatile organic compounds sources in the Non-urban region				
Off-Road Mobile	Commercial Boats Exhaust	6,710	26.1	26.1
Domestic-Commercial	Domestic/Commercial Solvents/ Aerosols	3,425	13.3	39.4
Off-Road Mobile	Recreational Boats Exhaust	2,393	9.30	48.7
Off-Road Mobile	Industrial Vehicles and Equipment	1,890	7.34	56.0
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	1,530	5.95	62.0
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,412	5.49	67.5
Domestic-Commercial	Surface Coatings	1,161	4.51	72.0
On-Road Mobile	All - Evaporative	987	3.83	75.8
Industrial	Generation of electrical power from coal	840	3.26	79.1
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	653	2.54	81.6
Human-made	Other	4,734	18.4	100.0

Figure ES-37, Figure ES-38, Figure ES-39, Figure ES-40 and Figure ES-41 show the proportions of total estimated annual emissions for the top 10 human-made sources of VOC in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

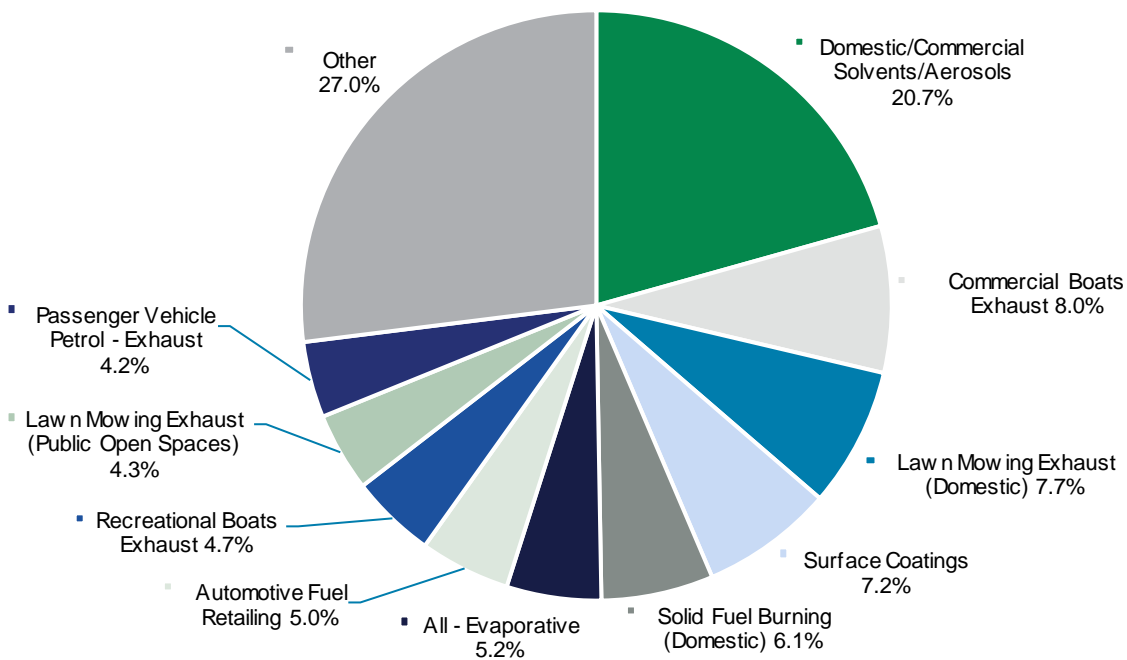


Figure ES-37: GMR: top 10 human-made sources of VOC

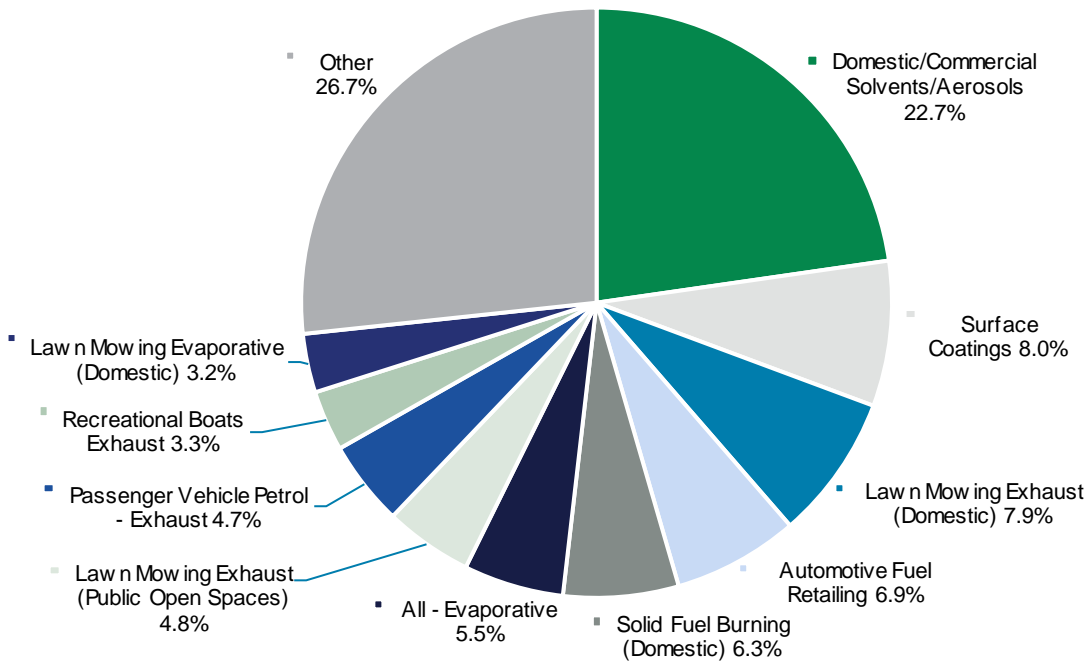


Figure ES-38: Sydney region: top 10 human-made sources of VOC

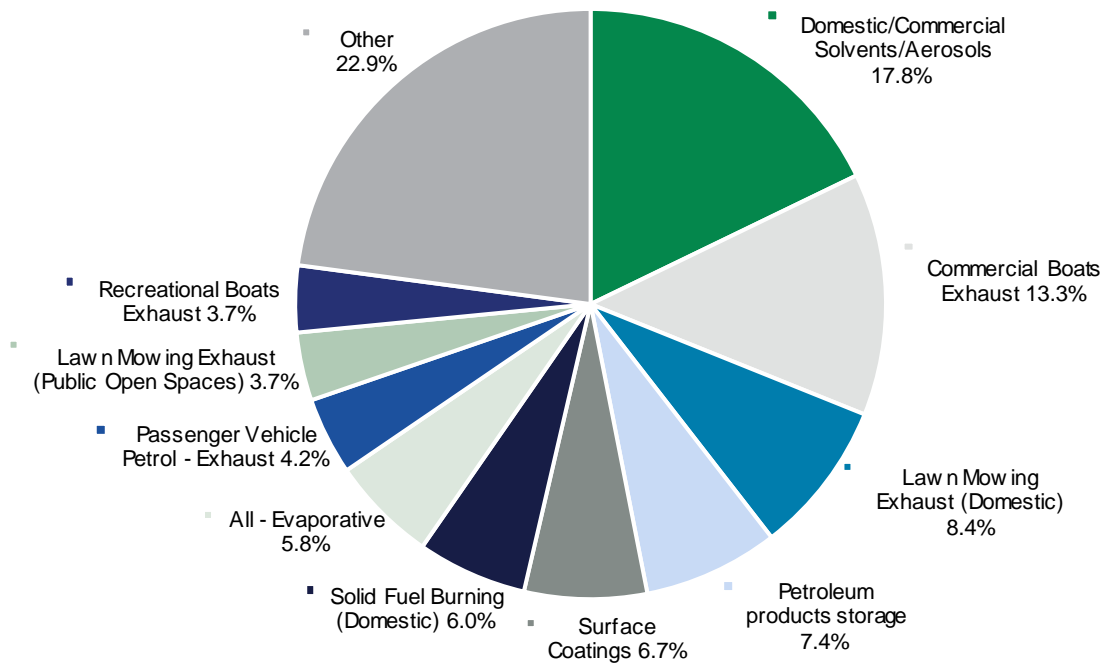


Figure ES-39: Newcastle region: top 10 human-made sources of VOC

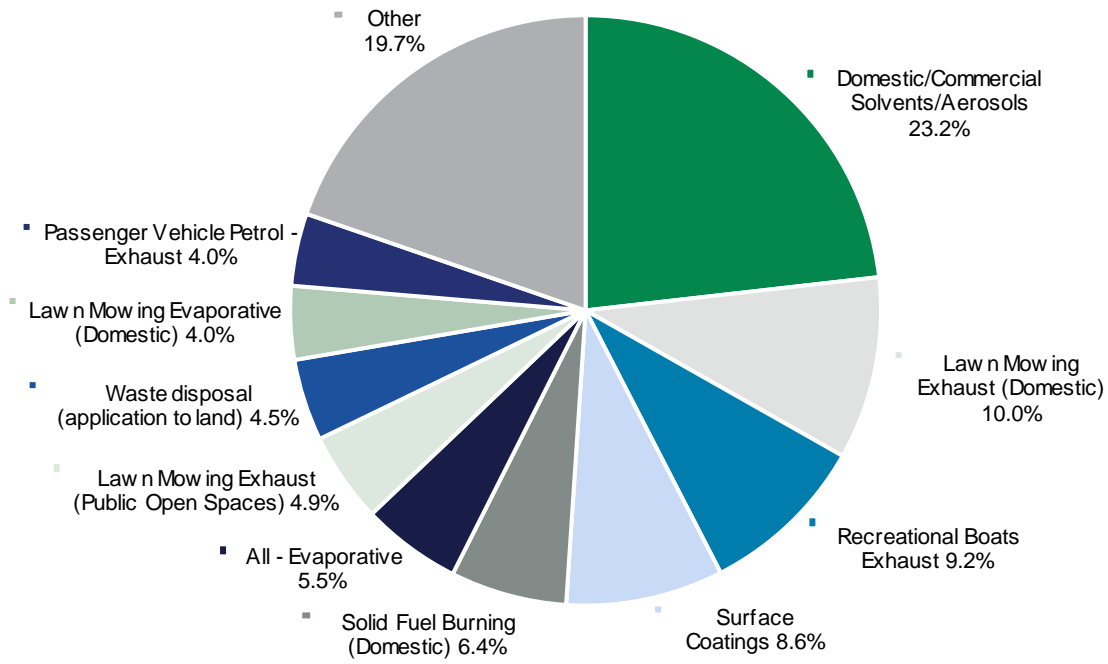


Figure ES-40: Wollongong region: top 10 human-made sources of VOC

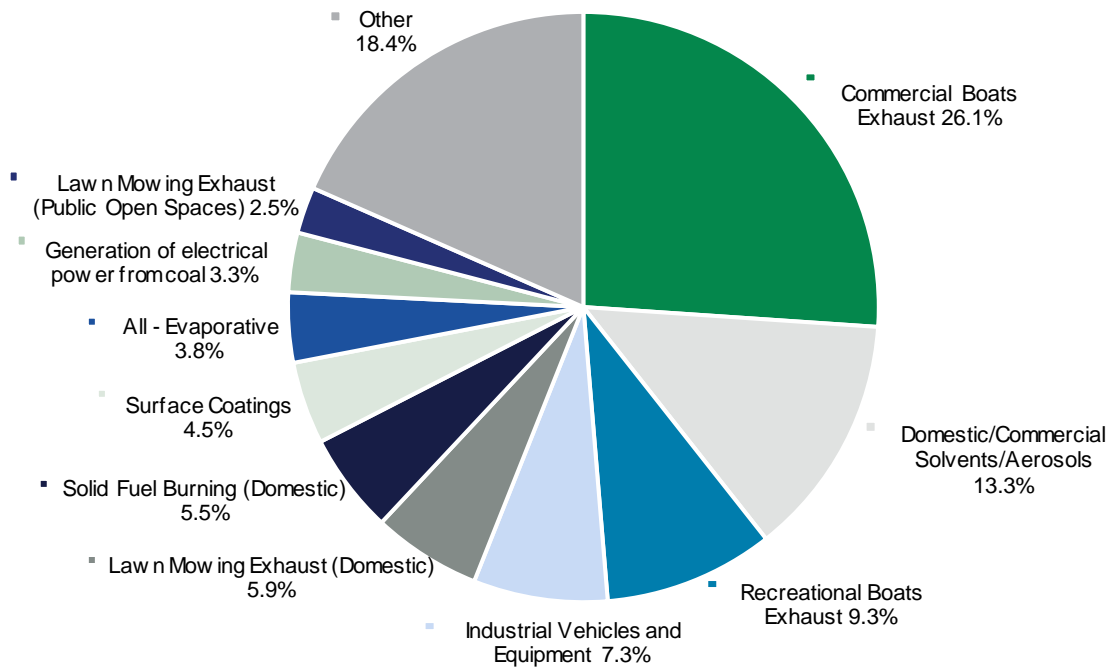


Figure ES-41: Non-urban region: top 10 human-made sources of VOC

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