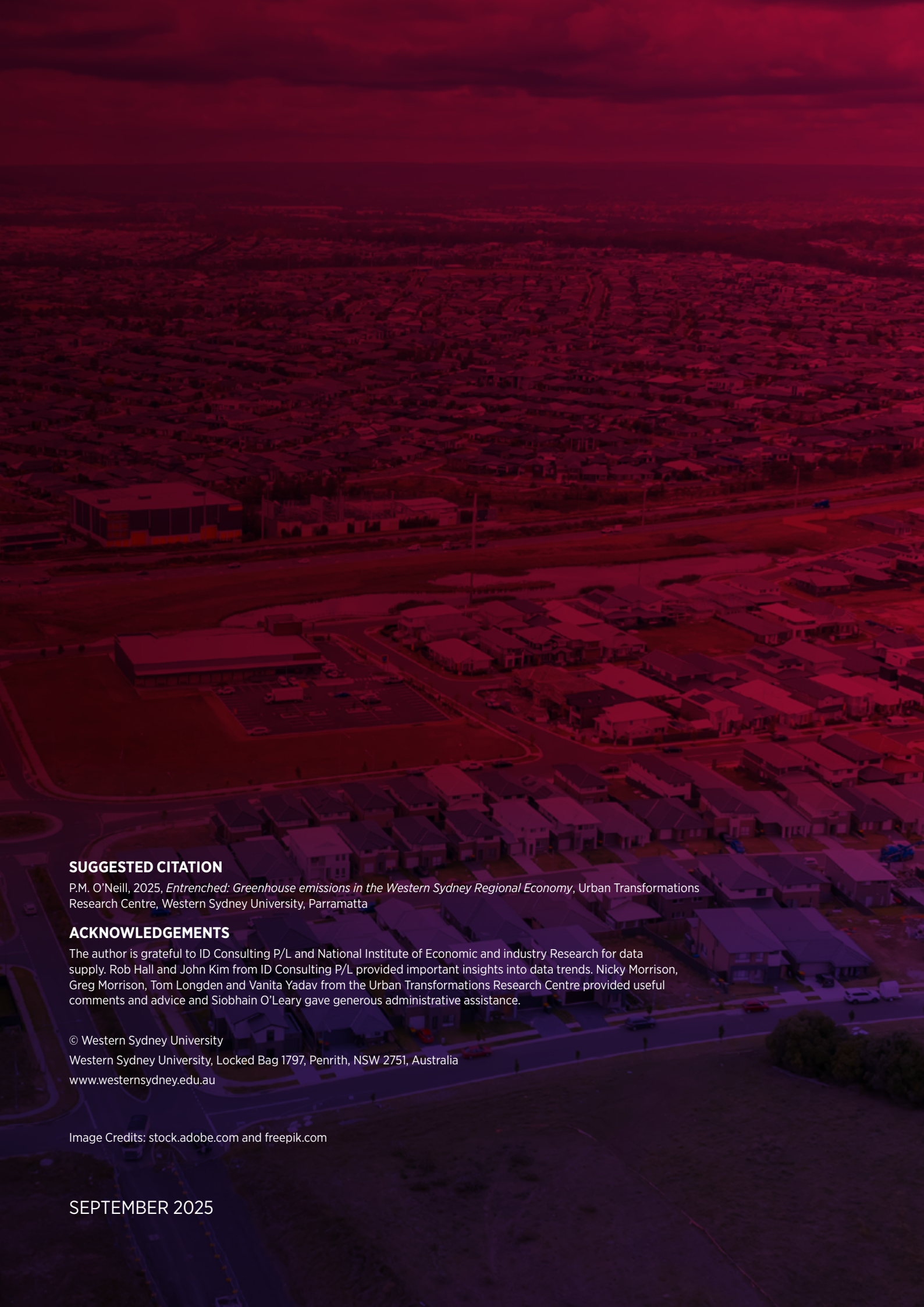
WESTERN SYDNEY
UNIVERSITY

ENTRENCHED

GREENHOUSE EMISSIONS IN THE WESTERN SYDNEY REGIONAL ECONOMY

SEPTEMBER 2025



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EXECUTIVE SUMMARY

EMISSIONS

Four observations can be made from the material presented in this report.

1. Western Sydney is a major metropolitan region whose energy transition has significant implications for the nation's commitment to reduce greenhouse gas emissions. Yet major regulatory action by the Australian and NSW governments has yet to directly impact businesses in the region.
2. Western Sydney's regional economy is structured in two quite different ways, with different implications for greenhouse gas emissions. The region's very large manufacturing sector, composed of many firms with technological and organisational traits from the 20th century, struggles with the task of lowering scope 1 emissions intensity. In the population-serving industry sectors, some sectors, like education, personal care and public administration, have limited opportunity to undertake industry-specific emissions reduction activity. There are other population-serving sectors, however, where there is considerable scope for significant industry contribution. One of these is the transport, warehouse and storage services sector and another is the waste collection, treatment and disposal services sector.
3. Western Sydney's emissions performance is strongly influenced by its industry structure. Our findings show that, while there has been some decline in aggregate scope 1 emissions across Western Sydney's industrial sectors over the past two decades, much of this decline can be attributed to the exit of firms, especially manufacturing firms, which have had historically high levels of emissions intensity.

   For scope 2 emissions, our analysis shows that for industry in Western Sydney emissions intensity has been falling at a faster rate than scope 1 emissions intensity over the past two decades. Once again, however, improvement in scope 2 emissions intensity cannot be attributed to any extent to actions by Western Sydney firms. Rather, falling scope 2 emissions intensity has been the consequence of the decarbonisation of statewide electricity generation.

   In terms of geographic variation across Western Sydney, emissions intensity mimics the historical development of the region. The LGAs with the most significant sources of emissions are Wollondilly, because of there being two major coal mines in the LGA; and Blacktown, because it hosts the largest manufacturing and distribution facilities in the region. The next most significant areas for greenhouse gas emissions lie within the post-WW2 industrial belt namely in the Parramatta, Canterbury-Bankstown and Cumberland LGAs. In Western Sydney's outer LGAs the level of emissions correlates positively with the extent to which these areas host new industrial estates.

4. Across Western Sydney's industry sub-sectors, emissions performance varies widely, with strong correlation between favourable emissions performance and a sub-sector's technology and investment profile.

   In general, Western Sydney's older industrial sub-sectors are the region's poorer performers in terms of greenhouse gas emissions. Emissions intensity in a sub-sector is also strongly influenced by the position of the sub-sector in a broader industrial supply chain, and by the extent to which output in the sub-sector is influenced by external economic forces.

   For the basic chemicals and chemical product manufacturing sub-sector, we find that scope 1 emissions have shown little net change over the last 20 years. Falls in total emissions have come almost entirely by falling scope 2 emissions, the consequence of actions to decarbonise the NSW electricity grid rather than by actions on-site or within-region.

   For polymer product and rubber product manufacturing, we find similar trends, namely, that the intensity of scope 1 emissions has fluctuated over the last two decades without any clear downward trend, while scope 2 emissions intensity has fallen but largely as a consequence, again, of the decarbonisation of the state's electricity grid.

   For primary metal and metal product manufacturing, falling levels of scope 1 emissions can be attributed to long-term industry decline in the sub-sector. As with the other sub-sectors, falling levels of scope 2 emissions are attributable to the progressive shift to renewables in state energy generation.

   For waste collection treatment and disposal services, the changing level of scope 1 emissions reflects major changes in the way that the waste collection and treatment cycle has changed in Western Sydney and Greater Sydney over the last two decades. Falling scope 1 emissions came in the first of these decades from the shift away from locally-based municipal waste collection and disposal, and subsequently falls came from the substantial changes in waste treatment and recycling in the hands of a small number of large waste corporations.

   For the warehousing and storage services sub-sector, rising levels of scope 1 emissions intensity coincide with the massive expansion of warehousing and storage services in Western Sydney and their heavy reliance on liquid fuels for transportation. The sub-sector also has experienced sustained increases in scope 2 emissions performance, which is unusual compared to the sub-sectors. This trend seems to be the consequence of the rising importance of electricity in the operation of large warehouses and logistics facilities and in the data centres which often accompany new facilities.

POLICY

We make three comments about the policy implications of our study.

1. Because the decarbonisation of the Western Sydney economy depends so obviously on reducing scope 2 emissions, there is a need for more aggressive interventions to expand and accelerate the electrification process.

2. Federal and state governments need to act urgently to end urban sprawl and abate the worst outcomes of logistics urbanism.

   A feature of our study is the finding of a problematic relationship between Western Sydney's urban structure and the region's industry structure. Waves of development over the past 75 years have entrenched Western Sydney's sprawl in two respects. One has been the emergence of low-density housing estates distant from the high concentration of jobs created elsewhere in Sydney's post-industrial economy. The other has been the creation of sprawling industrial estates with low-density jobs configurations.

   Western Sydney has become a sprawling urban region with the legacy of a manufacturing sector where unacceptable emissions practices are historically embedded. In parallel, its largest new industrial sub-sector – warehousing and storage – has so far failed to forge a pathway to lower emissions intensity. Indeed, the sub-sector seems dependent on increases in emissions intensity in order to maintain its handsome growth trend. In other words, Western Sydney's urban configuration makes it difficult to devise and implement solutions to the region's greenhouse gas emissions problem.

3. Federal and state governments need to engage with large firms more fulsomely to devise ways to capture and disseminate in-house practices of emissions reduction.

   There is high probability that the most significant motivation for large Western Sydney firms to address the emissions problem comes currently from wider corporate commitment to social and environmental responsibility agenda rather than from government regulatory programs.

   Encouraging large firms, including their dissemination of effective actions along a supply chain, can lead to betterment across Western Sydney's ecosystem of firms – meaning lower emissions intensity and rising profitability, a very desirable pairing.

SECTION 1

INTRODUCTION AND REGULATORY CONTEXT

INTRODUCTION

The rising concentration of greenhouse gases is warming the earth's atmosphere and its oceans. For Australia, severe weather events are intensifying and becoming more common. Ecosystems and native species face new threats. In response, long-standing economic practices across all industries – agriculture, fishing, forestry, mining, manufacturing, transport, the services sectors included – need transformation.

There are two imperatives. First, the contribution to greenhouse gas emissions by humans has to be substantially reduced in order to curtail the heating of the atmosphere and the oceans. Second, industries need to adopt new ways of doing business. The latter is the focus of this report. In general terms, the transformation of business involves four processes:

- A shift to renewable energy
- The electrification of pretty much every energy-consuming vehicle, machine and device
- The removal of carbon from supply chains
- The transformation of where and how people live and how they move about and interact.

As a large, diverse, metropolitan and peri-urban economy, Western Sydney will be immersed in all these transformations. Everything will change. The only questions are when? and how quickly?

As a large, diverse, metropolitan and peri-urban economy, Western Sydney will be immersed in all these transformations. Everything will change.

In respect to policy response, there is worldwide commitment to reduce greenhouse gas emissions to limit global warming above pre-industrial levels to a maximum of 2 degrees Celsius. Specific targets are in place in Australia to align with this goal. The Australian government's Net Zero Plan sets out a pathway to reach net zero emissions by 2050. An intermediate objective is to reduce 2005 emissions (the base year set by the Kyoto protocols[1]) by 43% by 2030.[2] By and large, state governments' net zero ambitions align with the national targets.

Absent from national and state government strategies, however, are measures that explicitly target emissions in regional economies, save for those involving firms targeted by the Safeguard Mechanism (see below) – which for Western Sydney involves only the region's two coal mines located on its south-west perimeter. The inattention by governments to emissions generation in regional economies like Western Sydney's has significant consequences. These include:

- An absence of data about the dimensions and sources of emissions at the regional scale
- A lack of guidance to industry sectors from governments as to the emissions targets and conditions that will apply to regional firms in the future
- Poor alignment between emissions reduction pathways of regional firms subject to the sustainability policies of parent corporations and the larger number of other regional firms operating without emissions reduction plans. Note that the latter group of firms tend to be locally-owned and small- or medium-sized in scale.

This report responds in part to this inattention. Research underpinning the report has three questions:

1. What is the changing emissions profile of the Western Sydney regional economy?
2. What are the significant trends for scope 1 and scope 2 categories of emissions across Western Sydney's key industry sectors?
3. What lessons in emissions reduction practices are available from firms and facilities in Western Sydney that, in the absence of government regulation, operate within parameters mandated by the policies of a parent corporation?

These questions guide discussion throughout this report commencing with Section 2 which outlines the methodology employed in the research. Section 3 then provides an overview of industry structure in Western Sydney and reveals emissions trends for the region. Section 4 follows with a detailed exploration of emissions trends at disaggregated industry scales in order to better expose what is happening on the ground across the region. Finally, Section 5 discusses the findings of the project and sets out considerations for policy action.

In the remainder of this introductory section we examine the wider regulatory settings for emissions reduction activity in Western Sydney. We commence at the national scale.

EMISSIONS POLICY IN AUSTRALIA

SAFEGUARD MECHANISM

The Safeguard Mechanism commenced in 2016 and was reformed in 2023.[3] The Safeguard Mechanism targets "designated large facilities," defined as sites where 100,000 tonnes or more of greenhouse gases (CO_2e[4]) are emitted annually as scope 1 emissions. CO_2e emissions within the scope 2 category (usually involving electricity use) are not regulated by the Safeguard Mechanism.

A facility covered by the Safeguard Mechanism has an annual emissions baseline (its maximum allowable level of emissions) which falls by 4.9% each year. Meeting progressively lower baselines ensures Australia's large industrial emitters contribute substantially to efforts to meet national emissions reduction targets. Only two facilities in Western Sydney are designated facilities. These are the Appin and Tahmoor underground coal mines in the Wollondilly LGA. Note that operations at the Tahmoor mine were suspended in February 2025 arising from financial difficulties with Tahmoor's parent corporation. The mine has regulatory approval to operate until 2033.

Apart from the region's two coal mines, it is important to observe that firms and agencies in Western Sydney are not targeted by the Safeguard Mechanism or, indeed, by another mechanism with a site-specific requirement to reduce greenhouse gas emissions.

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SECTORAL DECARBONISATION PLANS

Six sector plans have been developed by the Australian government to support its emissions reduction targets.[5] The sectors are electricity and energy, industry (largely referring to manufacturing industry), resources, built environment, agriculture and land, and transport.

THE ELECTRICITY AND ENERGY SECTOR PLAN

Thus far, the most thorough sector plan is for electricity and energy.[6] Reform of the electricity and energy sector has been the central plank of the Australian government's actions to meet its target of powering 82% of Australia's electricity grids with renewables by 2030. This plan has major relevance for the Western Sydney economy given the importance of decarbonising electricity supply in driving down scope 2 emissions across the region.

The electricity and energy sector plan should generate substantial decarbonisation opportunities in Western Sydney. These opportunities will come from:

- → Shifting to electricity sourced from renewables
- → Electrification of industrial processes and transportation
- → Investment in behind-the-meter generation and storage
- → Shifting from liquid and gas fuels to low-carbon fuel alternatives.

Done successfully, alongside reductions in emissions intensity, the electricity and energy sector plan will provide opportunities for investment in the industry sector in Western Sydney. New ventures might involve low-carbon, high-energy products including green chemicals and green metals; processing of critical minerals; and the manufacture of energy storage products. Moreover, the value of an across-the-board technological shift affecting all industries should not be under-estimated.

THE INDUSTRY SECTOR PLAN

The industry sector plan identifies two major pathways for lowering emissions in manufacturing activity more broadly.[7] These pathways are the electrification of industrial processes in the context of decarbonisation of the grid; and the adoption of (largely unspecified) technologies involving the removal of carbon dioxide and methane generation from industrial processes. The federal government's Safeguard Mechanism and the Future Made in Australia fund are highlighted as the government's key policy initiatives. By and large, however, the industry sector plan is aspirational and descriptive. As our report demonstrates, successful transformation away from fossil fuels by the manufacturing sector in regions like Western Sydney requires multi-pronged, place-specific interventions and assistance. Without these there is a high probability that decarbonisation will come from deindustrialisation rather than through genuine industrial transition.

We now turn to relevant policies of the NSW government.

EMISSIONS POLICY IN NEW SOUTH WALES

The NSW government's ambitions for lowering greenhouse gas emissions are set out in the NSW Climate Change (Net Zero Future) Act.[8] The Act defines the following emissions reduction targets for NSW:

- → 50% reduction on 2005 levels by 2030
- → 70% reduction on 2005 levels by 2035
- → Net zero by 2050.

While there are no site-specific measures mandating emissions reduction by firms or agencies in Western Sydney, the government has a number of incentive schemes targeting technology advancement and equipment upgrades that might result in more favourable emissions outcomes for the business and industrial sectors.[9] Also significant is the government's NSW Electricity Infrastructure Roadmap, as enabled by the Electricity Infrastructure Investment Act 2020 (EII Act). The Roadmap seeks to accelerate investment in renewable electricity generation and long-duration storage. In summary, state government measures in NSW are designed to help rather than mandate NSW firms and agencies, including those in Western Sydney, to shift readily to renewable forms of electricity supply and so reduce their emissions intensity.

We now turn to the role of initiatives by corporations to reduce emissions intensity.

CORPORATE POLICIES

Corporations across the world are highly likely to have formal emissions reduction programs aligned with international treaty targets. These programs are typically embedded in a corporation's ESG (environmental, social, and governance) policy framework and are usually available for verification through regular public reporting. The likelihood of a corporation having independent, effective emissions reduction programs within a robust ESG policy framework has been found to be associated with the engagement of independent directors on a board, the influence of large shareholders, pressure from debt providers, and the situation of the corporation's activities within industry-wide standards and benchmarks aligned with greenhouse emission reduction targets. A review of this literature can be found in Haque and Ntim (2022).[10]

Investigation of the presence and effectiveness of independent emissions reduction programs among large firms in Western Sydney was one purpose of this research. Unfortunately, this purpose was not satisfactorily realised despite many research hours and resources spent. The major problem in finalising this part of the research was, in the end, the reluctance of participants to agree to disclosure of their emissions performance. Participants have been targeted because of their significance within key industry sub-sectors in the Western Sydney economy. Detailed case studies of each firm were drafted showing the presence of corporate-wide emissions reduction targets and the extent to which the Western Sydney operations of the firm were progressing these targets.

Nevertheless, and absent the specific case study material, two general observations can be made about the presence of independent emissions reduction programs among large firms in Western Sydney. First, Western Sydney industrial operations under the ownership and control of Australia-wide or international corporations are more likely to have formal emissions reduction targets and programs targeting scope 1 emissions. Second, given the absence of state and federal government regulations targeting scope 1 emissions, reductions in the emissions intensity of locally owned and operated firms in Western Sydney are unlikely to match the reductions for externally owned facilities where independent emissions reduction programs are more common. As we note in Section 5, however, these are speculative assertions warranting further research.

1 See https://unfccc.int/kyoto_protocol accessed 18 April 2024
2 See https://www.dcceew.gov.au/climate-change accessed 18 April 2024
3 https://www.dcceew.gov.au/climate-change/emissions-reporting/national-greenhouse-energy-reporting-scheme/safeguard-mechanism#:-:text=The%20Safeguard%20Mechanism%20applies%20to,baseline%20determined%20by%20the%20Regulator accessed 26 March 2024
4 Carbon dioxide equivalent, abbreviated as CO2e, is a measure (usually in tonnes) of total greenhouse gas emissions in terms of the equivalent amount of carbon dioxide with the same atmospheric warming potential.
5 https://www.dcceew.gov.au/about/news/setting-2035-target-path-net-zero, accessed 22 September 2025
6 https://www.dcceew.gov.au/climate-change/emissions-reduction/net-zero/electricity-and-energy-sector-plan
7 https://www.industry.gov.au/publications/industry-sector-plan
8 https://www.energy.nsw.gov.au/nsw-plans-and-progress/government-strategies-and-frameworks/climate-change-net-zero-future-act-2023 accessed 26 March 2024
9 https://www.energy.nsw.gov.au/business-and-industry/programs-grants-and-schemes accessed 26 March 2024
10 Haque, F. and Ntim, C. G. (2022). Do corporate sustainability initiatives improve corporate carbon performance? Evidence from European firms. *Business Strategy and the Environment*, 31(7), 3318–3334. https://doi.org/10.1002/bse.3078

SECTION 2

METHODOLOGY AND DEFINITIONS

Appendix 1 contains details of the methodology used in emissions calculations in this report. Here we present a brief summary of the methodology and some definitions.

SCOPE 1 AND 2 EMISSIONS

- Where appropriate we divide emissions into scope 1 emissions and scope 2 emissions.[1]
- Scope 1 emissions are those produced within the boundary of a facility as a direct result of activities on that site. These emissions might include fuel combustion to generate heat, steam and electricity; manufacturing processes which produce emissions; fuel combustion for transportation of materials, products, waste and people; fugitive emissions; and emissions associated with waste disposal and on-site treatment.
- Scope 2 emissions are those generated outside a facility's boundaries as a result of activities that supply the facility with energy via electricity, or directly through heating, cooling or steam generation off-site.

DATA

- National data come from *National Green House Gas Inventory by Economic Sector* reports from the Australian Department of Climate Change, Energy, the Environment and Water (DCCEEW).
- Local Government Area (LGA) emissions data come from the *Regional and Local Government Greenhouse Gas Emissions Account* reports from the NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW).

CALCULATIONS AND ESTIMATIONS

- Except where otherwise indicated, data sets are assembled by IDConsulting P/L.
- Data scaling to appropriate geographical level is based on modelling of local and regional performance by National Institute of Economic and industry Research (NIEIR) as supplied to IDConsulting P/L.

1 Definitions in this section are paraphrased from DCCEEW (2023).

SECTION 3

INDUSTRY STRUCTURE AND EMISSIONS TRENDS IN WESTERN SYDNEY

The Western Sydney economy has been slow to take on the challenge of reducing greenhouse gas emissions. It is also slow in its uptake of new approaches to doing business in a global economy where decarbonisation and electrification are part and parcel of the world's fourth industrial revolution - alongside digitisation, live-data analytics, artificial intelligence and an accelerated use of robotics. Throughout this report we argue that the structure of the Western Sydney regional economy is a major determinant of its emissions profile and of the region's response to federal and state emissions reduction targets. This section sets out the parameters of this economic structure.

Our argument is that the transformation of the Western Sydney economy starts from a difficult set-up. The region's core economic sector, manufacturing, is increasingly focussed on the local market and has undertaken only modest changes to operations that were forged in economic conditions from a distant past. What, then, is Western Sydney's industry structure? What emissions are generated within each industry sector? And how does this emissions profile vary from one part of Western Sydney to the next?

INDUSTRY STRUCTURE IN WESTERN SYDNEY

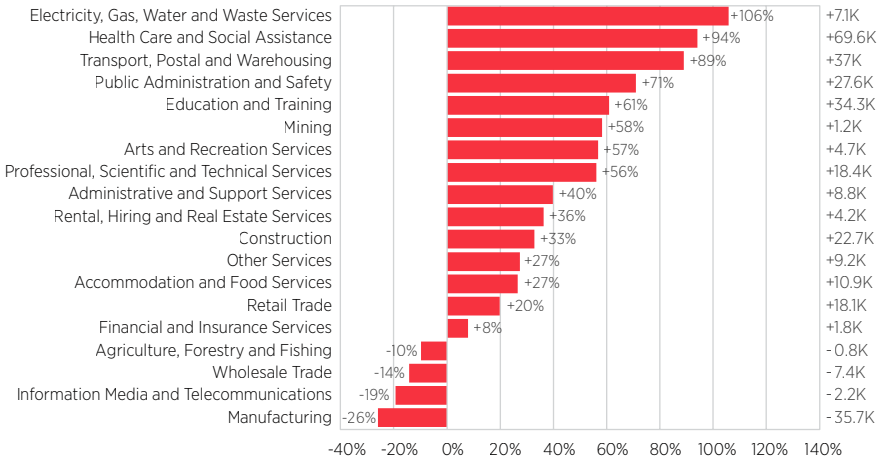
Western Sydney covers 13 local government areas (LGAs) from Hawkesbury in the north of the Hawkesbury-Nepean river basin, to Wollondilly and Campbelltown in the south, and from Parramatta and Cumberland in the east to Penrith and Blue Mountains in the west. With a total of 2,657,000 people in 2021-22, Western Sydney is home to around half of Greater Sydney residents.

The region has been Australia's most significant growth region over the last twenty years, with annual growth in this period averaging 1.6% for population, 2.1% for economic output, and 1.3% for employment. Impressive employment growth notwithstanding, the region's 989,000 jobs in 2021-22 comprised only 36.3% of Greater Sydney's jobs pool, a circumstance which creates a major daily commute for Western Sydney workers to jobs located elsewhere in the Sydney basin.[1]

> The Western Sydney economy has been slow to take on the challenge of reducing greenhouse gas emissions.

Western Sydney's regional economy is structured in two quite different ways. The region hosts a large number of manufacturing facilities and their suppliers, largely a legacy of the region's role as a twentieth-century national industrial agglomeration. In parallel, however, the region hosts significant economic activity in population-driven sectors including in transport and logistics, construction, retail, health and education services, care services, public administration and hospitality. The region's population-driven sectors have this century become the region's primary source of economic growth, in both output and jobs. In contrast, manufacturing-driven sectors, while still highly significant, have recorded stagnant or declining economic performance for at least three decades (figure 1).

Figure 1: Change in jobs by Industry, Western Sydney 2000/01 to 2021/22

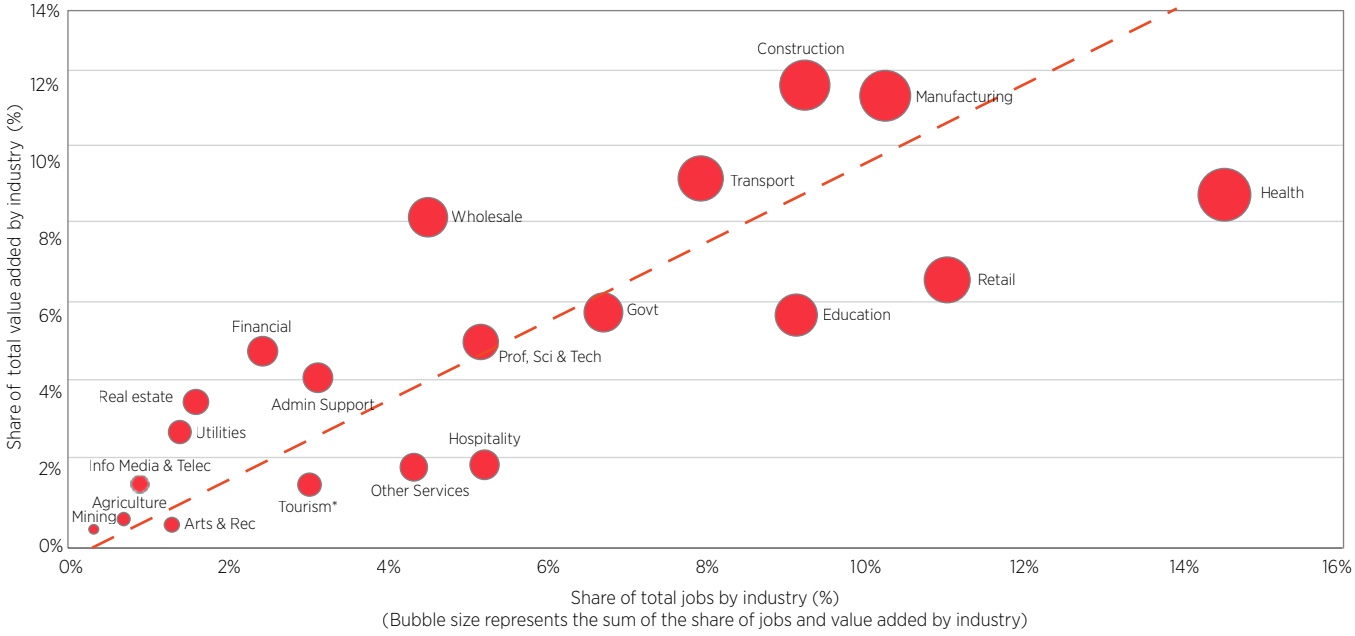


Source: NIEIR 2023

The region has been Australia's most significant growth region over the last twenty years

Figure 2 maps the diversity of Western Sydney's economic sectors. The sectors nearer the top of the figure are the region's most significant value generators, while those nearer the right-hand side of the figure are its major jobs providers. In simple terms, Western Sydney's materials handling firms (manufacturing, construction, transport, wholesale) are the region's value creators, while the services providers (health care and social assistance, retail, education, government) are particularly important in respect to jobs provision.

Figure 2: Industry share of local jobs and value added, Western Sydney 2022



Source: NIEIR 2023 | *Tourism includes activities from other industries

INDUSTRY SPECIALISATION

An important feature of the Western Sydney economy is the way it is specialised, especially within the manufacturing sector. Figure 3 shows the region's most specialised industries. The figure is based on calculations called location quotients. These are indicators of the extent to which an industry grouping over-delivers jobs in a region (Western Sydney) compared to the industry grouping's performance within a broader reference economy (Greater Sydney). The manufacture of polymer and rubber products, for example, has a jobs yield in Western Sydney 2.22 times the level that would be generated if the group's Western Sydney activity only achieved the jobs yield for this sub-sector in Greater Sydney as a whole.

Figure 3: Specialisation by Detailed Industries, Western Sydney 2022 (location quotient compared to Greater Sydney)

Industry	Jobs	Share of total	Specialisation
Polymer Product and Rubber Product Manufacturing	5,174	0.5%	2.22
Fabricated Metal Product Manufacturing	11,587	1.2%	2.21
Pulp, Paper and Converted Paper Product Manufacturing	3,883	0.4%	2.21
Primary Metal and Metal Product Manufacturing	5,545	0.6%	2.12
Motor Vehicle and Motor Vehicle Parts Wholesaling	4,364	0.4%	2.10
Aquaculture	221	0.0%	2.10
Warehousing and Storage Services	16,634	1.7%	2.07
Water Supply, Sewerage and Drainage Services	5,038	0.5%	2.02
Non-Metallic Mineral Product Manufacturing	4,891	0.5%	1.90
Wood Product Manufacturing	4,363	0.4%	1.85
Basic Material Wholesaling	9,662	1.0%	1.80
Agriculture	5,554	0.6%	1.79
Coal Mining	2,117	0.2%	1.76
Petroleum and Coal Product Manufacturing	630	0.1%	1.75
Waste Collection, Treatment and Disposal Services	4,521	0.5%	1.71
Road Transport	34,682	3.5%	1.71
Gas Supply	787	0.1%	1.68
Transport Equipment Manufacturing	5,306	0.5%	1.68
Machinery and Equipment Manufacturing	16,963	1.7%	1.66
Postal and Courier Pick-up and Delivery Services	13,977	1.4%	1.48

Source: NIEIR 2023

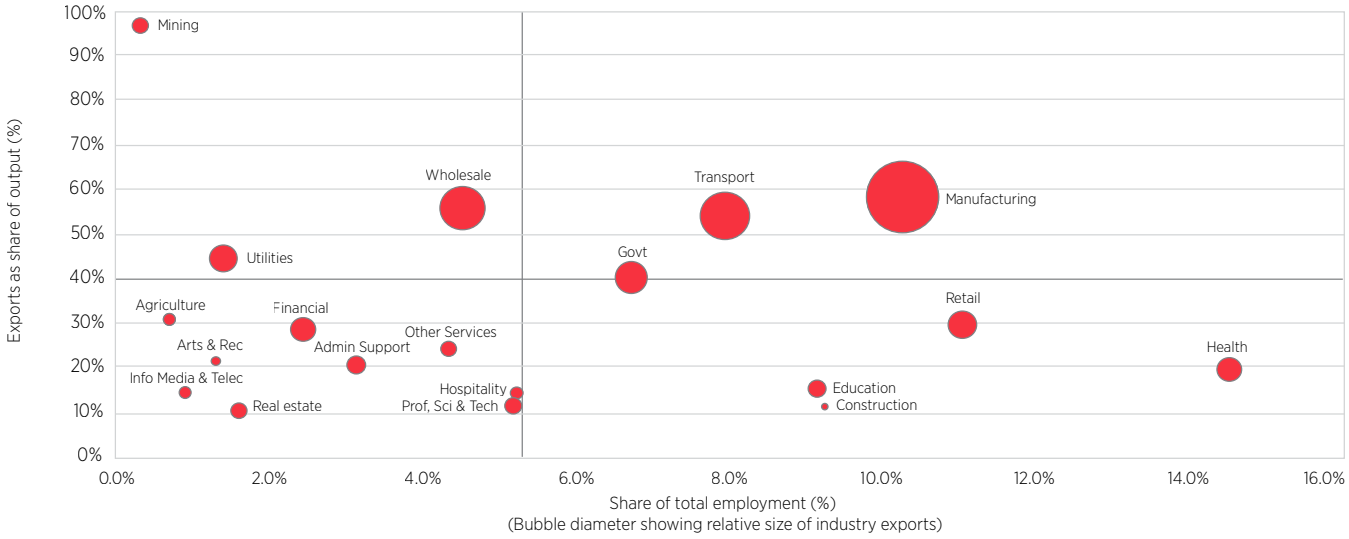
Close examination of the key specialisations for Western Sydney shows the critical importance of the following sub-sectors:

- → Manufacturing and materials handling, including polymer and rubber product manufacturing and primary and metal product manufacturing
- → Warehouse and storage services
- → Water supply, sewerage and drainage services
- → Waste collection, treatment and disposal services.

These specialisations have particular relevance to the nature and level of greenhouse gas emissions in the Western Sydney economy and are highlighted in the sections below.

Alongside its contribution to jobs, the value of an economic sector is measurable by the extent to which it generates income from the sale of goods and services to customers outside a region's boundary. Having a healthy proportion of local production sold to outsiders – by what are called the 'tradeables' sectors – is desirable because these sales capture money circulating in other economies rather than the money already circulating locally; that is, money flowing already to businesses servicing local demand.[2]

Figure 4: Export Propensity by Industry, Western Sydney 2022



Source: NIEIR 2023

Significantly, industry emissions in Western Sydney in 2022 fell by only 9.9% from the level of industry emissions for the region in 2005 (the base year in global agreements), which is a poor outcome.

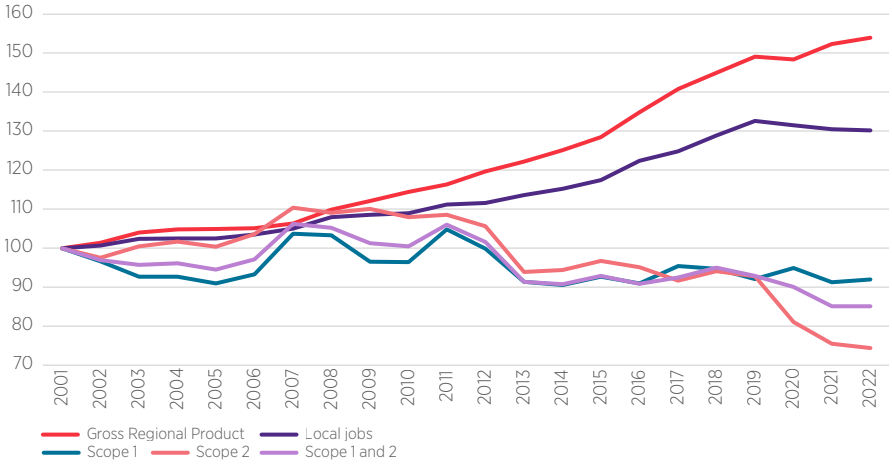
Figure 4 identifies those industries with above-median contributions to the Western Sydney economy via both jobs and exports. Again we observe the lingering importance of the manufacturing and materials handling sectors, with manufacturing and transport the only sectors landing in the *top* right quadrant, given their dual accomplishments in both jobs and exports performance. Note the position of the population-serving sectors in the *bottom* right quadrant, showing their underperformance in export income generation despite above-median jobs performance. Note also the excellent export performance of the mining, utilities and wholesaling sectors (*top* left-hand quadrant) — although in mining and utilities, employment generation is under par, explainable by the capital-intensive nature of firms and agencies in these sectors.

We now turn to the emissions profile of Western Sydney. Here we see the ongoing significance of Western Sydney's economic specialisations in the task of greenhouse gas abatement.

EMISSIONS TRENDS IN WESTERN SYDNEY

In 2022, industry emissions (scope 1 and scope 2) in Western Sydney totalled 19.5Mt, which was 49.6% of total industry emissions for Greater Sydney. Significantly, industry emissions in Western Sydney in 2022 fell by only 9.9% from the level of industry emissions for the region in 2005 (the base year in global agreements), which is a poor outcome. Moreover, for scope 1 emissions, there was a rise in Western Sydney in the 2005-2022 period, from 12.8Mt in 2005 to 13.0Mt in 2022. Fortunately, total scope 2 emissions fell by over a quarter in this period, from 9.2Mt to 6.8Mt, even as the region grew in terms of gross regional product and total jobs (figure 5).

Figure 5: Change in Gross Regional Product, Jobs and Emissions, Western Sydney (Index, 2001 = 100)



Source: NIEIR 2023; DCCEEW 2023; NSW Department of Planning and Environment 2022

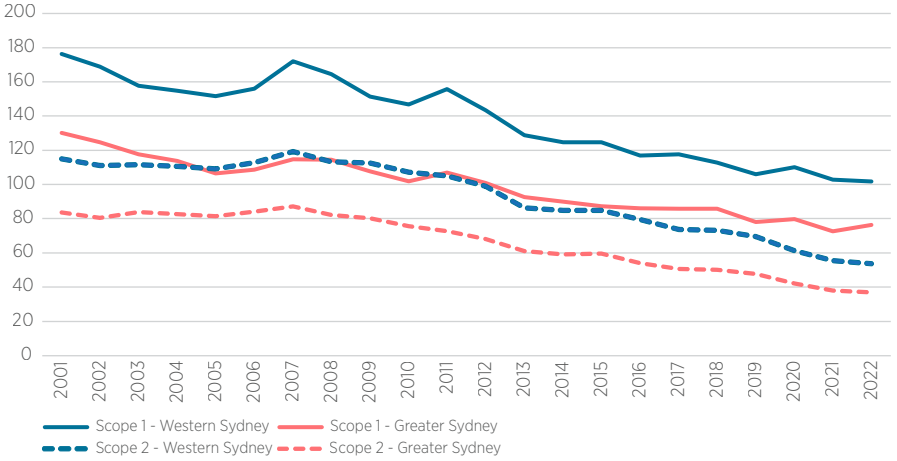
The impacts on scope 1 emissions of the global financial crisis (GFC) from 2008 and of COVID-19 from 2020 are noteworthy. In each circumstance significant weakening of the region's economy coincided with an accelerated fall in scope 1 emissions; although decline proved to be short lived in each case. For scope 2 emissions we can observe an ongoing fall over the two decades. Yet, as we detail below, this fall can be attributed to the decarbonisation of electricity sourced from the grid in general rather than to any specific within-region initiatives.

It can be argued, then, that modest falls in total greenhouse gas emissions for the Western Sydney economy over the last two decades have been driven as much by external forces, like global economic downturns and national energy policy, as by deliberative firm actions or policy interventions at the regional scale – although there are notable exceptions as we see in the detailed industry profiles in Section 4 below.

Trends in scope 1 and scope 2 emissions over the past two decades across Western Sydney's economic sectors are also observable from figures 6 and 7. These figures show trends in greenhouse gas emissions moderated by the actual economic value being generated, which we call 'emissions intensity' (measured in tonnes CO2e per $1 million of value added). While scope 1 emissions intensity in Western Sydney has been falling over the past two decades, scope 2 emissions intensity has been falling at a faster rate, as shown on the figure by the steeper downwards sloping curve. In other words, reductions in both emissions intensity and total emissions in Western Sydney have relied disproportionately on the decarbonisation of electricity generation (scope 2 emissions) rather than on direct on-site decarbonisation actions (scope 1 emissions). This represents a significant outsourcing of the decarbonisation task to other facilities in other regions.[3]

...reductions in both emissions intensity and total emissions in Western Sydney have relied disproportionately on the decarbonisation of electricity generation (scope 2 emissions) rather than on direct on-site decarbonisation actions (scope 1 emissions).

Figure 6: Emissions intensity, All Industries, Western Sydney and Greater Sydney 2001/2 to 2021/22 (Tonne CO2 Equivalent per $1 million value added)

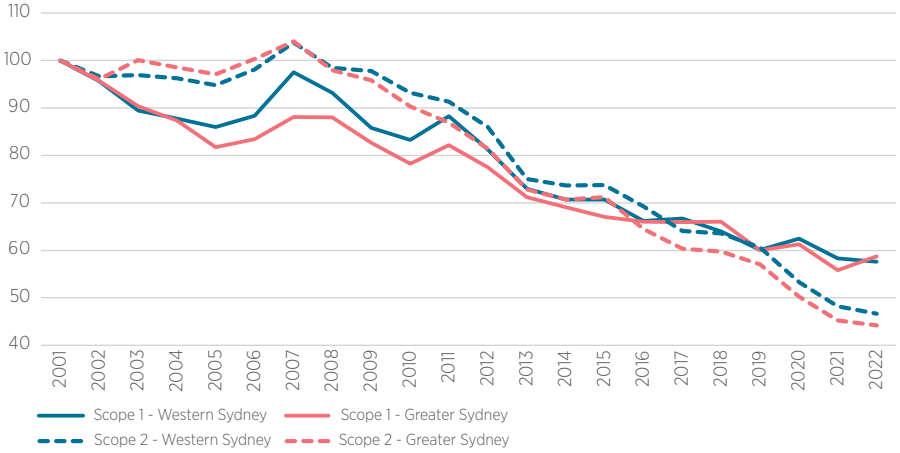


Source: NIEIR 2023; DCCEEW 2023; NSW Department of Planning and Environment 2022

It needs restating, that even with such significant outsourcing the rate of emissions decline in the Western Sydney economy remains modest. Our calculations show if the national target of 43% reduction in year 2005 emissions were applied to Western Sydney, industry emissions in the region would need to fall to 12.3Mt by 2030 from 19.5Mt in 2022. Trends revealed in our analysis show this is not going to occur unless there are major changes in the slow pace and manner of the region's emissions abatement.

We expand on this argument throughout the remainder of this report.

Figure 7: Change in Emissions intensity, All Industries, Western Sydney and Greater Sydney (Index, 2001 = 100)



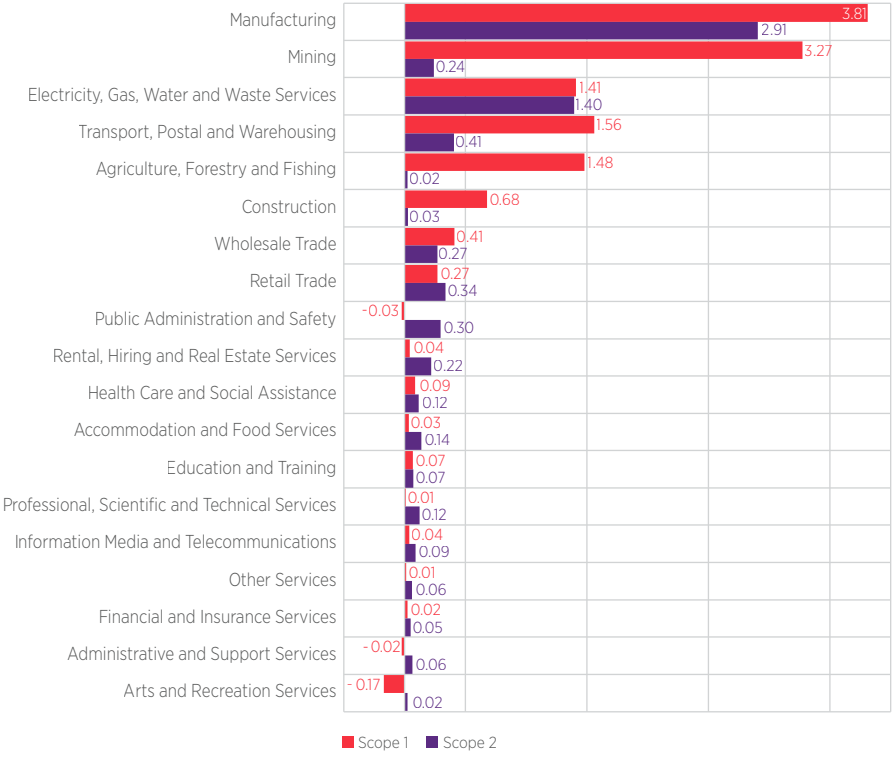
Source: NIEIR 2023; DCCEEW 2023; NSW Department of Planning and Environment 2022

EMISSIONS TRENDS BY INDUSTRY SECTORS

In 2021-22, Western Sydney's manufacturing sector accounted for 29.4% of the region's scope 1 emissions and 42.4% of its scope 2 emissions (calculated from figure 8). The next most significant emissions-generating sectors in 2021-22 were mining (25.2% scope 1, 3.5% scope 2), utilities (10.9% scope 1, 20.4% scope 2), and transport, postal and warehousing (12.0% scope 1, 5.9% scope 2). Notably, as revealed in Section 1 above, high emissions from the mining sector come from the Appin and Tahmoor coal mines in the Wollondilly LGA and both are targeted by regulations prescribed in the nation's Safeguard Mechanism.

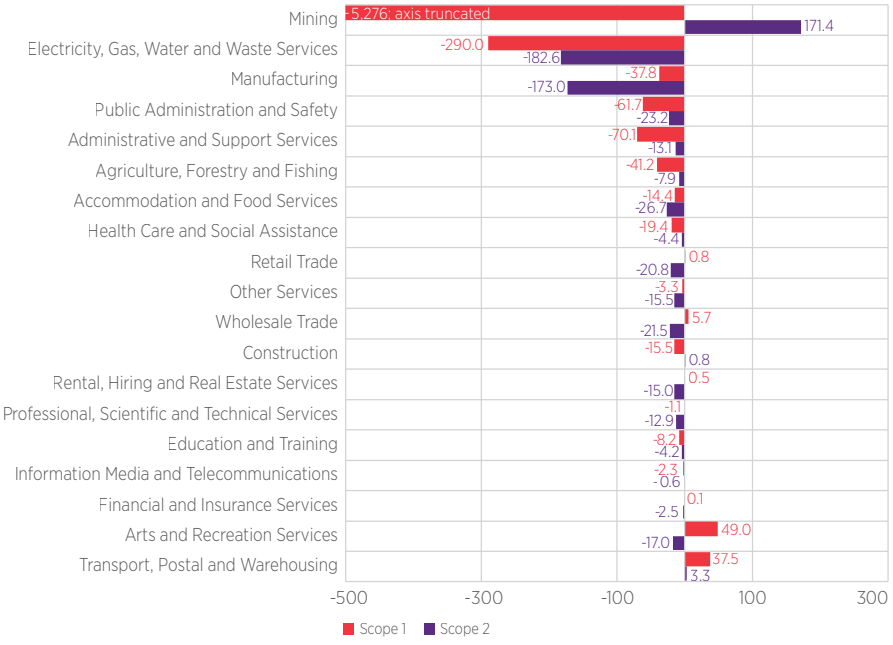
Significantly, the emissions for most industry sectors have changed little over the last two decades. But there are notable exceptions. In agriculture, scope 1 emissions have risen by 0.70Mt (+90.9%) over the 20-years period, while in transport, postal and warehousing, scope 1 emissions have risen by 0.98Mt (+170.1%) over this period. This reflects the sector's substantial growth rather than an actual rise in emissions intensity, as we see in figure 9. In respect to sectors with significant *falls*, scope 1 emissions in the mining sector fell by 1.83Mt (-35.9%) between 2000-01 and 2021-22, probably the consequence of successful fugitive emissions capture. In manufacturing, scope 1 emissions fell by 0.74Mt (-16.3%) in this period, probably the consequence of the closure of old-technology firms reliant on the use of liquid and gaseous fuels, while scope 2 emissions in manufacturing fell by 2.82Mt (-49.2%), likely the consequence of decarbonisation in the electricity grid, as discussed above.

Figure 8: Emissions by industry, Western Sydney 2021/22 (Mt CO2e)



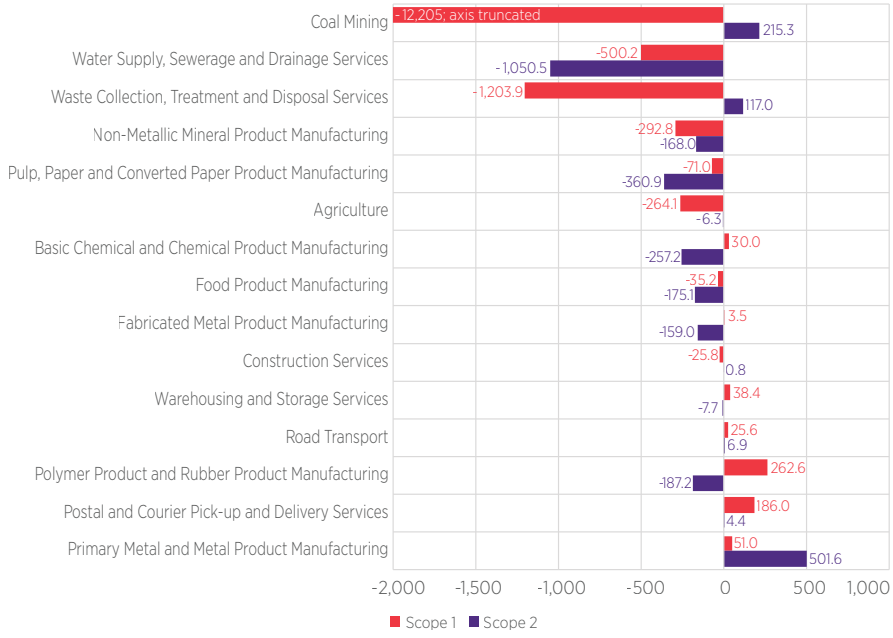
Source: DCCEEW 2023; NSW Department of Planning and Environment 2022; .id Analysis 2024

Figure 9: Change in Emissions Intensity by Industry, Western Sydney 2001/2 to 2021/22 (Tonnes CO2e per $1 million value added)



Source: DCCEEW 2023; NSW Department of Planning and Environment 2022; .id Analysis 2024

Figure 10: Change in Emissions Intensity by Detailed Industry, Western Sydney 2001/2 to 2021/22 (Tonnes CO2e per $1 million value added)



Source: DCCEEW 2023; NSW Department of Planning and Environment 2022; .id Analysis 2024

In terms of emissions intensity — the quantity of emissions (tonnes of CO2e) needed to generate a unit of output ($1 million of value added) — there has been wide variation across industry sub-sectors over the last two decades (figure 10). Scope 1 emissions intensity has fallen most significantly in coal mining, and in waste collection, treatment and disposal services. Scope 1 emissions intensity has also fallen, although to lesser extents, in water supply, sewerage and drainage services, in non-metallic mineral products (chiefly cement production), and in agriculture.

...*rising* emissions intensity *within* industry sub-sectors over the last two decade has diminished the region's overall performance in emissions reduction.

For scope 2, emissions intensity has fallen over the last two decades in water supply, sewerage and drainage services, in pulp and paper manufacturing, in basic chemical and chemical products, in food products, in fabricated metals, and in polymer and rubber products.

Yet, *rising* emissions intensity *within* industry sub-sectors over the last two decade has diminished the region's overall performance in emissions reduction. For example, while scope 1 emissions intensity has fallen in coal mining and in waste collection, treatment and disposal services, these industry groups have shown rising scope 2 emissions intensity. Conversely, rising scope 1 emissions intensity in the polymer and rubber products sub-sector has somewhat diminished the effect of that sub-sector's falling scope 2 intensity. We return to the analysis of industry sub-sectors in Section 4 below.

GEOGRAPHIC VARIATIONS IN EMISSIONS

As noted above, Western Sydney generates about 50% of Greater Sydney's industry greenhouse gas emissions (table 1). The most significant source of emissions by LGA is Wollondilly, the consequence of there being two coal mines in the LGA, as explained above. Wollondilly LGA is the source of 21% of all greenhouse gases emitted by industry in the Western Sydney region. Blacktown LGA is the source of 18% of the region's industry emissions reflecting the extent to which it hosts the region's largest manufacturing and distribution facilities. Next in significance are LGAs with concentrations of post-WW2 industrial facilities, namely Parramatta, Canterbury-Bankstown and Cumberland. The next group are the LGAs with industrial mixes forged later in the 20th century, namely Penrith, Liverpool, Fairfield and Campbelltown. The final group are the peri-urban LGAs where residential development has been more recent with (so far) minimal investment in industrial activity.

> It is remarkable how accurately the league table of emissions by LGA reflects the historic sequence of urban development in Western Sydney.

Table 1: Emissions by Local Government Areas, Western Sydney and Greater Sydney 2021/22 (Mt CO2e)

LGA	Emissions (Mega Tonne CO2 Equivalent)	Share of Western Sydney	Share of Greater Sydney
Wollondilly (A)	4.0	21%	10%
Blacktown (C)	3.4	18%	9%
Parramatta (C)	1.7	9%	4%
Canterbury-Bankstown (A)	1.5	8%	4%
Cumberland (A)	1.5	8%	4%
Penrith (C)	1.5	8%	4%
Liverpool (C)	1.3	7%	3%
Fairfield (C)	1.2	6%	3%
Campbelltown (C) (NSW)	1.1	6%	3%
The Hills Shire (A)	0.8	4%	2%
Camden (A)	0.6	3%	2%
Blue Mountains (C)	0.4	2%	1%
Hawkesbury (C)	0.3	2%	1%
Western Sydney	19.5		50%

Source: DCCEEW 2023; NSW Department of Planning and Environment 2022; .id Analysis 2024

It is remarkable how accurately the league table of emissions by LGA reflects the historic sequence of urban development in Western Sydney. This finding is reinforced by data in table 2. Here we see a very tidy ordering of emissions intensity, matching the ordering of total emissions shown in table 1 and described above. The anomaly is Blue Mountains LGA which despite very low *total* emissions registers elevated emissions intensity in two sectors, namely agriculture and waste treatment and disposal.

Table 2: Emissions Intensity by Local Government Areas, Western Sydney (Tonnes CO2e per $1 million value added)

LGA	2021/22	2000/01	Change 2000/01 to 2021/22
Wollondilly (A)	1,926	4,372	-2,446
Blue Mountains (C)	203	357	-154
Blacktown (C)	184	259	-75
Campbelltown (C) (NSW)	171	278	-108
Penrith (C)	145	287	-142
Fairfield (C)	143	295	-152
Camden (A)	136	228	-92
Cumberland (A)	131	327	-195
Canterbury-Bankstown (A)	117	201	-85
Liverpool (C)	112	216	-104
Hawkesbury (C)	100	137	-37
The Hills Shire (A)	75	162	-87
Parramatta (C)	68	114	-46
Western Sydney	**153**	**286**	**-133**

Source: DCCEEW, 2023; NSW Department of Planning and Environment, 2022; .id Analysis, 2024

A simple summary can be made. The tables show how the geography of greenhouse gas emissions in Western Sydney is underpinned by the industrial structure of the region's local economies. The tables also reflect how little the region's local economic geography has changed in the last two decades.

1 O'Neill 2020

2 O'Neill and Tannous 2021

3 The Clean Energy Australia Report 2024 says that renewables overall accounted for 39.4% of Australia's total electricity supply in 2023, a major increase from 2017, when the share of Australia's total renewable generation was just 17 per cent. See https://assets.cleanenergycouncil.org.au/documents/resources/reports/clean-energy-australia/Clean-Energy-Australia-2024.pdf Accessed 22 April 2024

SECTION 4

DETAILED INDUSTRY PROFILES

We have observed the close relationship between industry structure and emissions performance across the Western Sydney regional economy. In this section we continue this exploration via the study of detailed emissions profiles for five significant industry sub-sectors in Western Sydney, namely:

1. Basic chemical and chemical product manufacturing
2. Polymer product and rubber product manufacturing
3. Primary metal and metal product manufacturing
4. Waste collection, treatment and disposal services
5. Warehousing and storage services.

These industry sub-sectors have been selected for two reasons, because they are significant generators of greenhouse gas emissions, and because they give insight into changes in emissions underway more broadly in the Western Sydney regional economy.

BASIC CHEMICAL AND CHEMICAL PRODUCT MANUFACTURING

The basic chemical and chemical product manufacturing sub-sector (hereafter called chemicals manufacturing) includes the manufacture of basic chemicals and polymers, fertilisers, pesticides, pharmaceutical and medicinal products, cleaning compounds and toiletry preparations. Chemicals manufacturing is a significant industry sub-sector in Western Sydney, responsible for 6,412 jobs in 2021-22 and over $1 billion in value added, nearly 1% of the region's total (NIEIR 2023). Yet, as shown in the figures accompanying this sub-section, chemicals manufacturing in Western Sydney has experienced steady decline over the last two decades, in terms of employment (figure 11), in value added (figure 12) and as a share of the region's economy in total (figure 13). There is a general explanation for this decline. Many activities in the chemicals manufacturing sub-sector have involved, historically, the manufacture of upstream, intermediate products for use by other sectors, a supply chain rendered increasingly redundant by the rising level of imports of finished products.

With 4.1% of the region's emissions for just 0.9% of the region's value added, the chemicals manufacturing sub-sector in Western Sydney contributes disproportionally to total emissions. Moreover, as discussed immediately above, the sub-sector's falling level of emissions (figure 14) should be seen in the context of industry-wide decline. Figure 14 also gives insight into what is happening in terms of category of emissions. Scope 1 emissions data for chemicals manufacturing show minimal net change over the last twenty years. Falls in total emissions for the sub-sector are almost entirely explainable by falling scope 2 emissions, largely the consequence of external actions to decarbonise electricity supplies rather than the result of onsite actions. This outsourcing of emissions reduction is observable from figure 15 which shows that while the intensity of scope 1 emissions for chemicals manufacturing has barely changed over the last decade there has been significant reduction in the sub-sector's scope 2 emissions intensity.

Many activities in the chemicals manufacturing sub-sector have involved, historically, the manufacture of upstream, intermediate products for use by other sectors, a supply chain rendered increasingly redundant by the rising level of imports of finished products.

Figure 11: Local Jobs, Basic Chemical and Chemical Product Manufacturing, Western Sydney 2000/1 to 2021/22 (number of workers)

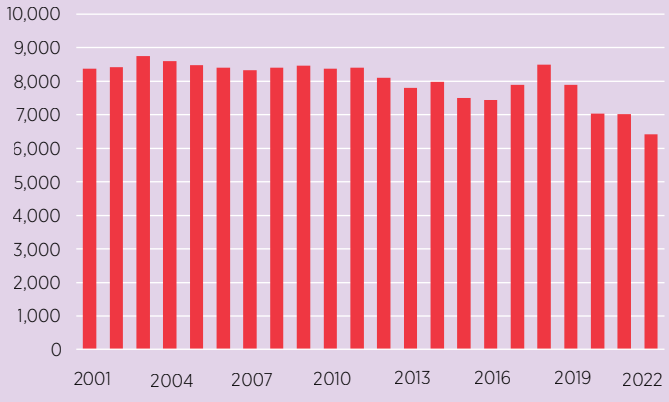


Figure 12: Value Added, Basic Chemical and Chemical Product Manufacturing, Western Sydney 2000/1 to 2021/22

Figure 13: Share of Regional Economy, Basic Chemical and Chemical Product Manufacturing, Western Sydney and Greater Sydney 2021/22 (percent)

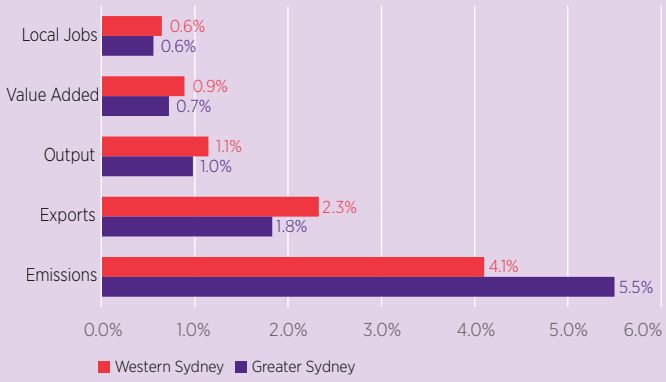


Figure 14: Emissions, Basic Chemical and Chemical Product Manufacturing, Western Sydney 2000/1 to 2021/22 (Mt CO2e)

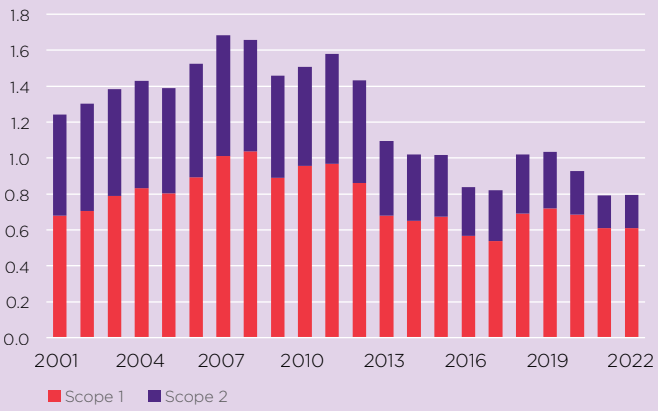
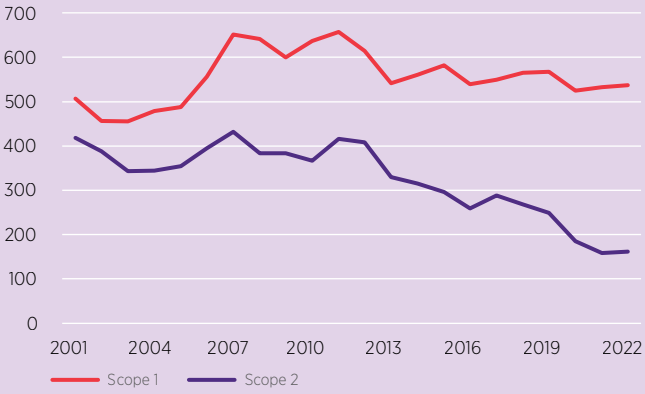


Figure 15: Emissions intensity, Basic Chemical and Chemical Product Manufacturing, Western Sydney 2000/1 to 2021/22 (Tonnes CO2e per $1mil. value added)



Source: NIEIR 2023, ABS Census of Population and Housing 2021, ABS 2023

Figures 16 to 19 give insight into trends at the 3-digit or sub-industry level for chemicals manufacturing. The figures show four activity groups – pharmaceutical and medicinal products, cleaning compounds and toiletry preparations, basic chemicals, and basic polymers – which are, for Western Sydney, the chemical sub-sector's major employers and its major emitters of greenhouse gases. Yet, as shown in figure 18, the three largest employment groups in the chemicals sector – pharmaceutical and medicinal products, cleaning compounds and toiletry preparations, basic chemicals – are where the lion's share of jobs shedding has occurred in the sub-sector

...the most significant source of falling emissions in the chemicals manufacturing sub-sector is industry closure.

over the last twenty years. In turn, this falling level of manufacturing activity is directly responsible for the falling level of greenhouse gas emissions in this sub-sector over the same period (figure 19). In other words, the most significant source of falling emissions in the chemicals manufacturing sub-sector is industry closure.

Figure 16: Jobs, Basic Chemical and Chemical Product Manufacturing, Western Sydney 2021/22 (number of workers)

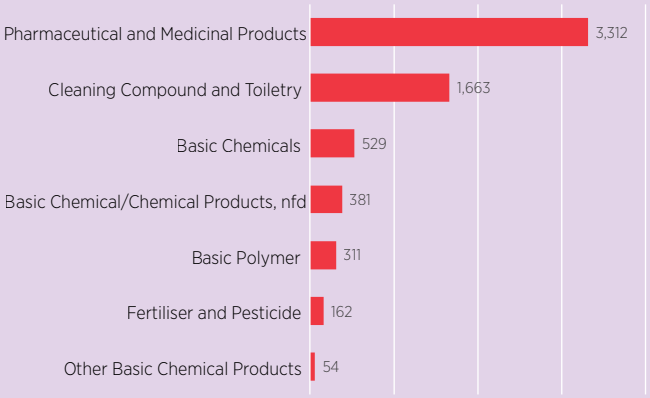


Figure 17: Emissions, Basic Chemical and Chemical Product Manufacturing, Western Sydney 2021/22 (Mt CO2e, scope 1 and 2 combined)

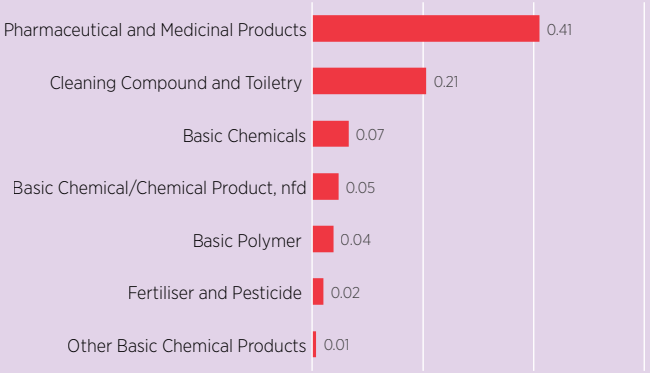


Figure 18: Jobs Change, Basic Chemical and Chemical Product Manufacturing, Western Sydney 2000/1 to 2021/22 (number of workers)

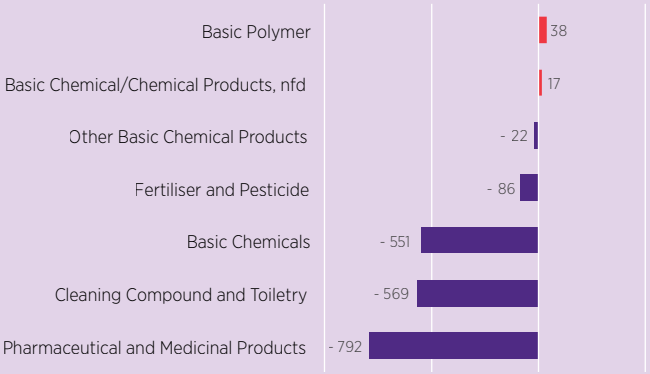
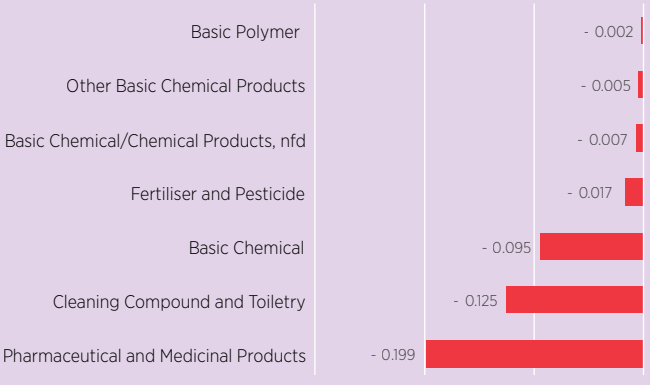


Figure 19: Emissions Change, Basic Chemical and Chemical Product Manufacturing, Western Sydney 2000/01 to 2021/22 (Mt CO2e, scope 1 and 2 combined)



Source: NIEIR 2023, ABS Census of Population and Housing 2021, ABS 2023

The chemicals manufacturing sub-sector is located in a variety of suburbs across Western Sydney including both older and more recently released industrial districts. As is observable from table 3, the highest concentration of chemicals manufacturing workers in Western Sydney is located in the Toongabbie-Constitution Hill district (using ABS SA2 geographical areas) west from Parramatta. Other significant SA2 clusters are Ingleburn and Minto-St Andrews in the southwest of the region, Ermington-Rydalmere in the region's north and Wetherill Park centred on the junction of the M4 and M7 motorways.

Table 3: Jobs Location, Basic Chemical and Chemical Product Manufacturing, Western Sydney SA2s 2021/22 (number of workers)

SA2	Workers	Share of Western Sydney	Share of Greater Sydney
Toongabbie - Constitution Hill	618	14%	6%
Ingleburn	382	9%	4%
Ermington - Rydalmere	357	8%	4%
Wetherill Park Industrial	283	6%	3%
Minto - St Andrews	267	6%	3%
Smithfield Industrial	159	4%	2%
Prospect Reservoir	155	4%	2%
Pendle Hill - Girraween	142	3%	1%
Pemulwuy - Greystanes (North)	141	3%	1%
Prestons	136	3%	1%

Source: NIEIR 2023

POLYMER PRODUCT AND RUBBER PRODUCT MANUFACTURING

The polymer product and rubber product manufacturing sub-sector includes the manufacture of polymer products such as packaging, foam products, adhesives, paint and coatings, and the manufacture of rubber products such as tyres, bathmats, condoms, conveyor belts, floor coverings, garden hoses, pillows, balloons, gloves, washers and tubing. The manufacture of polymer and rubber products is a significant industry sub-sector in Western Sydney, responsible for 5,174 jobs in 2021-22 and nearly $1 billion in value added, around 0.8% of the region's total (NIEIR 2023). While the sub-sector has experienced ongoing jobs loss in Western Sydney over the last two decades (figure 20), the sub-sector's contribution to regional value added (figures 21 and 22) has remained reasonably steady, following significant falls at the turn of the century.

> ...the *intensity* of scope 1 emissions for polymer and rubber products sub-sector has fluctuated over the two-decades without establishing any convincing downward trend.

Figure 20: Local Jobs, Polymer and Rubber Product Manufacturing, Western Sydney 2000/1 to 2021/22 (number of workers)

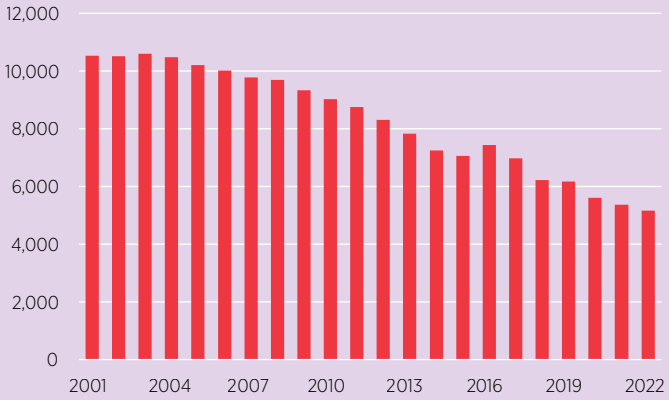


Figure 21: Share of Regional Economy, Polymer and Rubber Product Manufacturing, Western Sydney and Greater Sydney 2021/22 (percent)

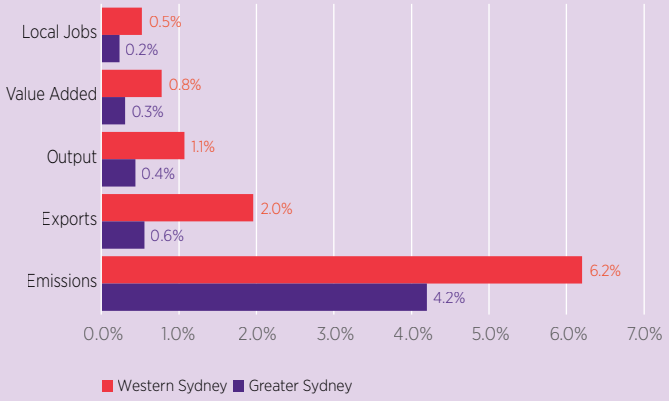


Figure 22: Value Added, Polymer and Rubber Product Manufacturing, Western Sydney 2000/1 to 2021/22

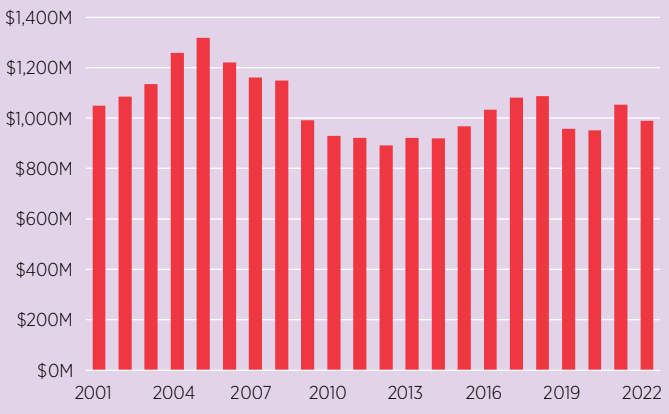
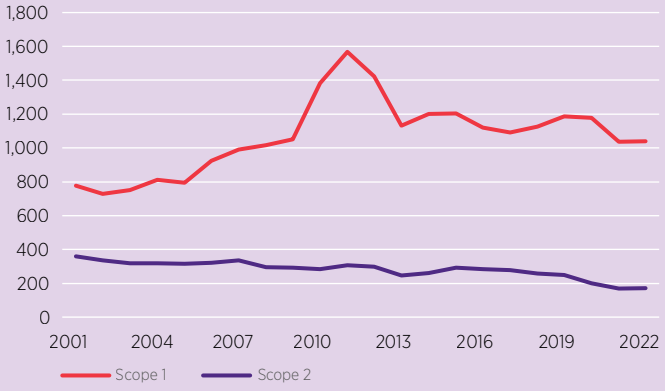


Figure 23: Emissions, Polymer and Rubber Product Manufacturing, Western Sydney 2000/1 to 2021/22 (Mt CO2e)

Figure 24: Emissions intensity, Polymer and Rubber Product Manufacturing, Western Sydney 2000/1 to 2021/22 (Tonnes CO2e per $1mil. value added)



Source: NIEIR 2023, ABS Census of Population and Housing 2021, ABS 2023

Fluctuations in the level of emissions for the sub-sector (figures 23 and 24) correspond to fluctuations in the sub-sector's value added. Scope 1 emissions for the sub-sector have declined only marginally over the last decade following sustained rises between 2001 and 2013. These trends are also evident in the sub-sector's emissions intensity data (figure 24). As with *total* scope 1 emissions, the *intensity* of scope 1 emissions for polymer and rubber products sub-sector has fluctuated over the two-decades without establishing any convincing downward trend.

For scope 2 emissions intensity, there have been consistent falls over the last twenty years, probably reflecting, like with other manufacturing sub-sectors, the progressive decarbonisation of the electricity grid, the sub-sector's primary means of energy supply.

Figure 25: Local Jobs, Polymer and Rubber Product Manufacturing, Western Sydney 2021/22 (number of workers)

Figure 26: Emissions, Polymer and Rubber Product Manufacturing, Western Sydney 2001/1 to 2021/22 (Mt CO2e, scope 1 and 2 combined)

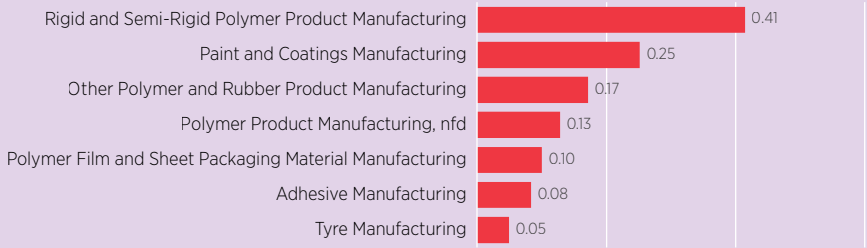


Figure 27: Jobs Change, Polymer and Rubber Product Manufacturing, Western Sydney 2001/1 to 2021/22 (number of workers)

Figure 28: Emissions Change, Polymer and Rubber Product Manufacturing, Western Sydney 2000/01 to 2021/22 (Mt CO2e, scope 1 and 2 combined)

Source: NIEIR 2023, ABS Census of Population and Housing 2021, ABS 2023

Figures 25 to 28 give insight into trends at the 3-digit or sub-industry level. Figures 25 and 26 show that two activity groups — rigid and semi-rigid polymer products, and paint and coatings manufacturing – dominate employment in the polymer product and rubber product manufacturing sub-sector. These two activity groups are also the sub-sector's major emitters of greenhouse gases. Yet, as shown in figure 27, these two activity

> ...the falling level of greenhouse gas emissions in the polymer and rubber products sub-sector over the same period can be traced to decline within the sub-sector, rather than to deliberate changes in manufacturing practices

groups contribute most to jobs shedding in the sub-sector over the last twenty years. In turn, the falling level of greenhouse gas emissions in the polymer and rubber products sub-sector over the same period can be traced to decline within the sub-sector, rather than to deliberate changes in manufacturing practices (figure 28). The same relationship is also observable across the sub-sector's other groupings (figures 27 and 28); that is, there is a positive correlation between falling emissions and falling levels of economic activity. This relationship is obviously at odds with the aspiration of reducing greenhouse gas emissions without diminishing the prosperity of the regional economy.

The polymer product and rubber product manufacturing sub-sector is located in a variety of suburbs across Western Sydney. In general, facilities in the sub-sector can be found in most of Western Sydney's industrial areas (table 4) including Chester Hill-Sefton (379 workers), Smithfield (339), Wetherill Park (329) and Ingleburn (317). Key factors of location for the sub-sector are the availability of suitably-zoned land and access to quality local labour.

Table 4: Jobs Location, Polymer and Rubber Product Manufacturing, Western Sydney SA2s 2021/22 (number of workers)

SA2	Workers	Share of Western Sydney	Share of Greater Sydney
Chester Hill - Sefton	379	9%	7%
Smithfield Industrial	339	8%	6%
Wetherill Park Industrial	329	7%	6%
Ingleburn	317	7%	6%
Bankstown - South	295	7%	5%
Chipping Norton - Moorebank	241	5%	4%
Condell Park	239	5%	4%
Minto - St Andrews	233	5%	4%
Blacktown (East) - Kings Park	221	5%	4%
Prospect Reservoir	198	4%	4%

Source: NIEIR 2023

PRIMARY METAL AND METAL PRODUCT MANUFACTURING

The primary metal and metal product manufacturing sub-sector involves the manufacture of basic ferrous and non-ferrous metal products. This is a significant industry sub-sector in Western Sydney, responsible for 5,545 jobs in 2021-22 and around $340 million in value added, about 0.3% of the region's total (NIEIR 2023). Yet, as shown in figures 29 and 30, the trend for primary metal and metal product manufacturing in Western Sydney over the last two decades, for both jobs and value added, is one of persistent decline. Even after accounting for elevated value added during Western Sydney's boom construction years pre-COVID19 (O'Neill & Tannous 2021), the sub-sector has experienced falls over the longer term in each of employment (figure 29), value added (figure 30), and contribution to the total value of the region's economy (figures 31 and 32).

Figure 29: Local Jobs, Primary Metal and Metal Product Manufacturing, Western Sydney 2000/1 to 2021/22 (number of workers)

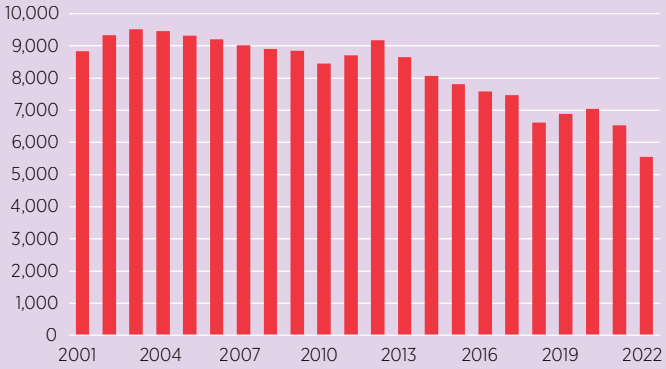


Figure 30: Emissions, Primary Metal and Metal Product Manufacturing, Western Sydney 2000/1 to 2021/22 (Mt CO2e)

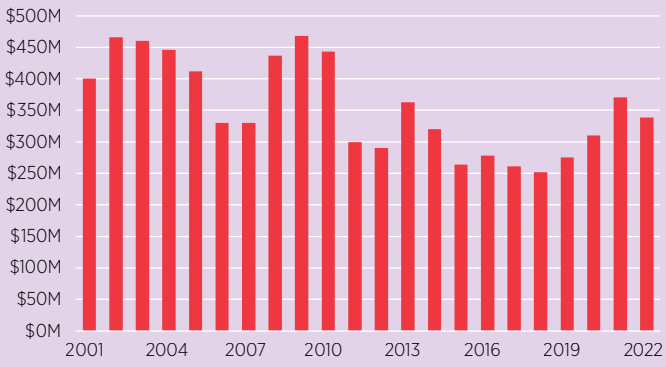


Figure 31: Share of Regional Economy, Primary Metal and Metal Product Manufacturing, Western Sydney and Greater Sydney 2021/22 (percent)

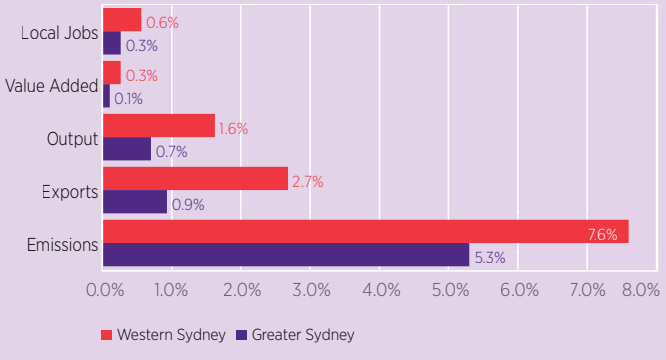


Figure 32: Emissions, Primary Metal and Metal Product Manufacturing, Western Sydney 2000/1 to 2021/22 (Mt CO2e)

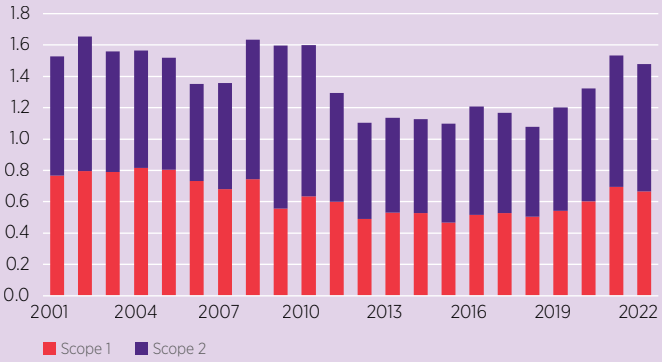
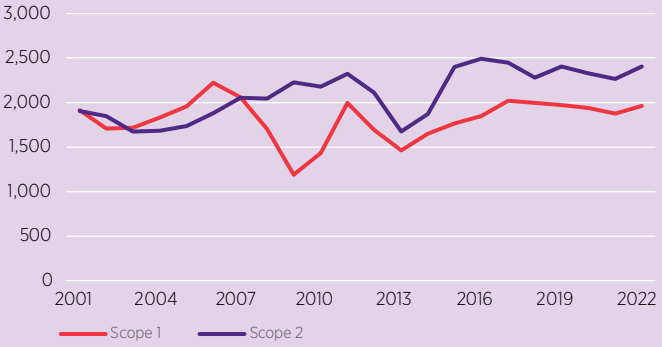


Figure 33: Emissions Intensity, Primary Metal and Metal Product Manufacturing, Western Sydney 2000/1 to 2021/22 (Tonnes CO2e per $1mil. value added)



Source: NIEIR 2023, ABS Census of Population and Housing 2021, ABS 2023

...an examination of emissions intensity within scope 1 and scope 2 categories reveals the sub-sector's intransigence in terms of emissions performance.

Significantly, the primary metal and metal product manufacturing sub-sector is another Western Sydney manufacturing sub-sector experiencing general decline. The explanation for this decline matches observations made above for the chemicals manufacturing sub-sector. Many activities in the metal and metal product manufacturing sub-sector involve the production of upstream, intermediate products for purchase by downstream users in other industrial sectors. A positive consequence of this supply-chain position occurred between 2018 and 2021 when construction activity in Western Sydney was at record highs, coinciding with significant problems in international supply chains. A surge in local demand was thereby met by local suppliers of the products needed by the construction sector, such as reinforcement steel and metal formwork. As boom conditions dissipated, however, growth in local output has abated. Moreover, as with chemicals manufacturing, a growing volume of imported finished products comes at the expense of locally-manufactured intermediate products.

The sub-sector's falling level of emissions should, therefore, be seen in the context of long-term industry decline and short-term bounce-backs. Total emissions for the sub-sector (figure 32) mirror the sub-sector's value-added performance (figure 30). Yet, an examination of emissions intensity within scope 1 and scope 2 categories (figure 33) reveals the sub-sector's intransigence in terms of emissions performance. Following impressive falls in the short period between 2011 and 2013, emissions intensity in the sub-sector returned to elevated levels for both scope 1 and scope 2 categories, without subsequent decline.

Just like the location pattern for the polymer product and rubber product manufacturing sub-sector described above, primary metal and metal product manufacturers are located in a variety of Western Sydney industrial areas (table 5), although with higher concentrations in outer western districts especially Wetherill Park (393 workers), Rooty Hill-Minchinbury (325), Erskine Park (273) and St Marys-North St Marys (268). Again, this location pattern reflects the availability of suitably-zoned land and access to quality local labour.

Table 5: Jobs Location, Primary Metal and Metal Product Manufacturing, Western Sydney SA2s 2021/22 (number of workers)

SA2	Workers	Share of Western Sydney	Share of Greater Sydney
Wetherill Park Industrial	393	9%	7%
Rooty Hill - Minchinbury	325	7%	6%
Erskine Park	273	6%	5%
St Marys - North St Marys	268	6%	5%
Condell Park	209	5%	4%
Minto - St Andrews	182	4%	3%
Smithfield Industrial	176	4%	3%
Ingleburn	159	4%	3%
Chipping Norton - Moorebank	151	3%	3%
Penrith	122	3%	2%

Source: NIEIR 2023

WASTE COLLECTION, TREATMENT AND DISPOSAL SERVICES

The waste collection, treatment and disposal services sub-sector involves household, industrial and construction waste collection, including solid, liquid and hazardous waste; the treatment and disposal of waste; recovery of materials from the waste stream; and the remediation of materially-affected sites.

Waste collection, treatment and disposal services are a significant industry sub-sector in Western Sydney, responsible for 4,521 jobs in 2021-22 and around $570 million in value added, about 0.4% of the region's total (NIEIR 2023). Being a population-driven sub-sector, there has been steady jobs growth in waste collection, treatment and disposal services in Western Sydney over the last two decades (figure 34). Likewise, the sub-sector's contribution to regional value added (figures 35 and 36) has grown steadily, except for the period 2010-2014. This was when the sector's regional presence was diminished by the closure of many municipal waste facilities and their substitution by waste services delivered from non-metropolitan locations. The subsequent emergence of high-value waste services within the region in recent years has reversed this trend.

Figure 34: Local Jobs, Waste Collection, Treatment and Disposal Services, Western Sydney 2000/1 to 2021/22 (number of workers)

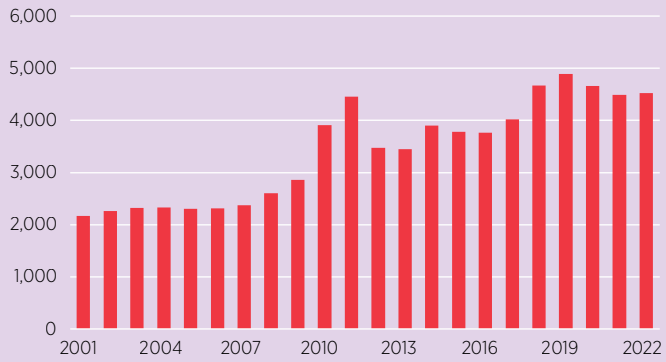


Figure 35: Share of Regional Economy, Waste Collection, Treatment and Disposal Services, Western Sydney and Greater Sydney 2021/22 (percent)

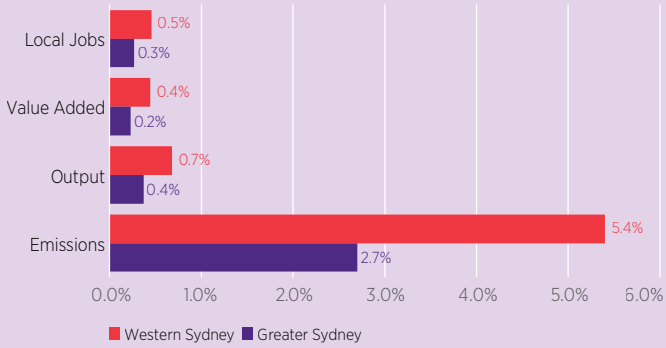


Figure 36: Value Added, Waste Collection, Treatment and Disposal Services, Western Sydney 2000/1 to 2021/22

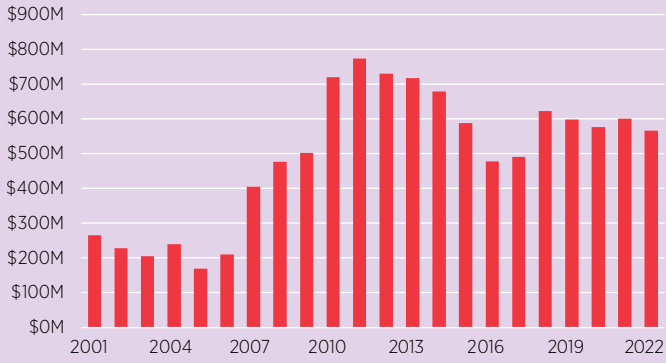


Figure 37: Emissions, Waste Collection, Treatment and Disposal Services, Western Sydney 2000/1 to 2021/22 (Mt CO2e)

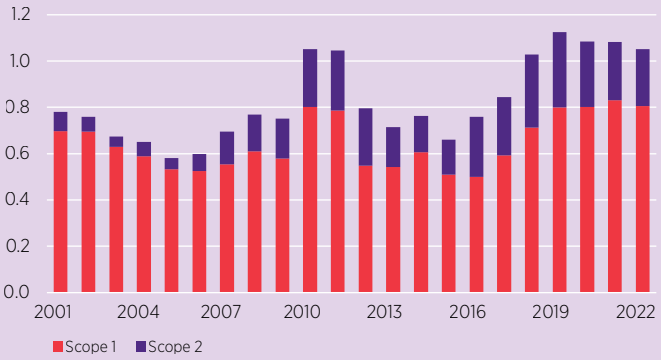
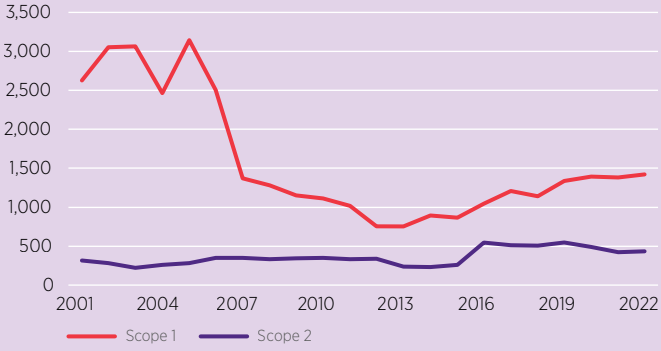


Figure 38: Emissions intensity, Waste Collection, Treatment and Disposal Services, Western Sydney 2000/1 to 2021/22 (Tonnes CO2e per $1mil. value added)



Source: NIEIR 2023, ABS Census of Population and Housing 2021, ABS 2023

The sub-sector's level of emissions (figures 37 and 38) correlates positively with the sub-sector's fluctuations in value added. The aggregate of scope 1 and scope 2 emissions shows an upward trajectory, matching the sub-sector's growth pathway. Yet, emissions intensity data show a more complex story. For scope 2 emissions, the long-term trend is one of little overall change, although with intensity rising slightly in recent years. For scope 1 emissions intensity, however, the sub-sector has experienced major changes. After significant ups and downs, from a high baseline, in the early-2000s, scope 1 emissions intensity for the sub-sector fell dramatically between 2005 and 2013. This prolonged and sizeable fall is explainable by the substantial structural changes undertaken in the waste collection and treatment industries during this period. Of most significance were the closure of municipal-based landfill facilities, the change away from landfill towards treatment and recovery, the upscaling of waste treatment and recovery facilities, and actions across the waste handling and treatment sub-sector to address emissions intensity.

The waste collection, treatment and disposal services sub-sector has a very specific geography in Western Sydney. On one hand, waste services need to be located *proximate to* where waste is generated, given the low value of the waste to be transported. On the other hand, waste treatment and recovery facilities need to be *located away from* residential and commercial zones to minimise the impacts of noise, smell and heavy vehicles. In addition, significant shifts in the location of waste facilities have accompanied the exit of municipalities from waste collection and disposal in favour of out-sourcing, with considerable increase in operational scale. This has accelerated the presence of large waste corporations such as Cleanaway, Veolia, Suez and Bingo. Facilities operated by these corporations dominate Western Sydney's waste landscape. The industrial area with the most jobs in the waste sub-sector in Western Sydney (table 6) is Prospect Reservoir (465 jobs), the SA2 hosting Veolia's Eastern Creek waste management facility. Other significant sites for waste sub-sector jobs are St Marys-North St Marys (395) where there are two facilities operated by Cleanaway; Wetherill Park Industrial (244) where both Cleanaway and Veolia have facilities; and Blacktown East-Kings Park (228) where there are several small operations involving a variety of services providers.

After significant ups and downs, from a high baseline, in the early-2000s, scope 1 emissions intensity for the sub-sector fell dramatically between 2005 and 2013.

Table 6: Jobs Location, Waste Collection, Treatment and Disposal Services, Western Sydney SA2s 2021/22 (number of workers)

SA2	Workers	Share of Western Sydney	Share of Greater Sydney
Prospect Reservoir	465	11%	7%
St Marys - North St Marys	395	10%	6%
Wetherill Park Industrial	244	6%	4%
Blacktown (East) - Kings Park	228	6%	3%
Chipping Norton - Moorebank	185	5%	3%
Glendenning - Dean Park	158	4%	2%
Smithfield Industrial	153	4%	2%
Lidcombe	151	4%	2%
Rosehill - Harris Park	102	2%	2%
Silverwater - Newington	93	2%	1%

Source: NIEIR 2023

WAREHOUSING AND STORAGE SERVICES

The warehousing and storage services sub-sector includes facilities dedicated to the storage, handling and distribution of liquid fuels, refrigerated products and general goods including furniture, electronic and other household goods. The sub-sector also includes the operation of third-party distribution centres.

Warehousing and storage services is a significant and high-growth industry sub-sector in Western Sydney, responsible for 16,634 jobs in 2021-22 and nearly $4 billion in value added, around 3% of the region's total (NIEIR 2023). Significantly, the sub-sector has experienced consistent growth over the last two decades, in terms of employment (figure 39), value added (figure 40) and as a share of the region's economy in total (figure 41). There is a general explanation for this growth, known in the academic literature as logistics urbanism.[1] Logistics urbanism refers to the rollout of urban areas in configurations that seek to optimise the movement and handling of goods by the private sector within the post-industrial city. Key aspects of logistics urbanism include the design of transport infrastructure to accommodate mass-scale containerisation, the mass movement of freight vehicles, establishing strategically-located distribution centres, the design of neighbourhoods to facilitate the movement of goods to the final destination, and the incorporation of smart technologies to coordinate goods transport and delivery using real-time, finely-scaled data. Given these characteristics, logistics urbanism confronts significant greenhouse gas issues. These include high levels of liquid fuel consumption generated by intense use of heavy vehicles and the high level of electricity consumption required for the operation of modern warehouses, including their reliance on data centres.

Figure 39: Local Jobs, Warehousing and Storage Services, Western Sydney 2000/1 to 2021/22 (number of workers)

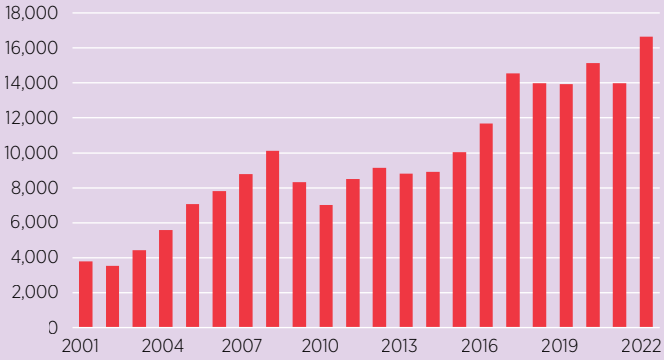


Figure 40: Value Added, Warehousing and Storage Services, Western Sydney 2000/1 to 2021/22

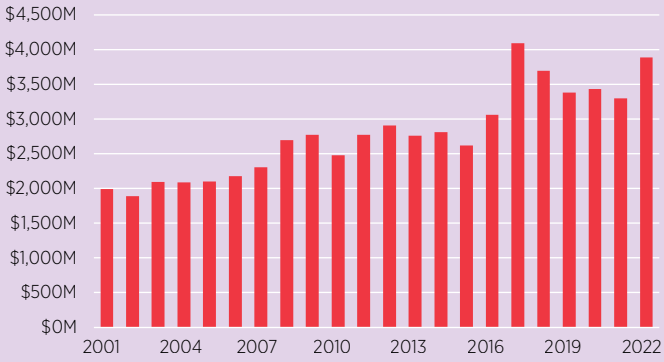


Figure 41: Share of Regional Economy, Warehousing and Storage Services, Western Sydney and Greater Sydney 2021/22 (percent)

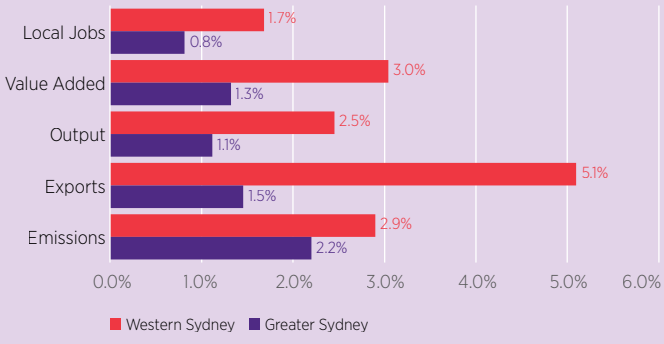


Figure 42: Emissions, Warehousing and Storage Services, Western Sydney 2000/1 to 2021/22 (Mt CO2e)

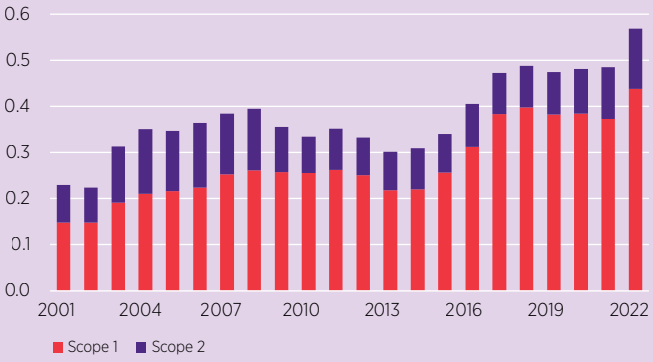
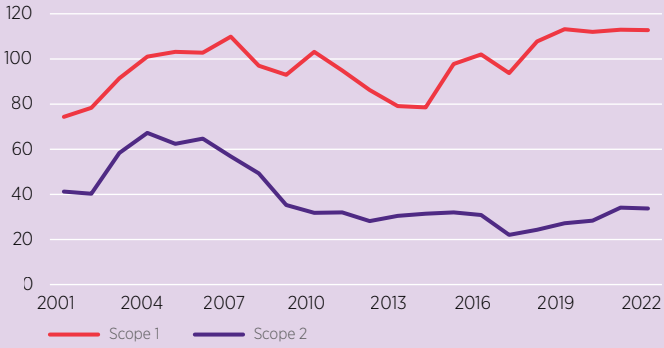


Figure 43: Emissions intensity, Warehousing and Storage Services, Western Sydney 2000/1 to 2021/22 (Tonnes CO2e per $1mil. value added)



Source: NIEIR 2023, ABS Census of Population and Housing 2021, ABS 2023

...logistics urbanism confronts significant greenhouse gas issues. These include high levels of liquid fuel consumption generated by intense use of heavy vehicles and the high level of electricity consumption required for the operation of modern warehouses, including their reliance on data centres.

In 2021-22, warehousing and storage services in Western Sydney generated 568Gt (CO2e) of greenhouse gas emissions, which was 2.9% of the region's total emissions. That the sub-sector generated 3.0% of the region's value added indicates the sub-sector is not in the forefront of emissions reduction in the regional economy, a role that might be expected in a post-industrial sub-sector with a high proportion of facilities designed and constructed after Australia's formal adoption in 2005 of the Kyoto Protocol on greenhouse gas emissions reduction.[2] Indeed figure 42 shows that emissions from warehousing and storage services in Western Sydney have grown at a pace commensurate with growing activity in the sub-sector – as if free from 21st century expectations for action to address climate change by the business community, and from regulations backing these expectations. The poor performance of the sub-sector in this respect is further illustrated by figure 43 which shows the sub-sector's performance in respect to emissions intensity.

Three issues can be highlighted. First, record levels of emissions intensity in the sub-sector were arrested by slowing economic activity in the years following the global financial crisis (2008-2013); modest reductions that were quickly reversed as Western Sydney entered its pre-COVID19 boom period (2013-20).[3] Second, as shown in figures 42 and 43, the sub-sector's disappointing emissions performance comes overwhelmingly from the generation of scope 1 emissions, the consequence of its heavy reliance on liquid fuels for transportation activity. Third, even in respect to scope 2 emissions, where we have found for other sectors a reduction in emissions intensity as the NSW grid progressively decarbonises, *rising* scope 2 emissions intensity has accompanied the rollout of new warehouses across Western Sydney over the last decade. This might be explained by the rising use of energy-intense data processing and storage equipment by the sub-sector.

As discussed above, the growth of warehousing and storage services in Western Sydney corresponds to the global urban phenomenon known as logistics urbanism. There are consequences of this patterning for the location of warehousing and storage services in the region (table 7). The pattern is a simple one, involving concentrations of warehousing and storage activity in appropriately-zoned industrial lands adjacent to Sydney's major motorways. Such locations enable optimisation of transportation and delivery functions by ensuring efficient long-distance journeys to container terminals at Port Botany, convenient motorway on- and off-ramps, large sites for warehouse operation, and access to local road networks for subsequent delivery operations. Not surprisingly, the highest concentration of employment in warehousing and storage services in Western Sydney is found in Prospect Reservoir SA2 (with 1,544 jobs) adjacent to the M4-M7 motorways interchange; the Horsley Park-Kemps Creek SA2 (639 jobs) which embraces the industrial areas west of this interchange; Pemulwuy-Greystanes (North) SA2 (594 jobs) adjacent to the M4 motorway east of Prospect Reservoir SA2; Prestons SA2 (575 jobs) adjacent to the intersection of the M5 and M7 motorways; Erskine Park SA2 (532 jobs) which includes the Mamre Rd warehousing facilities south of the M7 motorway; and Wetherill Park Industrial SA2 (501 jobs) with access to the M4 and M5 motorways via a selection of arterial roads.

Table 7: Jobs Location, Warehousing and Storage Services, Western Sydney SA2s 2021/22 (number of workers)

SA2	Workers	Share of Western Sydney	Share of Greater Sydney
Prospect Reservoir	1,544	15%	11%
Horsley Park - Kemps Creek	639	6%	5%
Pemulwuy - Greystanes (North)	594	6%	4%
Prestons	575	6%	4%
Erskine Park	532	5%	4%
Wetherill Park Industrial	501	5%	4%
Yennora Industrial	360	3%	3%
Chipping Norton - Moorebank	315	3%	2%
Rooty Hill - Minchinbury	310	3%	2%
Ingleburn	271	3%	2%

Source: NIEIR 2023

...the sub-sector's disappointing emissions performance comes overwhelmingly from the generation of scope 1 emissions, the consequence of its heavy reliance on liquid fuels for transportation activity

1 See Fried & Goodchild 2023
2 See https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/BriefingBook45p/InternationalApproach
3 See O'Neill & Tannous 2021.

SECTION 5

DISCUSSION AND POLICY

In this section we discuss the findings of our investigations and draw implications for future policy development.

DISCUSSION

Four observations can be made from the material presented in this report.

1. Western Sydney is a major metropolitan region whose energy transition has significant implications for the national effort to reduce greenhouse gas emissions.

In Section 1 we observed the need for global action to reduce greenhouse gas emissions and we noted that, as a large metropolitan economy, Western Sydney will inevitably be immersed in the major economic transformations needed. Significantly, however, we find that major regulatory actions of the Australian and NSW governments have yet to directly impact businesses in Western Sydney. The notable exceptions are the large coal mines operated in the Wollondilly LGA, both of which are targeted by the federal government's Safeguard Mechanism.

Western Sydney's regulatory vacuum has significant consequences. One is that data about the sources and dimensions of emissions in Western Sydney are scarce. Another consequence is widespread uncertainty in the business community about future regulations and emissions targets. A third is the discordance among large firms between the lack of regulatory clarity by governments and the commitment of parent corporations to sustainability goals that convert to specific emissions targets and action. As we argue in Section 1, understanding this friction and its implications would constitute a very important research project.

2. While Western Sydney is a high growth region, its regional economy is structured in two quite different ways.

While the region hosts a very large manufacturing sector, many firms in the manufacturing sector carry technological and organisational traits from the 20th century and can be seen to lack the innovation, flexibility and entrepreneurial characteristics needed for the creation and adoption of effective emissions reduction strategies without commensurate reductions in profitability. In parallel, the region hosts many population-serving industry sectors which directly benefit from the region's ongoing expansion. Some of these sectors, like education, personal care and public administration, have limited opportunity to undertake industry-specific emissions reduction activity. There are other population-serving sectors, however, where there is considerable scope for significant industry contribution. One of these is the transport, warehouse and storage services sector and another is the waste collection, treatment and disposal services sector.

> ... major regulatory actions of the Australian and NSW governments have yet to directly impact businesses in Western Sydney

3. Western Sydney's emissions performance is strongly influenced by its industry structure.

Our findings show that while there has been some decline in aggregate emissions across Western Sydney's industrial sectors over the past two decades much of this decline can be attributed to the exit of firms, especially manufacturing firms, which have had been the consequence of the decarbonisation of statewide electricity generation.

In terms of the geographic variation in emissions across Western Sydney, emissions intensity mimics the historical development of the region. The LGAs with the most significant sources of emissions are Wollondilly, because of there being two major coal mines in the LGA; and Blacktown, because it hosts the largest manufacturing and distribution facilities in the region. The next most significant areas for greenhouse gas emissions lie within Western Sydney's post-WW2 industrial belt, notably in the Parramatta, Canterbury-Bankstown and Cumberland LGAs. In Western Sydney's outer LGAs, the level of emissions correlates positively with the extent to which these areas host new industrial estates.

historically high levels of emissions intensity. In the context of a gradual decline of the manufacturing sector, then, the gradual decline in scope 1 emissions over the past two decades in Western Sydney cannot be attributed to active measures to address greenhouse gas emissions.

For scope 2 emissions, our analysis shows that emissions intensity has been falling at a faster rate than scope 1 emissions intensity over the past two decades. Once again, however, the improvement in scope 2 emissions intensity cannot be attributed to any major extent to active measures by Western Sydney firms. Rather, falling scope 2 emissions intensity has

4. Across Western Sydney's industry sub-sectors, emissions performance varies widely, with strong correlation between favourable emissions performance and a sub-sector's technology and investment profile.

In general, Western Sydney's older industrial sub-sectors are the region's poorer performers in terms of greenhouse gas emissions. Emissions intensity in a sub-sector is also strongly influenced by the position of the sub-sector in a broader industrial supply chain, and by the extent to which output in the sub-sector is influenced by external economic forces.

> ...improvement in scope 2 emissions intensity cannot be attributed to any major extent to active measures by Western Sydney firms

For the basic chemicals and chemical product manufacturing sub-sector, we find that scope 1 emissions have shown little net change over the last 20 years. Falls in total emissions have come almost entirely from falling scope 2 emissions, which, as we note above, is the consequence of actions to decarbonise the NSW electricity grid rather than by actions on-site or within-region.

For polymer product and rubber product manufacturing, we find similar trends, namely, that the intensity of scope 1 emissions has fluctuated over the last two decades without any clear downward trend, while scope 2 emissions intensity has fallen but largely as a consequence, again, of the decarbonisation of the state's electricity grid.

For primary metal and metal product manufacturing, falling levels of scope 1 emissions can be attributed to long-term industry decline in the sub-sector. As with the other sub-sectors, falling levels of scope 2 emissions are attributable to the progressive shift to renewables in energy generation in NSW.

For waste collection treatment and disposal services, the changing level of scope 1 emissions reflects major changes in the way that the waste collection and treatment cycle has changed in Western Sydney, and Greater Sydney more broadly, over the last two decades. Falling scope 1 emissions came in the first of these decades from the shift away from locally-based municipal waste collection and disposal, and subsequently falls came from the substantial changes in waste treatment and recycling in the hands of a small number of large waste corporations.

> Western Sydney's older industrial sub-sectors are the region's poorer performers in terms of greenhouse gas emissions

For the warehousing and storage services sub-sector, rising levels of scope 1 emissions intensity coincide with the massive expansion of warehousing and storage services in Western Sydney and the heavy reliance in this sub-sector on liquid fuels for transportation. The sub-sector also has experienced sustained increases in scope 2 emissions performance, which is unusual compared to the sub-sectors examined above. This trend seems to be the consequence of the rising importance of electricity in the operation of large warehouses and logistics facilities and in the data centres which often accompany new facilities.

POLICY

In this final section of the report, we make three comments about the policy implications of our study, and of the need for further research.

1. Because the decarbonisation of the Western Sydney economy depends so obviously on reducing scope 2 emissions, there is a need for more aggressive interventions to expand and accelerate the electrification process.

A major finding of our report is that industry in Western Sydney is highly dependent on electricity to satisfy energy needs. This means that emissions intensity in the region falls largely within the scope 2 emissions category and, therefore, that reductions in greenhouse gas emissions for the region depend heavily on the decarbonisation of the electricity grid. Moreover, this dependence on external actions to reduce greenhouse gas emissions will be compounded by the growing level of electrification of energy needs across all aspects of production, supply chains and final consumption – what some call the electrification of everything.

Policy measures for the Western Sydney economy should be mounted to accelerate both the decarbonisation of electricity supply and the take-up of electrification processes. On the supply side, these measures should not only involve action to decarbonise the grid statewide but also measures to encourage behind-the-meter capture of renewables, and to build decentralised carbon-free electricity networks such as via district-based power storage systems and back-up provisions.

Explicit government measures can also assist the accelerated take-up of electrification measures especially via shared technology and infrastructure investment to encourage electric vehicles, especially heavy vehicles, as well as the displacement (via the direct use of electricity) of heat-generation processes which depend on the burning of liquid and gaseous fossil fuels. Importantly, in the absence of this conversion, the survival of sub-sectors like primary metal and metal product manufacturing becomes precarious in the medium term.

Policy measures for the Western Sydney economy should be mounted to accelerate both the decarbonisation of electricity supply and the take-up of electrification processes.

2. Federal and state governments need to act urgently to end urban sprawl and abate the worst outcomes of logistics urbanism.

A feature of our study is the finding – over and over – that there is an inseparable relationship between Western Sydney's urban structure and Western Sydney's industry structure. A post-WW2 Western Sydney hosted mid-20th century manufacturing investments and technologies which have left the region with substantial challenges in reducing greenhouse gas emissions. The roll-out of a next phase of urbanisation later in the 20th century saw entrenched sprawl in two respects. One was the emergence of low-density housing estates distant from the high concentration of jobs being created elsewhere in Sydney's post-industrial economy. In association, was the creation of sprawling industrial estates with low-density jobs configurations as the modern firm embraced automation and labour cost minimisation strategies. Then, in the 21st century, we have witnessed Western Sydney's fastest ever roll-out of sprawling residential estates but without major concentrations of jobs.

The cumulative outcome of this 75 years of urbanisation is the creation of an urban problem with parallel industry configurations where unacceptable emissions practices have intensified; and where the overall urban configuration has made emissions solutions difficult to devise and implement. We trust our report offers some guidance in the battle to resolve this dual-edged dilemma.

3. Federal and state governments need to engage with large firms more fulsomely to devise ways to capture and disseminate their in-house practices of emissions reduction.

We note above the friction between the commitment of many large firms to greenhouse gas reductions and, with the exception of two coal-mining firms targeted by the Safeguard Mechanism, the absence of government regulatory programs pertaining to large producers at the scale of the region. Commitments by many large firms to emissions reduction come from their alignment with the commitments of parent corporations to global net zero accords. Effectively, many large Western Sydney firms are jumping scale, bypassing state and federal regulations (or their absence) to align local plant directly with global regulations. This is potentially an exciting and historically important policy innovation. It needs further exploration by researchers and governments given the opportunities for significant emissions reduction especially through the transfer of technologies and practices between firms and along supply chains.

A second area of further research and policy interest involving large firms is the need for policy to address scope 1 emissions. Invariably, large firms occupy pivotal positions in industry supply chains. That said, these firms face fundamental production and distribution challenges in shifting to sustainable pathways for lowering scope 1 emissions, especially those firms with obstinate 20th century production configurations. For these firms, general industry assistance measures, while important, may be insufficient to address specific needs. Inevitably, bespoke policy interventions will be needed. These will necessarily involve both direct investment assistance and the sympathetic assembly of new regulatory environments.

The cumulative outcome of this 75 years of urbanisation is the creation of an urban problem with parallel industry configurations where unacceptable emissions practices have intensified

Third, a focus on large regional firms can also address the important question of the way that successful policy intervention is propagated and reproduced across the region and its industry sectors without direct government intervention. Voluntary take-up of good policy is the most effective form of regulation as it avoids costly and often ineffective development of regulatory programs where unintended negative consequences abound. Good public policy outcomes are available without difficult fiscal consequences or negative externalities when the common sense of an action becomes obvious to a business community — especially one defined by allegiance to a regional economy. Western Sydney is an example of a region where such policy transfer is possible.

Effectively, many large Western Sydney firms are jumping scale, bypassing state and federal regulations (or their absence) to align local plant directly with global regulations.

Fourth, when policy is properly targeted there are not just good outcomes at the level of the large firm but also good outcomes across each firm's value chain. These happen when upstream and downstream suppliers and purchasers become compelled to make substantial changes to products and processes necessary for a firm's survival in supply-chain relationships. The transfer of better emissions outcomes along a supply chain is an obvious pursuit when this realisation is taken on board. Encouraging large firms, and the dissemination of good actions along a supply chain, lead inevitably to betterment across Western Sydney's ecosystem of firms – meaning lower emissions intensity and rising profitability, a very desirable pairing.

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APPENDIX 1

EMISSIONS METHODOLOGY

WESTERN SYDNEY INDUSTRY ANALYSIS

To understand the level of greenhouse gas emissions in the Western Sydney region, the 2-Digit ANZSIC06 industry level scope 1 and scope 2 emissions for the Western Sydney region and its LGA are estimated. The methodology used to estimate the emissions is based on top-down methodology using both national, NSW and LGA level data. The following steps outline the methodology used to calculate both Scope 1 and Scope 2 emissions for the Western Sydney region.

DATA

- National emissions data: scope 1 (direct) and scope 2 (indirect) greenhouse gas emissions data are collected from the Department of Climate Change, Energy, the Environment and Water (DCCEEW) *National Greenhouse Gas Inventory by Economic Sector* 2021, where the data spans from 1990 to 2021. This dataset includes both national and NSW emissions data.
- LGA emissions data: additional greenhouse gas emissions data specific to LGAs in NSW are obtained from the NSW Department of Climate Change, Energy, the Environment and Water *Regional and Local Greenhouse Gas Emissions Account* spanning from 2016 to 2021. This dataset contains emissions data categorised by emission sources and LGAs.
- NIEIR data: National Economics (NIEIR) output/sales data spanning from 2000 to 2022.

CALCULATION OF 2-DIGIT ANZIC06 NSW EMISSIONS PER OUTPUT RATIO USING DCCEEW EMISSIONS ACCOUNT

- Disaggregation of broad industry level emissions: this step involves disaggregating the DCCEEW broad 2-digit industry-level emissions using 2-digit ANZSIC outputs to allocate emissions to specific industries within each 2-digit ANZSIC06 category for the national emissions.
- Calculation of emissions per output ratio: Following the disaggregation process, national emissions per output ratios were calculated for each industry within the 2-digit ANZSIC06 classification.
- Calculation of NSW emissions per output ratio: using the national emissions per output ratio, broad 1-digit industry level NSW emissions are disaggregated using the share of national 2-digit ANZSIC06 industry output. The 2-digit ANZSIC06 industry level emissions are scaled to match the NSW broad-level industry emissions. Finally, NSW 2-digit ANZSIC06 industry level emissions per output are calculated for each industry.

DISAGGREGATION OF LGA-LEVEL DATA AND NSW DATA SCALING

- Disaggregation process: the NSW emissions per output ratios derived from the DCCEEW emissions data are used to disaggregate the LGA-level emissions data obtained from the New South Wales Department of Climate Change, Energy, the Environment and Water. The 2-digit ANZSIC06 industry level emissions for each LGA are estimated and then scaled to match the LGA source emissions
- NSW data scaling: following the disaggregation process, LGA-level emissions for each 2-digit ANZSIC06 industry are scaled to match the NSW state-level emissions data from the DCCEEW *National Greenhouse Gas Inventory by Economic Sector* 2021. This is to ensure the emissions data are comparable to the national data.

ESTIMATION OF LGA LEVEL EMISSIONS

- Estimation from 2000 to 2015: LGA-level emissions from 2000 to 2015 are estimated using the emissions per output ratio for 2016 and applying the NIEIR output by industry for the corresponding years.
- Estimation for 2022: emissions for 2022 are estimated using the emissions per output ratio for 2021 and applying the 2022 NIEIR output by industry.
- The final output provides 2-digit ANZSIC industry-level scope 1 and scope 2 greenhouse gas emissions data for each LGA in NSW.

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