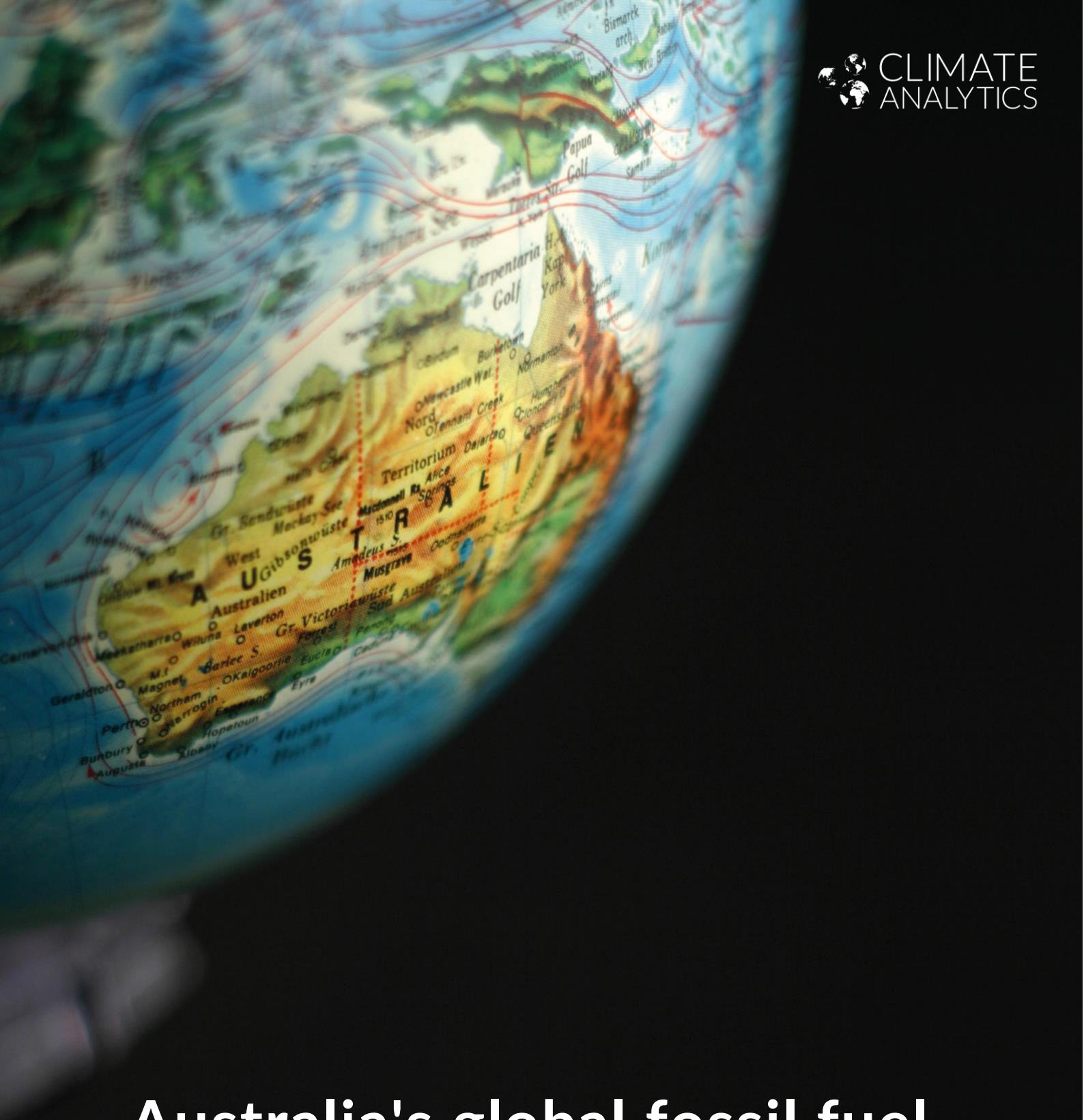

CLIMATE ANALYTICS

Australia's global fossil fuel carbon footprint

August 2024

AUTHORS

Hannah Grant, Bill Hare

CONTRIBUTORS OR REVIEWERS

Editing: Cindy Baxter

ABOUT CLIMATE ANALYTICS

Climate Analytics is a global climate science and policy institute. Our mission is to deliver cutting-edge science, analysis and support to accelerate climate action and keep warming below 1.5°C.

ACKNOWLEDGMENTS

This report was funded by the Australian Human Rights Institute UNSW through its Australian Climate Accountability Project, and we thank them for their support. The research for the report was undertaken at the request of the Institute, as part of its multidisciplinary collaboration on climate and human rights.

Climate Analytics Australia Ltd acknowledges the Traditional Custodians of the lands where we work and live, the Whadjuk people of the Noongar nation. We pay our respect to their Elders past and present and extend that respect to all Aboriginal and Torres Strait Islander peoples today.

COPYRIGHT

How to cite: Climate Analytics (2023). Australia's global carbon footprint.

Executive Summary

In this report we set out the full carbon footprint of Australia's fossil fuels: the global impact of its domestic emissions and its exported fossil fuels, both historical and projected.

While Australians regard their country as one of the world's smaller greenhouse gas emitters, this is not the case. Our findings show that Australia's fossil fuels have a very large global impact.

We find the emissions that would arise from the government's projected fossil fuel exports, in terms of both domestic production and end-use emissions, are clearly not consistent with a global 1.5°C compatible trajectory.

Australia has a responsibility not just to its own consumers of energy, but to the world.

Global fossil fuel carbon emissions footprint

- In 2022 Australia's total fossil fuel carbon dioxide footprint was around 4.5% of global fossil fuel CO_2 emissions. Only 1.0% was emitted within the country.
- Close to 80% of Australia's total fossil fuel CO_2 footprint in 2022 was due to exported carbon.

Per capita emissions

- Australia has one of the **world's highest per capita emissions** for all greenhouse gases, double that of China, and nine times bigger than India.
- In terms of fossil fuel emissions, in 2022 it was the eighth largest emitter of fossil fuel CO_2 per capita. This is purely *on a domestic basis*, without factoring in Australia's exports.

Third largest fossil fuel exporter

- Australia was the world's third largest fossil fuel exporter in 2021, trailing only Russia and the United States. But in terms of the total greenhouse gas footprint arising from those exports, specifically due to the large proportion of emissions-intensive coal, Australia ranked second in 2021.
- In 2022, Australia accounted for just over half of global metallurgical coal exports at 52%, and 17% of global thermal coal exports.

- Australia more than doubled its Liquefied Natural Gas (LNG) export capacity in just five years prior to 2020, adding 62 million tonnes per annum of capacity compared with the 25.5 million tonnes added in the two decades prior to 2012.
- Equally of note is that, of the fossil gas used domestically in Australia, a significant share is used within the oil & gas industry itself, most notably to power the liquefaction process required to create LNG for export. When excluding the oil & gas industry's own use of fossil gas, domestic consumption is just 19% of the gas Australia produces.
- Australia is now doubling down on fossil gas production and LNG exports, sanctioning several large-scale projects in 2021 and 2022.
- Against this gas-fuelled future for Australia, it's worth noting that the latest IEA Net Zero roadmap indicates total global use of fossil gas declines by 18-22% by 2030, 47-53% by 2035 and 78-91% by 2050 below 2022 levels.

Exported emissions: current and projected

- In 2023, Australia exported 1.15 billion tonnes of carbon dioxide emissions. (430 million tonnes from metallurgical coal, 443 million tonnes from thermal coal, 231 million tonnes from LNG and 48 million tonnes from oil)
- An additional 46 million tonnes of carbon dioxide were emitted domestically in the process of extracting, processing and distributing those fossil fuels purely for export, taking the total to 1.2 billion tonnes.

Cumulative emissions

- Cumulatively, from 1961 to 2023 Australia's fossil fuel exports have been responsible for emitting 30 billion tonnes of carbon dioxide to the atmosphere (including the export share of domestic emissions, i.e. 584 million tonnes)
- By 2035 we project Australia's fossil fuel exports will add another 15 billion tonnes to that cumulative total, bringing it to 45 billion tonnes.

Total emissions footprint

- Australia's total footprint can also be quantified by considering domestic emissions in addition to exported emissions embedded in its exported fossil fuels. Against this metric, Australia's total CO_2 footprint totalled 1.5 billion tonnes of carbon dioxide in 2023, and 47 billion tonnes cumulatively from 1961 to 2023.
- When considering all greenhouse gases, i.e. not just CO_2, then Australia's total GHG emissions footprint rises to 1.7 billion tonnes of carbon dioxide equivalent in 2023, and 57 billion tonnes cumulatively from 1961 to 2023.

- With the Federal government's continued support for the fossil fuel export industry, and based on what it has set out in its plans and projections, by 2035 we project this cumulative, all GHG figure would rise to 77 billion tonnes of carbon dioxide equivalent emissions.

Impact on the remaining carbon budget and 1.5°C limit

- The remaining global carbon budget from 2024 consistent with limiting global mean warming to 1.5°C is now estimated at only 200 $GtCO_2$.
- Australia's projected fossil fuel exports from 2024 to 2035 would consume around 7.5% of the remaining carbon budget and around 9.1% considering Australia's total carbon footprint.
- With no sign of government-projected fossil fuel exports starting to drop, this fraction of the global carbon budget would continue to increase beyond 2035.

Australia's markets and the race to 1.5°C

The market for Australia's fossil fuel exports is concentrated, with 78% of LNG, metallurgical coal, and thermal coal imported by just four countries: Japan, China, South Korea, and India. Japan imports the greatest share of both LNG and thermal coal, while India imports the most metallurgical coal.

All the major importers of Australia's fossil fuels are also signatories to the Paris Agreement and have set 2030 emissions reduction and net zero targets of their own, making sustained imports of Australian fossil fuels incompatible with their own commitments.

The 1.5˚C Paris Agreement warming limit

In contrast to the sustained emissions that would arise from the government's planned fossil fuel exports, 1.5°C compatible pathways see greenhouse gas emissions from both production and end-use fall sharply in this critical decade. Under the IEA's Net Zero scenario, CO_2 emissions from fossil fuel combustion, including those from industry and flaring, would fall 35% by 2030 and 64% by 2035, relative to 2022 levels.

The emissions that would arise from the Australian government's projected fossil fuel exports, in terms of both domestic production and end-use emissions, are clearly not falling consistent with a 1.5°C compatible trajectory.

Australia has a responsibility not just to its own consumers of energy, but to the world.

Table of Contents

Introduction

Australia's greenhouse gas emissions in 2023, excluding those from land use, land-use change and forestry, amounted to 527 $MtCO_2e$,[1] or just over 1 percent of global greenhouse gas (GHG) emissions.

Australia is therefore directly responsible for a relatively small percentage of global emissions, *which is also the case* for most of the 198 parties to the United Nations Framework Convention on Climate Change (UNFCCC).

It is frequently argued, by politicians, industry leaders, and some media, that Australia's contribution to climate change is comparatively small, and its actions inconsequential relative to other big polluters.

There are numerous issues with this argument. For one, Australia's domestic GHG emissions *per capita* are amongst the highest in the world. Australia is also one of the world's largest exporters of fossil fuels. While fossil fuel production also contributes substantially to Australia's domestic territorial emissions, the vast majority of emissions from Australia's fossil fuels occur outside of its borders when they are combusted and/or used overseas.

So, while state and federal governments, and the fossil fuel industry to an even greater extent, profit from those exported fossil fuels, very little of the emissions that occur from those fuels are attributed to Australia under the UNFCCC and Paris Agreement reporting frameworks. This report explores Australia's fossil fuel exports and its exported emissions and contextualises those relative to global fossil fuel exports and global emissions.

We examine Australia's historical fossil fuel exports in the context of domestic consumption, exports of other major fossil fuel states, and importing countries. We also quantify the impact Australia's fossil fuel production has on its domestic territorial emissions and its Paris Agreement commitments, in addition to the exported emissions from those fuels.

Further, we explore Australia's projected fossil fuel exports out to 2035, the total GHG emissions that would result from production and end-use of those fossil fuels, and how those emissions benchmark against 1.5°C compatible pathways for global CO_2 emissions.

Australia's fossil fuel industry

An export focused industry

Australia is amongst the world's largest producers and exporters of fossil fuels. In 2022, Australia was the world's seventh largest producer of fossil gas and the fifth largest producer of coal.[2]

However, as Australia produces fossil fuels far in excess of its domestic consumption, it consistently ranks amongst the world's largest fossil fuel exporters. In 2022, it ranked second in the world for both coal and LNG exports,[2] a slight drop from the previous year when it was the world's largest exporter of both.[3] Qatar and the US are the other two significant exporters of LNG, while Indonesia is the other large exporter of coal.

On an energy basis, Australia exports comparable amounts of metallurgical coal, thermal coal, and LNG. In 2022, they accounted for 31%, 34% and 29% of Australia's total energy exports, respectively. Coke, crude oil, LPG, and other refined petroleum products make up a small fraction of Australia's exports. In 2022, relative to domestic production, Australia exported 91% of black coal, 76% of fossil gas, and 86% of crude oil, on an energy basis.[4]

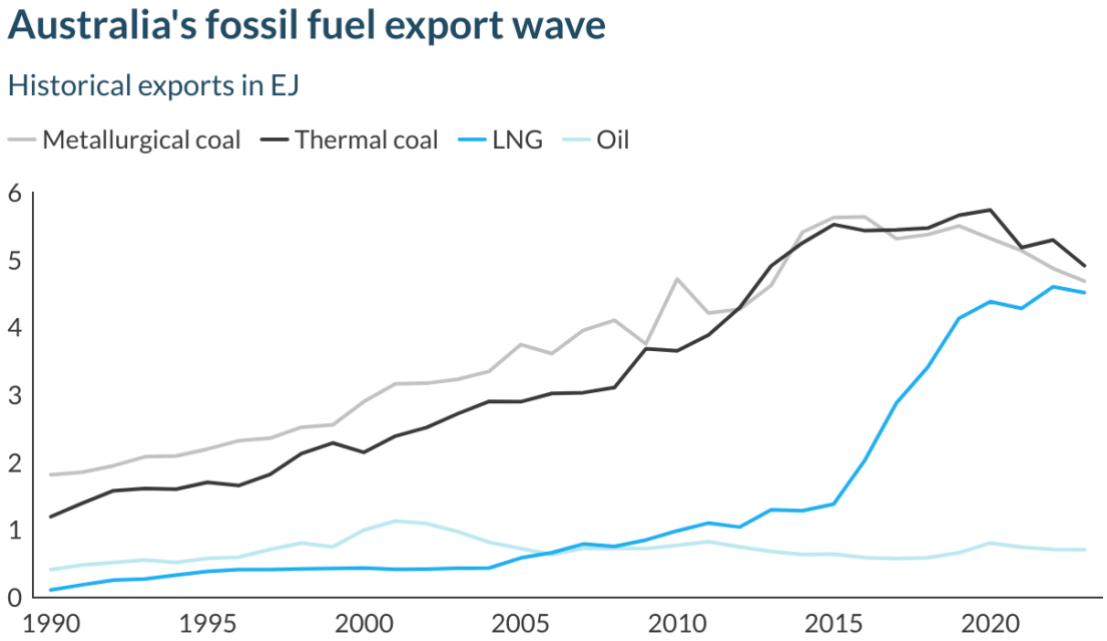

Figure 1: Australia's historical fossil fuel exports, energy units, 1990-2023. Source: Australian Energy Update 2023[4] and Resources and Energy Quarterly March 2024[5]

While Australia imports virtually no coal and fossil gas,[a] it is both an importer and exporter of oil. The majority of demand for refined petroleum products is met via imports, 73% in 2022,[4,b] with the remainder supplied by the domestic refining industry. Crude oil accounted for 4% of energy exports in 2022, but Australia also imports around half the amount of crude that it produces. The vast majority of crude oil is produced in Western Australia, 84% in 2022, but Australia's two remaining oil refineries, Lytton and Geelong, are on the east coast, in Queensland and Victoria, respectively.

Coal

1st	**2nd**	**5th**
Largest metallurgical coal exporter	Largest total coal exporter	Largest coal producer
103	**91%**	**338**
Operating coal mines	Black coal exported	Million tonnes coal exported 2023

As of 2023, there were 103 operating coal mines in Australia, of which 55 are in Queensland and 40 are in New South Wales.[6] While Australia produces both black coal and brown coal, only black coal is exported; all brown coal is used domestically for power generation due to its lower calorific and monetary value. Black coal is exported as either metallurgical coal, used primarily in steel making, or thermal coal, used for electricity generation. Most of Australia's economic black coal resources are in Queensland and New South Wales. Nearly all recoverable brown coal is in Victoria.[7]

In 2022, Australia accounted for just over half of global metallurgical coal exports at 52%, and 17% of global thermal coal exports, trailing Indonesia at 45%.[5] While the growth in coal exports has consistently outstripped domestic demand since the 70s, exports have been disrupted for several years; see Projections section.

[a] Fossil gas imports as reported in the *Energy Statistics* are solely those which are produced in the Joint Petroleum Development Area (JPDA) in the Timor Sea and produced via pipeline to Darwin for LNG export

[b] On an energy basis, excluding LPG

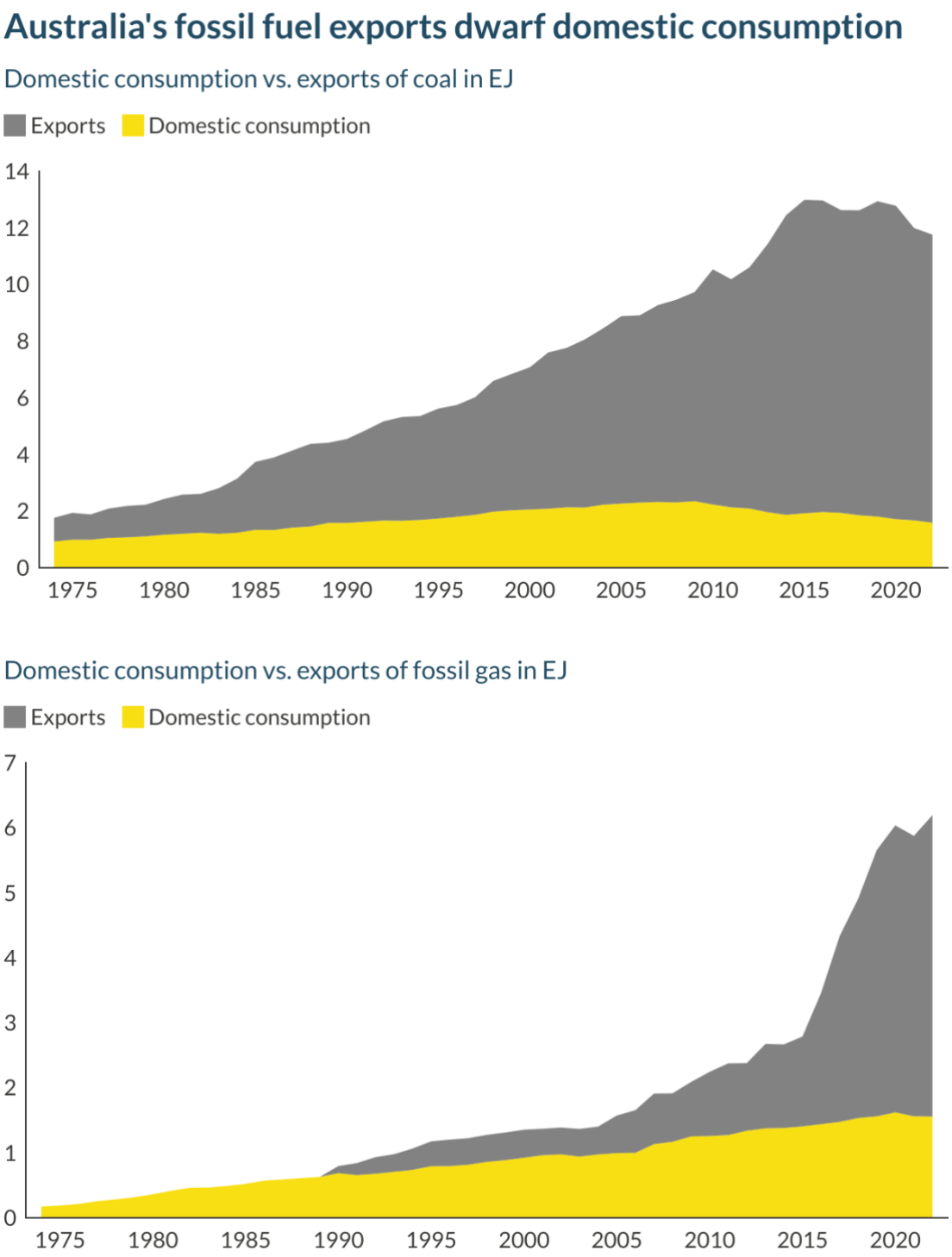

Figure 2: Domestic consumption and exports of fossil gas and coal, energy units, 1974 to 2022. Source: Australian Energy Statistics, Table D1 and Table J[4]

Oil and gas

2nd	**7th**	**81%**
Largest LNG exporter	Largest fossil gas producer	Produced gas used for LNG export[d]
10	**88**	**82**
Operating LNG plants	Million tonnes LNG capacity 2023	Million tonnes LNG exported 2023

Australia currently has 10 operating LNG plants – five in Western Australia, two in the Northern Territory and three in Queensland. The three Queensland LNG plants process fossil gas from coal seam gas (CSG) resources, which require a substantial amount of electricity from the state grid. The remaining seven LNG plants in WA and NT process fossil gas from conventional resources, mostly offshore on the North West Shelf of Australia.

LNG exports increased drastically after 2015 when a new wave of LNG projects began coming online, namely Queensland Curtis LNG (2015), Gladstone LNG (2015), Asia Pacific LNG (2016), Gorgon (2016), Wheatstone (2017), Ichthys (2018), and Prelude FLNG (2019). That's 62 million tonnes per annum (Mtpa) of LNG export capacity added in just five years, compared to the 25.5 Mtpa that was added in the two decades prior to 2012. Six companies operate Australia's LNG plants on behalf of their joint venture partners: Woodside, Chevron, Shell, Santos, ConocoPhillips, and INPEX.

Despite a clear need to phase out fossil fuels from the global energy system,[8] Australia is doubling down on fossil gas production and LNG exports, sanctioning several large-scale projects in 2021 and 2022. These include the massive Scarborough development and linked Pluto LNG plant expansion (Woodside), Crux LNG (Shell), Barossa backfill to Darwin LNG (Santos), and Jansz-Io backfill to Gorgon LNG (Chevron).

The latest IEA Net Zero roadmap indicates total global supply of fossil gas declines 18-22% by 2030, 47-53% by 2035, and 78-91% by 2050 below 2022 levels.[9,10,c]

Of the fossil gas used domestically in Australia, a significant share is used within the oil & gas industry itself, most notably to power the liquefaction process required to create

[c] The lowest fossil gas reductions are with the assumption that CCS is rolled out for gas and the high-end reductions are assuming that that CCS is not rolled out and the energy supplied by "abated" gas is replaced by renewables. We believe the latter scenario to be more likely.

LNG for export. When excluding the oil & gas industry's own use of fossil gas in 2022, domestic consumption was just 19% of what was produced.[4,d]

Continued government support

The first Global Stocktake at UNFCCC COP28 called for "transitioning away from fossil fuels in energy systems in a just, orderly and equitable manner, accelerating action in this critical decade, so as to achieve net zero by 2050 in keeping with the science".

Australia has not set targets for the phase-out of domestic fossil fuel consumption, nor for fossil fuel exploration, production and export, and is continuing to approve new gas and coal developments.

Australia has not joined the Powering Past Coal Alliance, which seeks to transition away from unabated coal power by the 2030s or 2040s and to cease building new coal plants, nor has it joined the Beyond Oil & Gas Alliance (BOGA), which seeks to facilitate a managed phase out of oil and gas production.

Australia did, however, join the Global Renewables and Energy Efficiency Pledge at COP28, which aims to triple global renewable energy and double global average energy efficiency improvements by 2030. Australia also joined the Clean Energy Transition partnership, pledging to stop financing fossil fuel projects abroad, and at COP26, joined the Global Methane Pledge, committing to cut methane emissions in all sectors by 30% globally over the next decade. For 1.5°C alignment total methane emissions would need to drop by 34% over the decade, with methane emissions in the energy sector needing to fall by 66%.[11]

Australia's current *Long-Term Emissions Reduction Plan*,[12] released in 2021 under the Morrison government, does not include any plans to curb fossil fuel exports, nor hold heavy polluters accountable. Some insight into the government's position on the fossil fuel industry can, however, be gleaned from the underlying economic modelling and analysis that informed the long-term plan.[13]

The core scenario adopted by the Morrison government (titled 'The Plan'), does not reach net zero emissions by 2050: it relies heavily on offsets and leaves, by design, a 15% residual emissions gap to be closed via "further technology breakthroughs". Of the alternative scenarios explored in the modelling, the 'NZE 100%' scenario not only achieves net zero emissions by 2050 but would result in similar economic growth as the 'the Plan'. The 'NZE 100%' scenario, which also relied significantly on offsets, was noted to adversely impact fossil fuel-based sectors, specifically impacting gas extraction and

[d] According to *Energy Statistics*, in 2022, 6,228 PJ of gas was produced (including 152 PJ from the JPDA), of which 4,637 PJ of LNG was exported with 450 PJ consumed in its manufacture. Therefore, about 81% of domestic gas production was used for LNG manufacture and export. Refer Figure 3 in the *Energy Statistics*.[4]

coal mining, and was not adopted by the government.[e] A new Net Zero Plan is currently under development by the Albanese government.[14]

Federal and state governments continue to subsidise the fossil fuel industry, providing $14.5 billion worth of spending and tax breaks in 2023-24.[15] While the largest contributor to this total, the Fuel Tax Credit Scheme, at $9.6 billion, is linked to fossil fuel consumption, this also indirectly subsidises fossil fuel production with the coal industry alone benefiting $1 billion from the scheme.

Significant assistance is also provided to proponents of fossil fuel projects. Federally, this includes $1.9 billion budgeted to assist the Middle Arm petrochemical hub in Darwin, $100 million to build roads explicitly for the onshore gas industry in the NT, $113 million on upgrading Hunter Valley coal railways, and $165 million in Petroleum Resource Rent Tax concessions.[15]

[e] The modelling found that 'the Plan' would result in 1.59% growth in GDP relative to the 'No Australian Action' scenario, whereas the 'NZE 100%' scenario would result in 1.58% growth. The modelling also found that the 'NZE 100%' scenario would require a higher marginal abatement cost of $80 tCO_2e in 2050 and this would result in $4.9 billion lower output from coal and gas in 2050 relative to 'The Plan'. The scenario also involves relying on higher volumes of land sequestration rather than abatement at source. The 'NZE 100%' scenario was modelled to have only modest impacts on the total value of economic activity, relative to 'the Plan' with real GDP only 0.01% ($0.4 billion) lower in 2050.

Domestic emissions

Domestic ambition

Australia's latest Nationally Determined Contribution (NDC), submitted to the UNFCCC in June 2022, sets an emissions reduction target of 43% below 2005 levels by 2030, including the land use, land-use change, and forestry (LULUCF) sector.[16] The target is both an absolute target for 2030 and an emissions budget covering the period 2021-2030 which declines on a linear trajectory. Australia does not yet have sufficient policies in place to meet its own 2030 target, as demonstrated by its most recent emissions projections.[17,f]

Although Australia's total GHG emissions have *reportedly* been declining since their peak in 2007, this is predominantly attributed to reduced deforestation and increased uptake of carbon on forest land occurring between 2005 and 2020, rather than effective climate policy. The LULUCF sector was historically a significant source of emissions, accounting for 31% of total emissions in 1990, but has been a net carbon sink since 2015.[17]

It must be noted that in recent years, since about 2018, successive governments have consistently and ongoingly revised historical LULUCF emissions and projected LULUCF sequestration estimates – projecting a greater sink in the future. The ongoing revisions to LULUCF estimates obscures the lack of meaningful progress in fossil fuel emissions reductions and also reduces the amount of effort needed for fossil fuel and industry emissions to reach 2030 targets.[18]

GHG emissions from fossil fuel use, industry, agriculture and waste (i.e. domestic emissions excluding LULUCF) are the main drivers of climate change. There are a range of different estimates for emission reductions consistent with Australia playing its role in global efforts to limit global warming to 1.5°C and bring greenhouse gas emissions to net zero.

---

[f] While neither the government's 'Baseline' nor 'With additional measures' scenarios meet the 2030 point-target, its latest projections indicate that the 'With additional measures' scenario will beat the cumulative 2021-2030 emissions budget by 1%. However, this should be contextualised with how the cumulative target is formulated. The cumulative budget is set by taking a linear decline from a 2020 target of 5% below 2000 levels and finishing at 43% below 2005 levels in 2030. This is despite the fact that total emissions in 2020 were actually 13% below 2000 levels, and in 2021 were 18% below 2000 levels. So, when the cumulative target was updated with the updated NDC in 2022, it was done with the knowledge that the target starting point was already higher than Australia's actual emissions for several years.

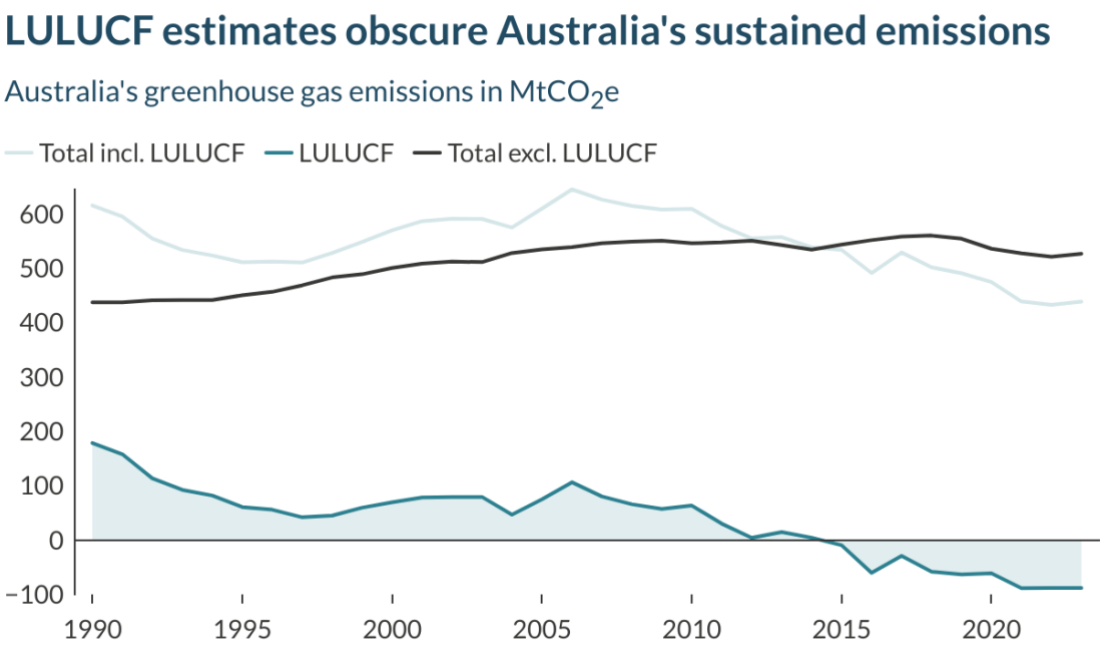

Figure 3: Australia's domestic GHG emissions with and without LULUCF. Source: Australia's emissions projections 2023[17]

Based on the currently available set of 1.5°C compatible pathways, Australia would need to reduce its emissions (excluding LULUCF) by 51% below 2005 levels by 2030 (range 45% to 59%).[g] This corresponds to a 2030 emissions level excluding LULUCF of 263 $MtCO_2e$ (range 219 to 297 $MtCO_2e$).

After accounting for the Government's 2030 LULUCF projection of -57 $MtCO_2e$, Australia's NDC translates to a 24% of emissions excluding LULUCF below 2005 levels by 2030, or an absolute value of 404 $MtCO_2e$.[1,20] Australia's total emissions excluding LULUCF totalled 527 $MtCO_2e$ in 2023,[1,h] only 1.5% below 2005 levels, indicating that for 1.5°C alignment these emissions need to be halved by 2030.

---

[g] Based on downscaled IPCC SR1.5 and AR6 pathways used in the National Pathway Explorer and Climate Action Tracker, respectively.[19,20] Here we take the 5th and 50th percentile as the upper and lower bound of the 1.5°C compatible range and highlight the 25th percentile. This is because while one global pathway is internally consistent with the 1.5°C limit, an ensemble of multiple pathways downscaled to the national level would not be, if each individual country took its highest emissions pathway. Refer to the NPE methodology.[21] To aggregate the two sets of downscaled pathways, we take the mean from equivalent percentiles from each study. This level of ambition also aligns with bottom-up studies such as the Climate Action Tracker's Scaling Up Australia.[22]

[h] A revised greenhouse gas inventory was published in May 2024 hence the numbers are different from those found in the Australian Government's 2023 projections. The most notable difference is in the LULUCF sector where the estimated sink for 2022 was increased from -63.9 $MtCO_2e$ to -88.4 $MtCO_2e$ and is reported at the same level in 2023.

To express these reductions consistent with 1.5°C to alignment including LULUCF one needs consider the projected sequestration in 2030. Assuming the government's projected sink of -57 $MtCO_2e$, then for 1.5°C compatibility, Australia would need to reduce its domestic emissions including LULUCF by 67% below 2005 levels by 2030 (range 61% to 74%).[g] This corresponds to a 2030 emissions level including LULUCF of 204 $MtCO_2e$ (range 160 to 238 $MtCO_2e$).

Domestic emissions, benchmarked globally

In terms of both total GHG emissions and CO_2 emissions from fossil fuels, Australia's share of global emissions is relatively small, as is the case for most countries. In 2022, Australia was responsible for 1.0% of global GHG emissions[i] and 1.0% of global fossil fuel CO_2 emissions.[1,23,j]

However, on a per capita basis, Australia's GHG and fossil fuel CO_2 emissions are amongst the highest in the world; and, in 2022, were double that of China and nine times higher than India.[23,24] In terms of fossil fuel CO_2, Australia was the 16th largest emitter in 2022, and the 8th largest on a per capita basis. This is all considering domestic emissions only, before factoring in Australia's significant fossil exports.

[i] Excluding emissions from land use, land-use change and forestry (LULUCF). We exclude LULUCF emissions and sequestration because of the large uncertainty associated with LULUCF data, the high degree of fluctuations year on year, and the pressing need to decrease CO_2 and other GHG emissions from the energy, industry, agriculture, and waste sectors.

[j] Here and throughout the report, "fossil fuel CO_2" is restricted to emissions from energy use and excludes CO_2 emissions from non-energy use in industrial processes and agriculture. This accounts for approximately 96% of global fossil CO_2 emissions.

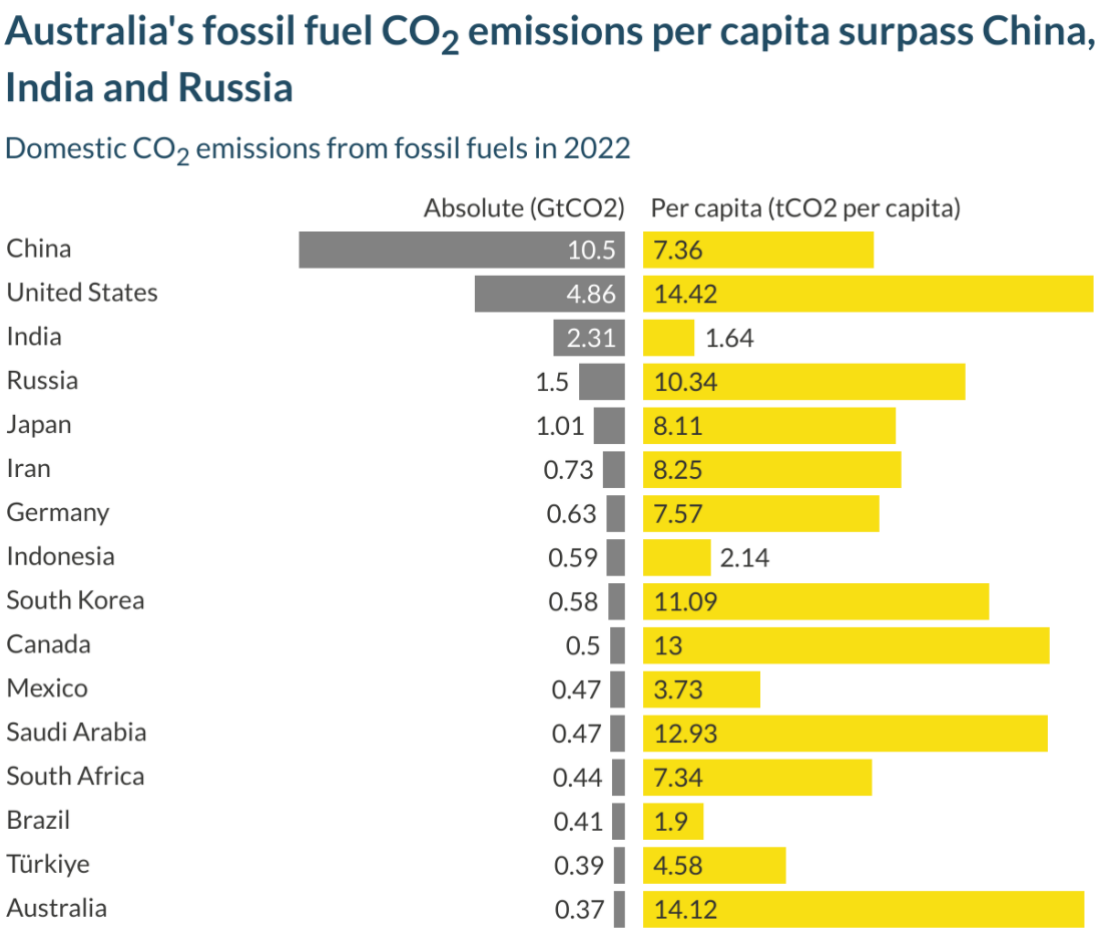

Figure 4: Domestic fossil fuel CO_2 emissions, selected countries, 2022. Source: PRIMAP-hist v.2.5.1[23] and UN World Population Prospects 2022[24]

Domestic production emissions

The majority of Australia's emissions occur within the energy sector. In 2023, the energy sector[k] was responsible for 76% of Australia's total greenhouse gas emissions, excluding LULUCF.[17] Fossil fuel production[l] alone is responsible for about a quarter of energy sector emissions – or about 18% of Australia's total greenhouse gas emissions, excluding LULUCF. They are the GHG emissions that occur during the extraction, processing, and distribution of oil, gas, and coal, via either the combustion of fossil fuels,

[k] Energy sector emissions are defined here according to the IPCC Guidelines for National Greenhouse Gas Inventories,[25,26] Category 1 Energy, which is equivalent to the Electricity, Stationary Energy, Transport and Fugitive categories used in the Emissions Projections.

[l] Fossil fuel production emissions are defined here as emissions occurring within oil & gas and coal mining industries that occur directly due to fuel combustion or fugitive emissions, or indirectly via electricity consumption. Refer to Methodology.

to generate electricity or drive machinery, or as fugitive emissions from venting, flaring, or unintended gas leaks.

We calculate the export-share[m] of fossil fuel industry emissions as 73% of total fossil fuel production emissions, and about 14% of Australia's total domestic emissions in 2023, excluding LULUCF.[4,17,27] We calculate this entirely from government data, and separately by industry for electricity, other combustion (i.e. stationary energy), and fugitives, as described in the Methodology.

To put that in context, the emissions occurring domestically to produce fossil fuels *purely for export* are equivalent to around half the emissions arising from country's total electricity generation. Also consider that in 2022, 49% of that electricity was still generated by burning coal.[4]

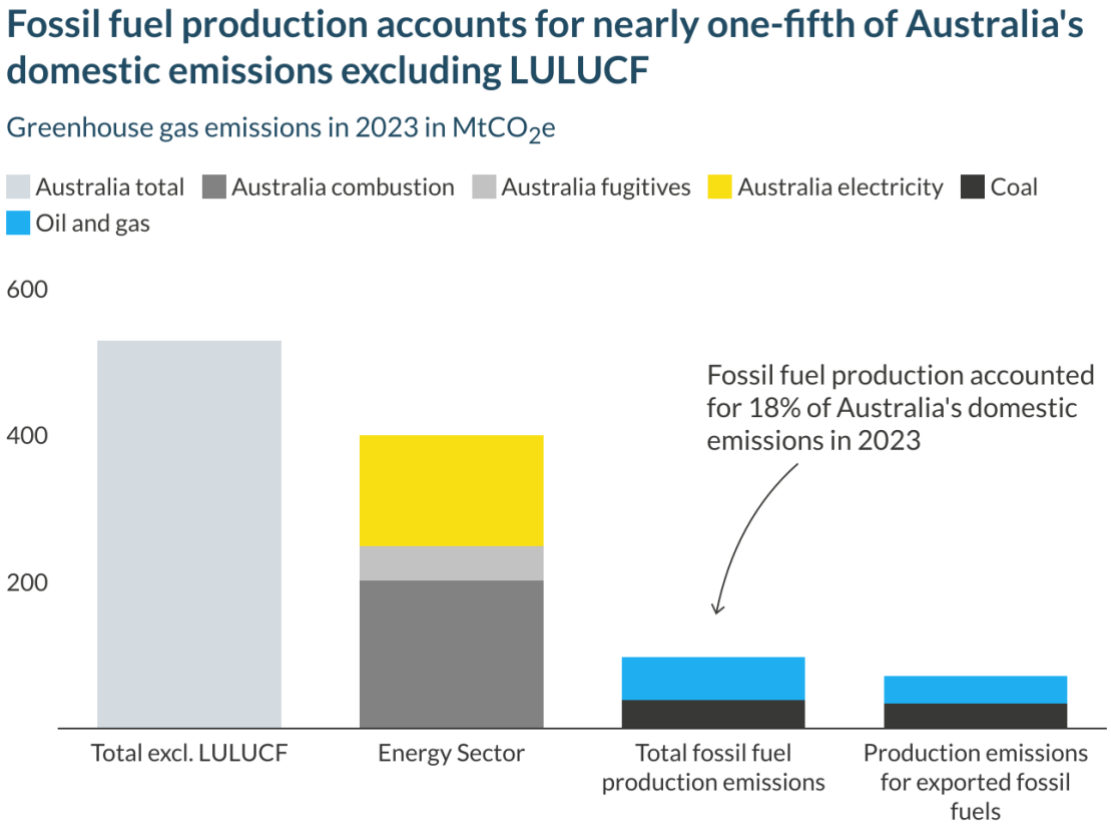

Figure 5: Fossil fuel industry emissions from combustion (stationary energy), fugitives, and electricity compared to total energy sector and total GHG excl. LULUCF. Sources: Australia's emissions projections 2023,[17] Australia's National Greenhouse Accounts,[27] Australian Energy Update 2023[4]

[m] For coal, this is calculated from the industry total, whereas for oil & gas this is calculated separately for LNG and domestic gas and oil.

Industrial emissions

Australia's industrial emissions are regulated under the Safeguard Mechanism (SGM). In 2023, six out of the ten most polluting facilities covered under the SGM were those dedicated to the extraction and processing of fossil fuels, with Chevron's Gorgon facility in Western Australia taking the dishonour of the most polluting facility in Australia for the second year in a row at 8.19 $MtCO_2e$.[28,29]

When Woodside's Burrup Hub is taken together i.e. the interconnected North West Shelf and Pluto facilities, then its emissions exceeded that of Gorgon at 8.78 $MtCO_2e$, and will grow further with the startup of Pluto Train 2 from 2026. The remaining four facilities and/or entities in the top ten were a steelworks plant, two alumina refineries, and Qantas domestic aviation.

Unsurprisingly, Chevron and Woodside rank as the sixth and ninth most polluting corporations in Australia, respectively.[30] The top four most polluting corporations in Australia are those operating coal and gas-fired power plants.

The under-representation of coal mines and corporations in these rankings doesn't imply that the coal industry is any less polluting, just that coal mining is more distributed with many more mines operated by several dozen corporations. In addition, methane emissions from coal mines are widely considered to be severely underreported, which obscures the true scale of emissions from the industry.[31] The same is true for oil and gas facilities, with actual methane emissions considered to be much greater than what is reported.[32]

In 2023, over half of the emissions covered under the safeguard mechanism were related to fossil fuel extraction and processing: 31% from oil & gas and 23% from coal mining.[28]

	Facility	Operator	Fossil fuel extracted	Reported emissions $MtCO_2e$
1st	Gorgon	Chevron	Oil & gas	8.19
2nd	North West Shelf	Woodside	Oil & gas	6.94
4th	Ichthys	INPEX	Oil & gas	5.84
6th	Wheatstone	Chevron	Oil & gas	3.79
9th	Appin Colliery	South32	Coal	2.43
10th	Moranbah North	Anglo American	Coal	2.27

Table 1: Reported emissions and ranking of fossil fuel facilities covered by the Safeguard Mechanism, 2022-23[28]

Substantial emissions arise when Australia's exported fossil fuels are combusted overseas; see Global Impact. While these emissions are not counted towards Australia's domestic emissions under the Paris Agreement, emissions from the extraction and processing of oil, gas, and coal do greatly impact Australia's domestic emissions footprint.

Continued fossil fuel production, regardless of where those fossil fuels are ultimately consumed, would result in sustained emissions in Australia's industrial sector and would increase the burden on the rest of the Australian economy to decarbonise consistent with its Paris Agreement commitments.

The missing piece in emissions reporting

Under the UNFCCC and Paris Agreement reporting frameworks, countries report territorial emissions - the emissions that occur within their own territorial boundaries - and follow the agreed IPCC and other reporting guidelines in doing so. From a country perspective, governments report total domestic emissions to the UNFCCC, against which their NDC targets are measured and evaluated.

Emissions arising from a country's fossil fuel exports are not reported by that country, but rather by the importing country that burns these fuels. Consequently, it's not easy to gain an understanding of a country's total fossil fuel production and use footprint. This report attempts to look at the situation for one country: Australia, because of the sheer scale of its exports

In the corporate space, emissions are classified by Scope according to the GHG Protocol,[33] where Scope 1 emissions are direct emissions arising within the company's own operations, Scope 2 emissions are those from the production of purchased energy (e.g. electricity, steam, heating), and Scope 3 are emissions that occur upstream or downstream of a company's activities. Under this framework, combustion of fossil fuels by the end consumer are classified as Scope 3.

Scope 3 emissions can therefore occur both domestically within the Australian economy, which are reported in Australia's national GHG accounts, or they can occur offshore. For most of the companies exporting Australian gas and coal, their Scope 3 emissions largely occur offshore, and are therefore not covered directly or indirectly by Australian government regulations or policies on domestic greenhouse gas emissions.

Unfortunately, in Australia, the Safeguard Mechanism, by allowing companies to offset their emissions from producing fossil fuels for export, de facto, permits greater exports of fossil fuels than would otherwise occur. If offsets were not allowed, fossil fuel companies would have to spend far more on reducing their fossil fuel production emissions. It is more than likely that a more robust Safeguard Mechanism would lower the overall production of fossil fuels.

Given that company emission reduction targets rarely cover Scope 3 emissions either comprehensively or transparently, and that governments pledge reductions against their domestic emissions, fossil fuel exports largely slip through the cracks.

In relation to companies (like fossil fuel companies), the UN High-Level Expert Group on the Net Zero Emissions Commitments of Non-State Entities (HLEG) recommended that all company emission reduction targets include Scope 3 emissions, with transparent timetables for reductions down to net zero, from 2025. It recommended that companies should have plans to reach net zero in line with IPCC or IEA net zero greenhouse gas emissions modelled pathways that limit warming to 1.5°C with no or limited overshoot, and with global emissions declining by 50% by 2030, reaching net zero CO_2 emissions by 2050, and net zero greenhouse gas emissions soon after.

The HLEG excluded the use of offsets to meet Scope 3 targets, recommending that companies "must prioritise urgent and deep reduction of emissions across their value chain. High integrity carbon credits in voluntary markets … cannot be counted toward a non-state actor's interim emissions reductions required by its net zero pathway."[34]

Efforts are growing globally to ensure that corporate net zero targets align with these recommendations. However, the Australian government has effectively mandated the use of offsets for Scope 1 emissions, with no apparent plans to require fossil fuel companies to publish and abide by Scope 3 emission reduction plans. The Australian offsets system effectively enables a greater level of Scope 3 emissions from fossil fuel exporters than would otherwise occur if offsets were not allowed.[35]

As a consequence of this situation Australian domestic policy is effectively undermining parts of the Global Stocktake outcome adopted at UNFCCC COP28, in particular the need for country actions and NDCs to align with 1.5°C[36,n] and for countries to begin a transition away from fossil fuels.[36,o] Instead, Australian domestic policy, especially its Safeguard Mechanism, along with the ongoing subsidies to fossil fuel development and use, together favour further fossil fuel development rather than beginning a transition away from fossil fuels.

---

[n] Paragraph 39 calls on "…Parties to come forward in their next nationally determined contributions with ambitious, economy-wide emission reduction targets, covering all greenhouse gases, sectors and categories and aligned with limiting global warming to 1.5°C, as informed by the latest science…"

[o] Paragraph 28(d) "Transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner, accelerating action in this critical decade, so as to achieve net zero by 2050 in keeping with the science"

Global impact

Australia' total fossil fuel CO_2 emissions footprint

This section shows that Australia's total fossil fuel CO_2 footprint, including domestic and exported emissions, was about 4.5% of global fossil fuel CO_2 emissions in 2022, of which only 1.0% was from emissions that occurred in Australia. In other words, close to 80% of Australia's total fossil fuel CO_2 footprint in 2022 was due to exported carbon.

Exported emissions

While Australia's fossil fuel industry is responsible for a sizeable share of the country's domestic footprint, those emissions are dwarfed by its exported emissions, i.e., the emissions arising when Australia's fossil fuel exports are ultimately combusted and/or used overseas.

Australia's combined fossil fuel exports in 2023 amounted to a total of 1.15 Gt exported CO_2 emissions: 430 $MtCO_2$ from metallurgical coal, 443 $MtCO_2$ from thermal coal, 231 $MtCO_2$ from LNG and 48 $MtCO_2$ from oil.[5,37] A further 46 $MtCO_2$ was emitted domestically to extract, process and distribute those fossil fuels purely for export, taking the total to 1.20 $GtCO_2$/yr.

Australia's cumulative fossil fuel exports from 1961 to 2023 are responsible for 30 $GtCO_2$ being released to the atmosphere, including both exported emissions and domestic production emissions for exported fossil fuels (584 $MtCO_2$). That's equivalent to 78 times Australia's total 2023 domestic CO_2 emissions, excluding LULUCF.[27]

When considering all GHG emissions, i.e. not just CO_2, Australia's fossil fuel exports were responsible for 1.24 $GtCO_2e$ in 2023, and 31 $GtCO_2e$ cumulatively from 1961. This is shown, for the last two decades, in Figure 6.

It should be noted that in this case, most of the non-CO_2 emissions are from methane, a very powerful greenhouse gas. The IEA has estimated that Australia's energy sector related methane emissions are likely to be about 50% higher than the official government inventory.[38] In other words, Australia's greenhouse gas footprint likely to be higher than indicated here.

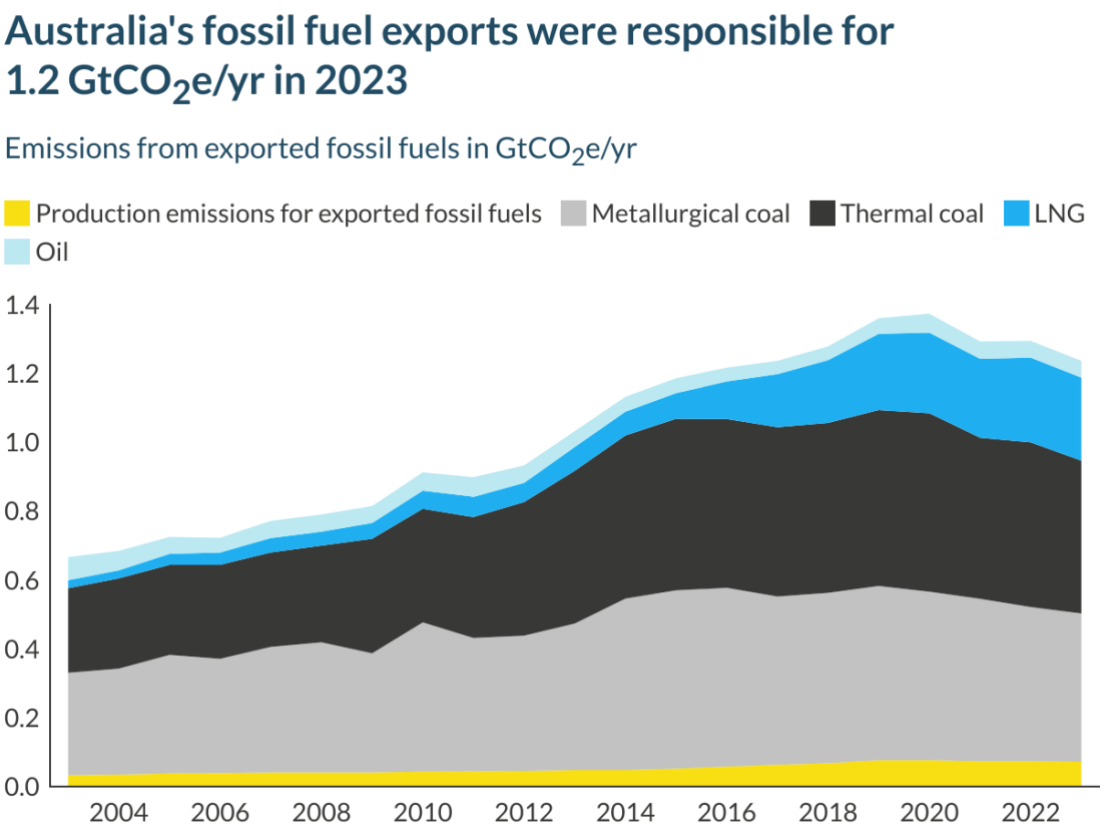

Figure 6: GHG emissions from combustion of exported fossil fuels and export-share of domestic fossil fuel industry emissions. Sources: Australian Energy Update 2023[4], Resources and Energy Quarterly March 2024[5], Australia's emissions projections 2023,[17] and Australia's National Greenhouse Accounts,[27]

Total emissions footprint

Australia's total, global GHG emissions footprint can be considered as domestic emissions plus exported emissions which are embedded in its exported fossil fuels. In 2023, Australia's total domestic emissions excluding LULUCF amounted to 527 $MtCO_2e$.[1] When taken together, this results in a combined footprint of 1.7 $GtCO_2e$ in 2023, and 57 $GtCO_2e$ cumulatively since 1961 (Figure 7).

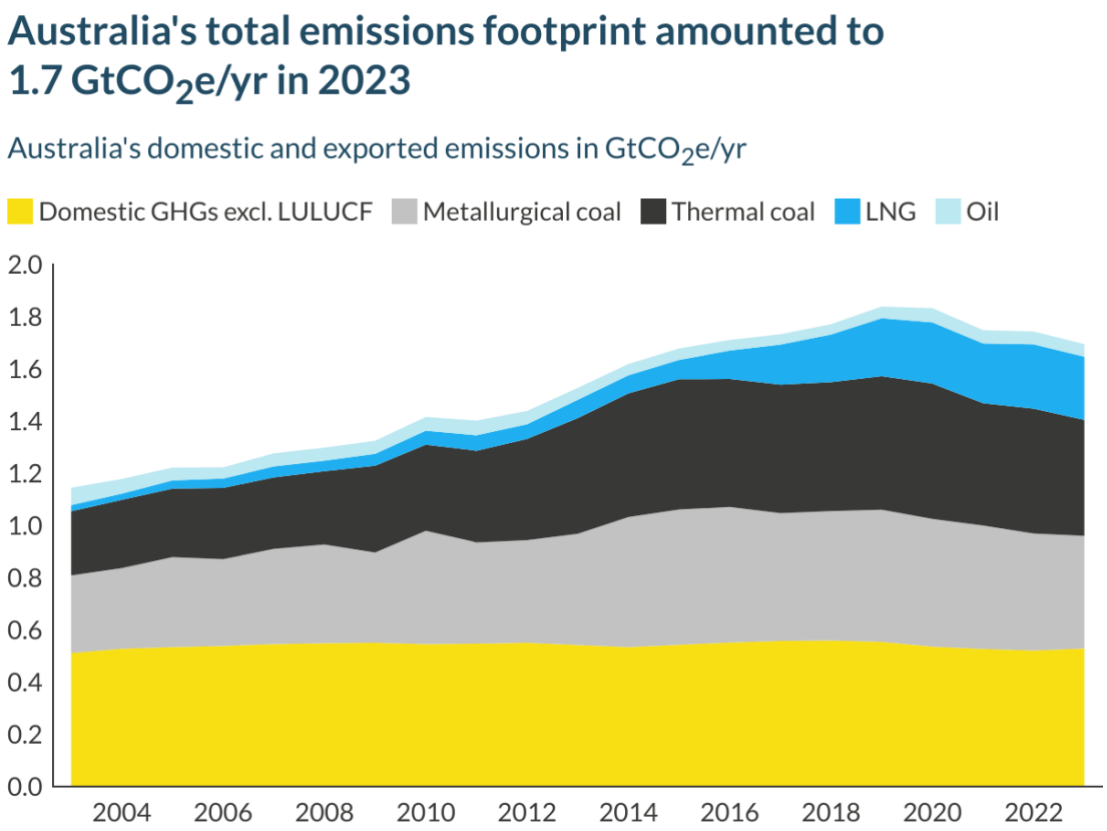

Figure 7: GHG emissions from combustion of exported fossil fuels and total domestic emissions excluding LULUCF. Sources: Australian Energy Update 2023[4], Resources and Energy Quarterly March 2024[5], Australia's emissions projections 2023,[17] and Australia's National Greenhouse Accounts,[27]

Table 2 summarises the annual and cumulative CO_2 and GHG emissions related to Australia's direct actions. These are

1. domestic excluding LULUCF i.e. the emissions that occur within Australia's territorial borders as reported to the UNFCCC,
2. emissions from exported fossil fuels, i.e. the emissions that occur when Australia's exported fossil fuels are combusted overseas, plus the share of domestic emissions from the extraction, processing and distribution of these fossil fuels for export, and
3. total footprint, i.e. Australia's total domestic emissions, plus exported fossil fuel CO_2 emissions.

			Domestic excl. LULUCF	Emissions from exported fossil fuels	Total footprint
Annual 2023	CO_2	$GtCO_2/yr$	0.39	1.2	1.5
	GHGs	$GtCO_2e/yr$	0.53	1.2	1.7
Cumulative 1961-2023	CO_2	$GtCO_2$	18	30	47
	GHGs	$GtCO_2e$	27	31	57

Table 2: Australia's annual and cumulative CO_2 and GHG emissions including domestic and exported emissions

In terms of fossil fuel CO_2, when considering both domestic and exported emissions, Australia was responsible for 4.5% of global fossil fuel CO_2 emissions in 2022,[p] down from 5.1% in 2020 (Figure 8).

However, it must be noted that the peak in 2020 and sharp decline in 2021 was primarily the result of low global CO_2 emissions in 2020 caused by COVID-19, rather than Australia's exports and domestic emissions. It is also premature to conclude that Australia's share of global CO_2 is on a downward trend. While fossil fuel exports fell for several years, they began to rebound throughout 2023 and are projected to further increase; see Projections section.

[p] Here and throughout the report, "fossil fuel CO_2" is restricted to emissions from energy use and excludes CO_2 emissions from non-energy use in industrial processes and agriculture. This accounts for approximately 96% of global fossil CO_2 emissions.

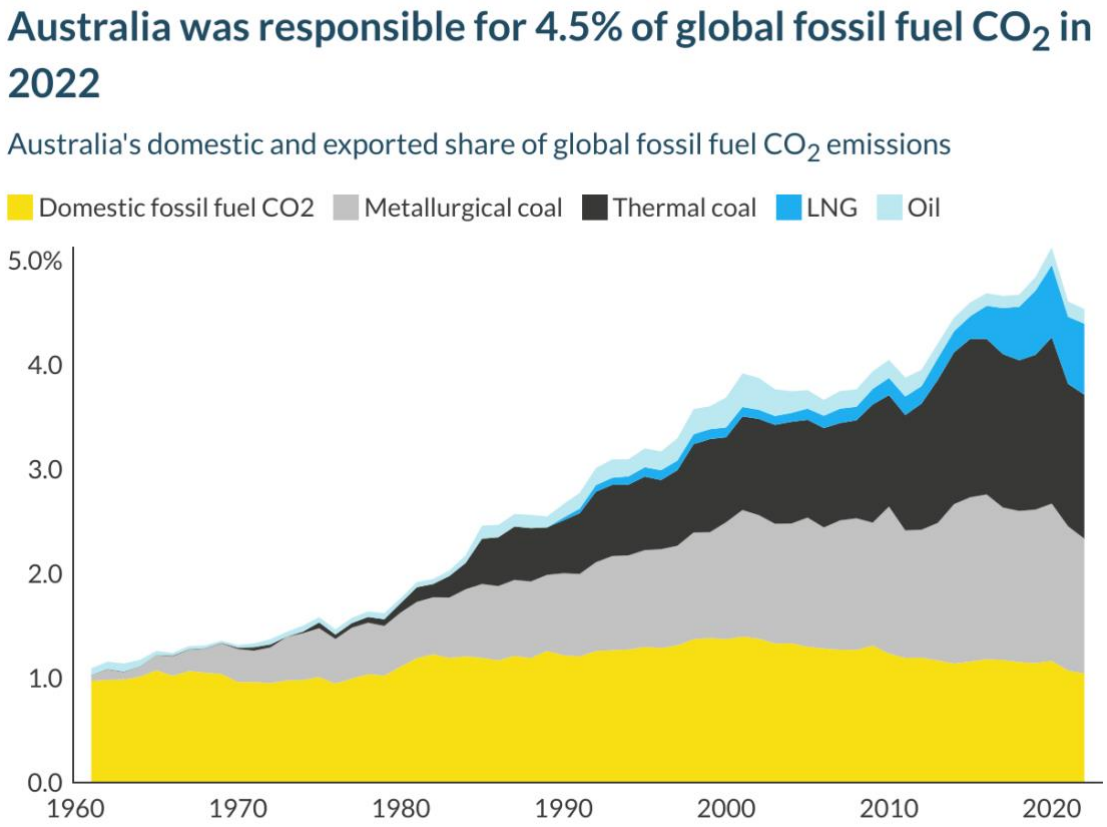

Figure 8: Australia's domestic and exported fossil fuel CO_2 as a share of global fossil fuel CO_2, 1961 to 2022. Sources: Australian Energy Update 2023[4], Resources and Energy Quarterly March 2024[5], Australia's emissions projections 2023,[17] and Australia's National Greenhouse Accounts,[27] PRIMAP-hist v.2.5.1[23], IEA-EDGAR CO_2 v2[39]

Globally benchmarked exported emissions

Australia exported fossil fuels can be benchmarked against other countries both in terms of total exports on an energy basis, and in terms of the total GHG footprint that arises from those exports, including the domestic extraction-based emissions and final combustion emissions.

In 2021, Australia was the third largest exporter, by energy, of primary fossil fuels i.e. excluding refined petroleum products, trailing only Russia and the United States (Figure 9).[40]

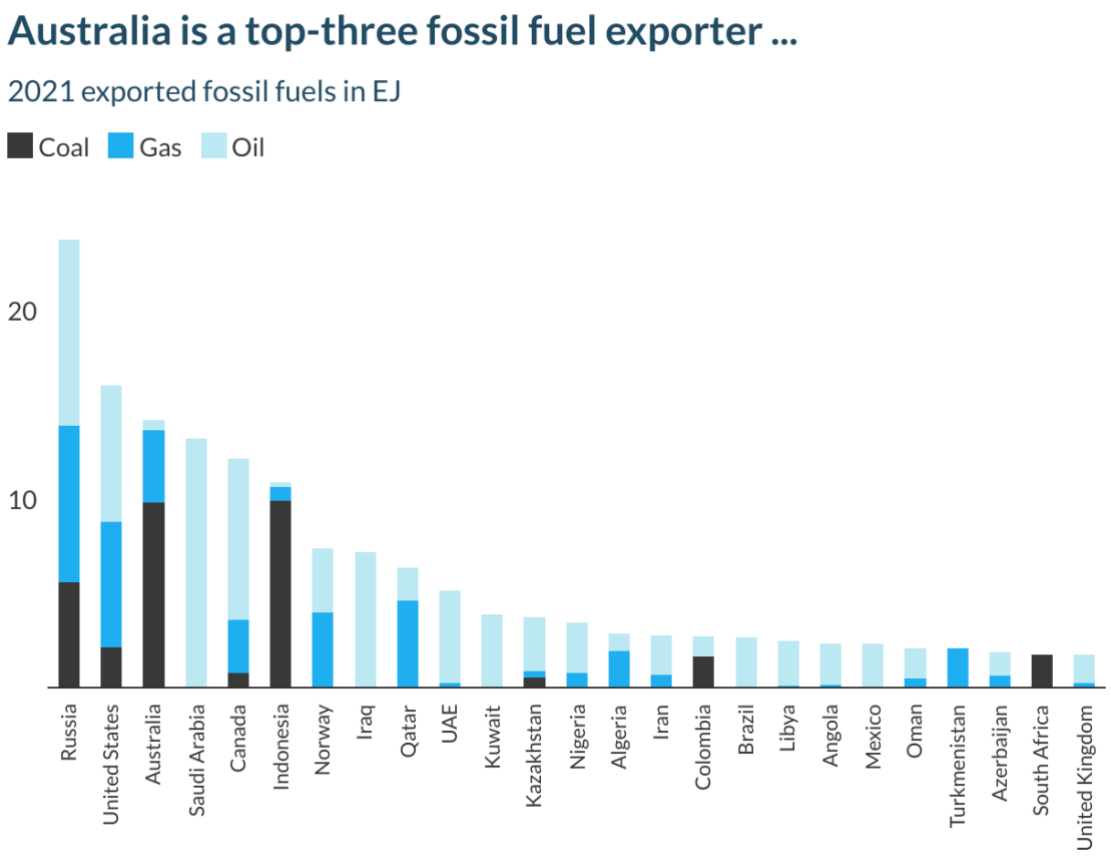

Figure 9: Primary fossil fuel exports, by country, 2021. Source: IEA World Energy Balances 2023[40]

In terms of the total GHG footprint arising from those exports, specifically due to the large proportion of coal, Australia ranked second in 2021 (Figure 10).[40,41]

This is calculated using emission factors derived in the Production Gap Report,[41] applied to each country's exports. The Production Gap Report uses an accounting method reflecting the total GHG emissions expected to be released from production activities and from the combustion of extracted fossil fuels and allocates those emissions to the producer country.

This is a top-down approach that accounts for emissions across the entire fossil fuel supply chain, including locating, extracting, processing, and delivering fossil fuels to consumers. This approach also, implicitly, accounts for the share of fossils fuels that are used for non-energy uses, such as feedstock to industrial processes. See also the Appendix to the Production Gap Report[42] and the Methodology section of this document.

Additional graphs including production, production and exports per capita, and GHG footprint for total production are included in the Appendix.

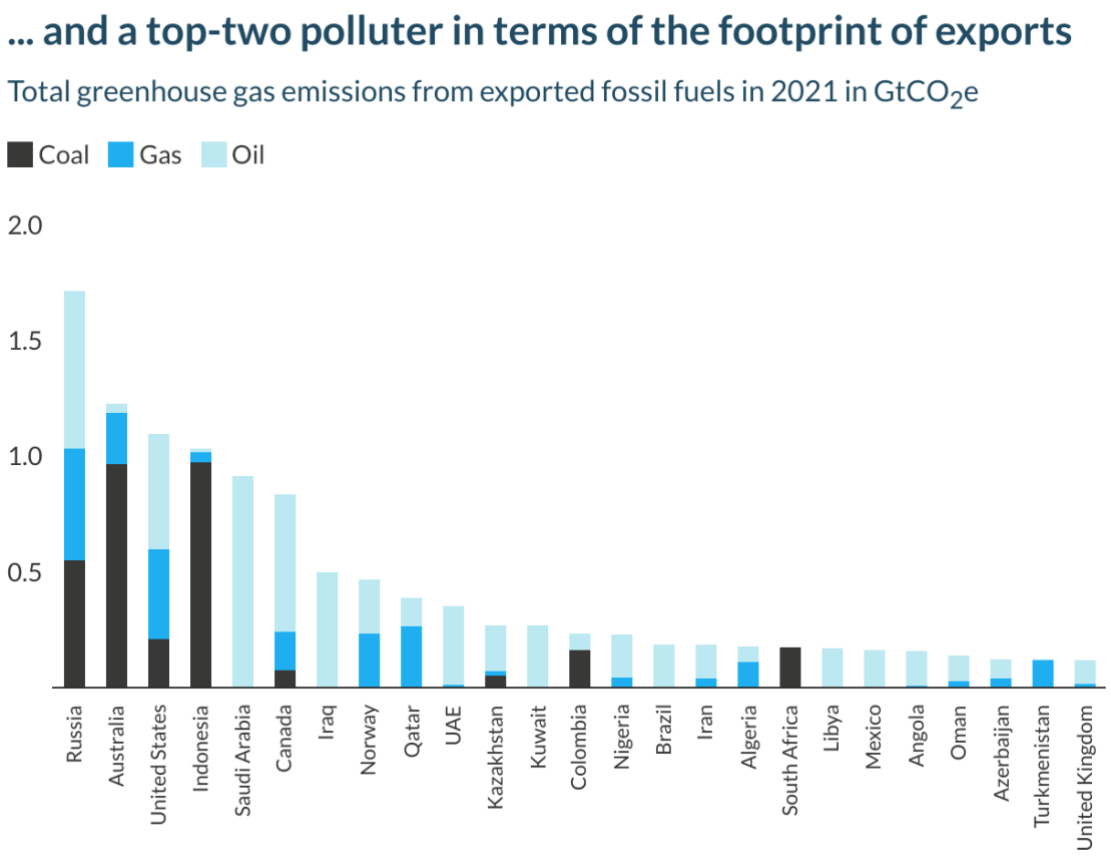

Figure 10: Total GHG footprint from production and end-use of exported fossil fuels, allocated to the producer country, applying Production Gap Report[41] factors. Source: IEA World Energy Balances 2023[40] and Production Gap Report 2023[41]

Importers

The market for Australia's fossil fuel exports is concentrated, with 78% of LNG, metallurgical coal, and thermal coal imported by just four countries: Japan, China, South Korea, and India. Japan imports the greatest share of both LNG and thermal coal, while India imports the most metallurgical coal.

	LNG		Metallurgical coal		Thermal coal	
	2023	Last decade	2023	Last decade	2023	Last decade
Japan	36%	44%	25%	22%	43%	40%
China	28%	31%	1%	18%	12%	17%
South Korea	14%	11%	13%	11%	8%	16%
India	1%	1%	28%	25%	4%	3%

Table 3: Share of Australia's LNG, metallurgical coal, thermal coal exports, by importing market. Source: Resources and Energy Quarterly December 2023[43]

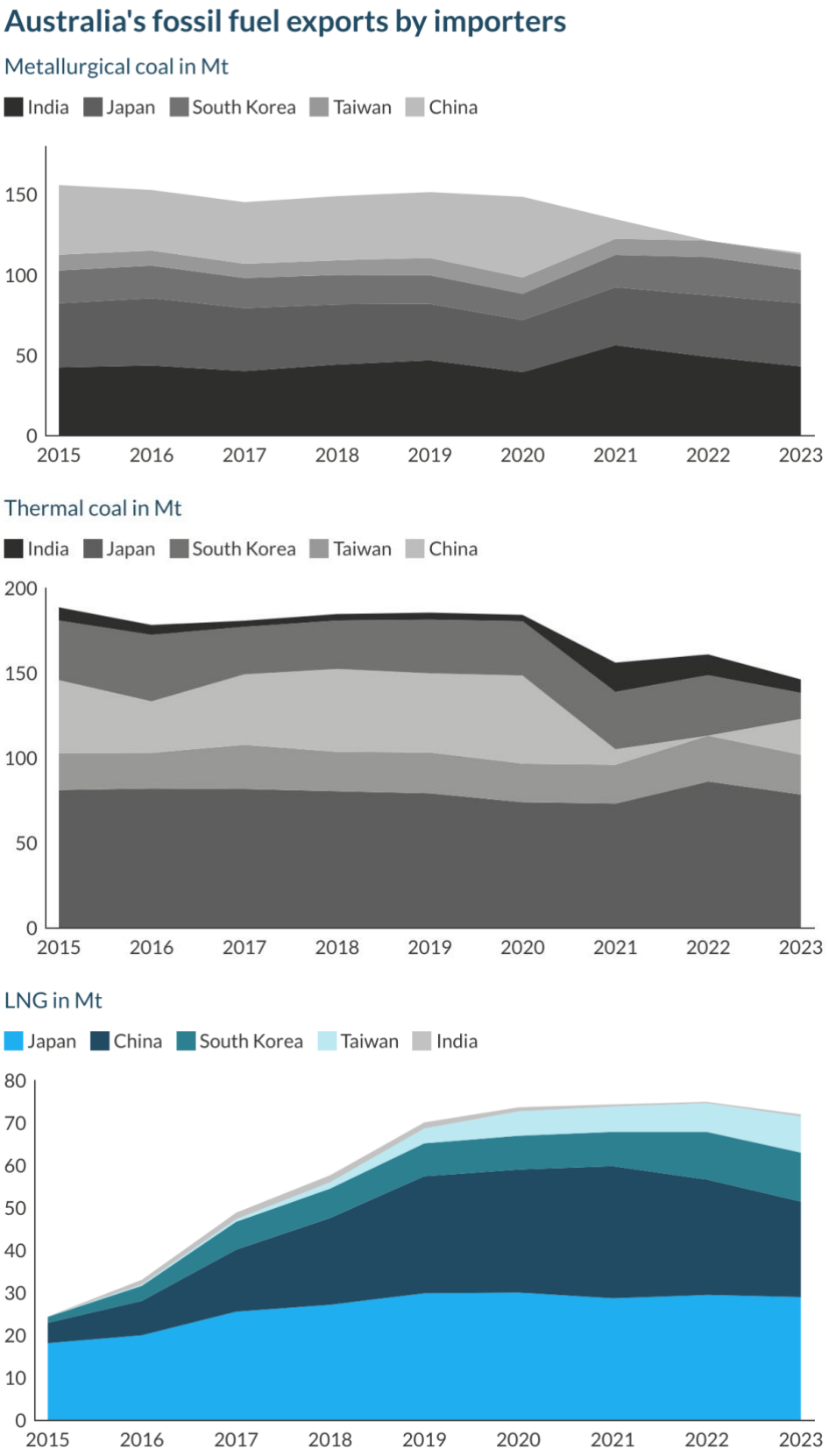

Figure 11: Australian fossil fuel exports, by importer. Source: Resources and Energy Quarterly March 2024[5]

All the major importers of Australia's fossil fuels are also signatories to the Paris Agreement and have set 2030 emissions reduction and net zero targets of their own, making sustained imports of Australian fossil fuels incompatible with their own commitments.

	2030 emissions reduction target incl. LULUCF	Long term target
Australia[20]	43% below 2005 levels by 2030	Net zero by 2050
Japan[44]	46% below 2013 levels by 2030	Carbon neutrality by 2050
China[45]	Lower carbon intensity by "over 65%" in 2030 from the 2005 level	Carbon neutrality before 2060
South Korea[46]	40% below 2018 by 2030	Carbon neutrality by 2050
India[47]	Emissions intensity of 45% below 2005 levels by 2030	Net zero by 2070

Table 4: Nationally Determined Contributions (NDC) to the UNFCCC, 2030 and long-term emission reduction targets.

While China is the world largest emitter, it is also rapidly adopting clean energy technologies. In 2022, China alone accounted for 60% of global EV sales, 50% of wind capacity additions, 45% of global solar PV capacity additions, and 30% of nuclear capacity additions.[10] In addition to its emission reduction targets, China is also targeting, by 2030, a share of non-fossil fuels in primary energy consumption of "around 25%" and installed capacity of wind and solar power increased to over 1,200 GW.

India is now the world's most populous country, is the world's third largest emitter and has one of the fastest-growing economies in the world. In addition to its emissions intensity NDC target, India is targeting 50% non-fossil installed power capacity by 2030 – a target which it is already on track to achieve. Despite substantial progress in renewable energy in the last decade, coal continues to be a part of India's long-term strategy, and it is actively pursuing efforts to boost LNG use.[47] India imports a significant share of Australia's metallurgical coal and has the fastest growing steel sector in the world. More effort is needed to decouple India's surging energy demand from emissions and to align its emissions trajectory with 1.5°C compatible pathways. As a developing country, international support is crucial to enable this.

Japan's current reliance on LNG and coal is directly linked to the Fukushima nuclear disaster in 2011, after which nuclear power was rapidly replaced with fossil generation. However, Japan is now aiming to reduce the share of both coal and gas in its power generation mix, aiming to reduce the share of LNG from 37% in 2019 to 20% in 2030, and the share of coal from 32% in 2019 to 19% in 2030.[48] Japan's LNG imports fell 8% in 2023 to their lowest levels since 2009 and Japanese companies on-sold more LNG in 2020-22 than they purchased from Australia.[49,50]

The role of fossil gas

It has been argued, by the Albanese government, state governments and fossil fuel companies, that Australia's fossil gas exports are crucial to decarbonisation, energy security and even regional stability in Asia.[51–54] The assumption that fossil gas displaces coal-fired power generation, and is therefore a net benefit for emissions reduction, is doing a lot of heavy lifting in these arguments and warrants closer inspection.

Globally, emissions need to roughly halve by 2030 and reach net zero CO_2 emissions by 2050 to meet the objectives of the Paris Agreement. 1.5°C compatible pathways from the IPCC's sixth assessment report (AR6) show that unabated fossil gas power generation needs to be effectively phased out by around 2040 in all regions of the world.[55] Fossil gas use falls to 15% of total global electricity generation by 2030 under these pathways.

Japan and China, the two biggest importers of Australian LNG, are not exceptions to this global trend. Japan needs to effectively phase out fossil gas from its power sector by 2035 to be consistent with 1.5°C compatible benchmarks, down from 34% in 2022.[56]

In China, where renewables already provide tenfold more power than gas-fired generation, gas use in the power sector would not rise above its 2022 share of 3% for 1.5°C compatibility.

Globally, new utility-scale solar PV and onshore wind is already cheaper than fossil fuel generation. In 2023, approximately 96% of new solar PV and onshore capacity had lower generation costs than new coal and gas plants. In both China and India, the levelised cost of energy (LCOE) from new solar PV plants is below the marginal cost of generation from existing coal and gas-fired power plants.[57]

New gas-fired power stations, and indeed new coal-fired power stations, risk becoming stranded assets in a decarbonising world at best and threaten the objectives of the Paris Agreement at worst. Australia's gas export industry would also be a stranded asset.

Projections

The recent historical exports of Australian fossil fuels have been turbulent, impacted by several global and domestic factors including global shocks to energy markets arising from Russia's illegal invasion of Ukraine and consequent Western sanctions imposed on Russia, informal trade restrictions imposed by China, severe domestic labour force shortages, COVID-19, and the La Niña weather event between 2020 and 2023.

While some of these factors are resolved or stabilising, several uncertainties regarding the outlook for domestic fossil fuel production and export remain. This includes the possibility for escalating conflict in the Middle East, the likelihood of another La Niña in 2024, a transitioning domestic energy mix, and downward pressure on fossil fuel capital investment due to eroding social licence and emission reductions targets.

We generate the following projections using the latest government data from the Department of Industry, Science and Resources (DISR) and the Department of Climate Change, Energy, the Environment and Water (DCCEEW).

Coal exports

At COP28 in December 2023, parties agreed to "transition away from fossil fuels in energy systems, in a just, orderly and equitable manner". In Australia's National Statement at COP28, Climate Change and Energy Minister, Chris Bowen, lauded the agreement made at the Pacific Island Forum to transition away from coal, oil and gas use, "in line with IPCC pathways for 1.5 degrees". Back at home, in the fourth quarter of 2023, thermal coal exports reached 55.6 Mt – the highest on record and 24% higher than the same quarter of 2022.[5]

Australian exports of thermal coal rebounded throughout 2023 (calendar year) from their recent historical low in September 2022 after two years of supply disruptions. Thermal coal exports to China have fully recovered after the removal of informal trade restrictions in early 2023, while trade sanctions imposed on Russia have raised global demand for Australian coal.

The government is projecting that the rebound in thermal coal exports will be sustained until 2029, then decline more rapidly beyond that. Globally, the government expects imports of seaborne thermal coal to fall at an average rate of 2.6% p.a. over the next six years.[5] Demand for coal is expected to rise in India over the next decade, but is projected to be met mostly by higher domestic production. Demand for thermal coal is expected to decline in China due to both expanding domestic production and rapidly expanding renewable power capacity.

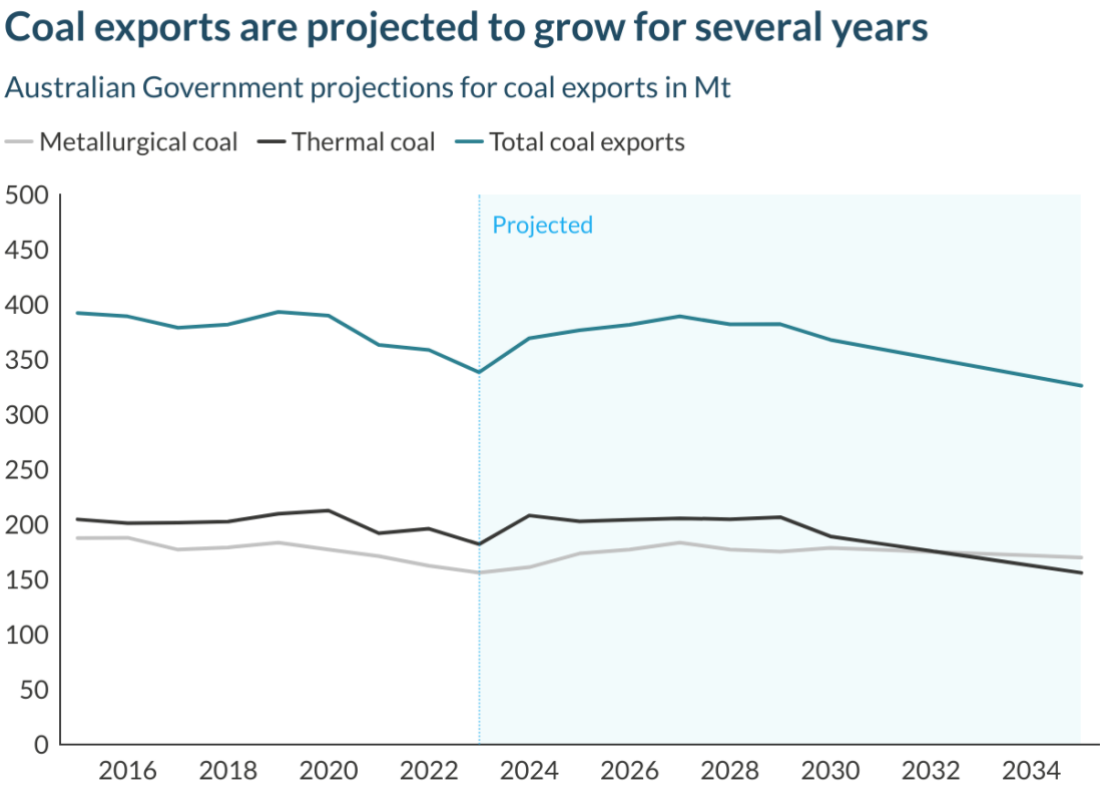

Figure 12: Historical and projected coal exports, 2015-2035.[q] Source: Resources and Energy Quarterly March 2024,[5] Australia's Emissions Projections 2023[17]

While the rebound in metallurgical coal exports is not projected to be as sharp as for thermal coal, export volumes are expected to remain high for many years. In 2023, coal exploration expenditure reached $320 million – the highest level since 2014 and a 33% increase on the previous year. It is expected that most of this expenditure will be directed towards metallurgical, not thermal, coal production.[5]

Total imports of metallurgical coal by India, the largest importer of Australian metallurgical coal, grew by 25% in 2023.[5] While imports of Australian thermal coal into China have recovered since the removal of trade restrictions, imports of metallurgical coal have not.

Considering combined black coal, i.e. thermal and metallurgical coal, exports declined for four consecutive years, and were 14% lower in 2023 than in 2019. However, by 2027, combined black coal exports are projected to return to 389 Mt, which is close to the all-time high seen in 2019.

[q] Based on Department of Industry, Science and Resources (DISR) projections to 2029, and then using run-of-mine production forecasts from the Department of Climate Change, Energy, the Environment and Water (DCCEEW) to 2035, assuming that the projected ratio of ROM production to exports in 2025 also applies in 2030 and 2035.

The Australian government is projecting combined run-of-mine[r] black coal production of 485 Mt in 2035, down 10% from the 539 Mt that was projected for 2035 in the previous years' projections.[17,58] The government forecasts that by 2029, Australia will export 98% of produced metallurgical coal and 82% of thermal coal, by mass.[5]

Under the IEA's Net Zero pathway, total global coal supply falls 44% by 2030, 71% by 2035, and 91% by 2050, relative to 2022 levels.[9,10]

Oil and gas

The government has been revising LNG export forecasts in recent years but is projecting sustained LNG production and export throughout the decade. The latest projections assume 82 Mt LNG production in 2035.[1,17] This is around the same as 2023 levels, and a slight reduction on the 86 Mt that was projected by the government one year prior.[58] More noticeable is the reduction in projections for 2030 LNG production, down from 88 Mt to 79 Mt. However, if no significant gas developments occur beyond those already committed, then exports would instead begin to decline after 2029.[5]

The government is expecting global gas consumption to grow at an average rate of 1.6% p.a. over the next eight years, compared to the 2.5% p.a. growth that occurred over the five years prior to 2021.[5]

As previously noted, the IEA's Net Zero roadmap indicates a reduction in global gas demand of about 18 to 22% by 2030 from 2022 levels under its 1.5°C pathway,[9,10] which translates to 2.2-2.7% p.a. *decline* over the eight years from 2022 to 2030. In other words, the Australian government appears to be betting that the Paris Agreement will not be implemented. Under the latest IEA Net Zero Emissions scenario, LNG trade would also fall 40% by 2035 relative to 2022 levels.[59]

Australian crude and condensate output fell by 10% in 2023.[5] Australia's two remaining oil refineries remain operational, propped up by federal government subsidies under the Fuel Security Services Payment. The subsidy is in place until 2027, with the option to extend until 2030.

[r] Run-of-mine coal production relates to the raw material extracted from the mine, not the saleable coal which is less than run-of-mine production. Saleable coal averages 80% of run-of-mine production.[17]

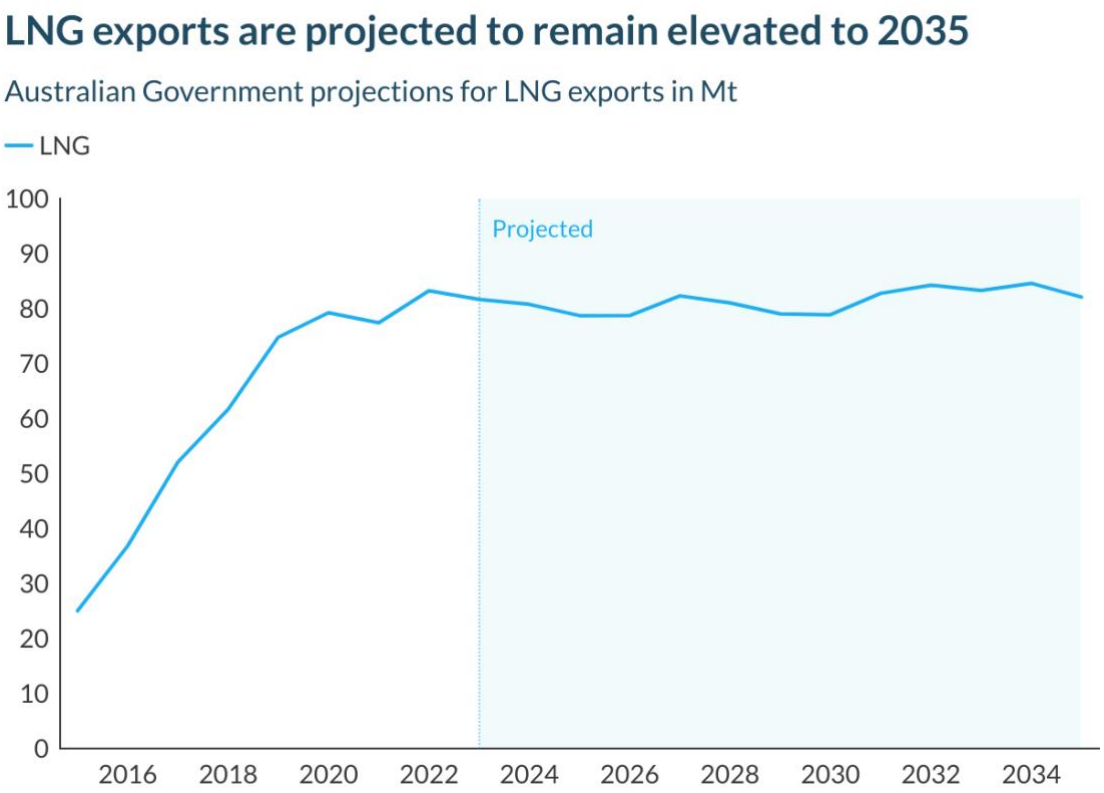

Figure 13: Historical and projected LNG exports, 2015-2035.[s] Source: Resources and Energy Quarterly March 2024,[5] Quarterly Update of Australia's National Greenhouse Gas Inventory December 2023[1]

Project pipeline

The latest *Resources and Energy Major Projects Report*[60] includes a pipeline of 88 fossil fuel production projects that have been announced, at the advanced feasibility stage, or are committed: 53 coal projects and 35 oil & gas projects, excluding LNG import terminals.

While not all early-phase developments will translate to committed projects, and while some additional capacity will be offset by other asset closures, the list gives an indication of the total scale of fossil fuel projects actively under development by the private sector and in many cases supported by state and/or federal governments.

In 2022, the same list included 66 coal and 40 oil & gas projects, excluding LNG import terminals.[61] The reduction in thermal coal projects is attributed to the declining quality of remaining resources, as well as issues with finance, insurance, social licence, and emission reduction commitments.[5]

[s] LNG projections taken directly from DCCEEW as a continuous timeseries out to 2035

More than 15 early-stage coal projects (mostly thermal coal) were removed from the 2023 list, and many coal projects have not progressed beyond the early stages for 10 years or more. This is attributed to deteriorating market conditions for coal, reduced access to project finance and insurance, and social licence erosion.[60] Four new oil and gas projects were added to the list, replacing completed projects, with another five projects cancelled.

Of the committed additional oil & gas production, 76% comes from just two projects: 240 PJ/year from Shell's Crux project and 676 PJ/year from Woodside Energy's Scarborough project and linked Pluto expansion (Train 2).

		Number projects	Additional production	Actual production 2022	Actual exports 2022
Coal	Announced	42	240 Mtpa	457 Mt	359 Mt
	Feasibility	1	7 Mtpa		
	Committed	10	40 Mtpa		
Oil & gas[t]	Announced	24	2162 PJ/yr	6967 PJ	5409 PJ
	Feasibility	N/A	N/A		
	Committed	11	1198 PJ/yr		

Table 5: Pipeline of Australian fossil fuel projects. Source: Resources and Energy Major Projects 2023[60]

Projected export emissions

We calculate that if exports of Australian fossil fuels remain elevated, consistent with government plans and projections, the cumulative CO_2 released to the atmosphere due to Australia's exported fossil fuels, from 1961 to 2035, would rise to 45 $GtCO_2$, considering both exported emissions and domestic production emissions for exported fossil fuels. Considering all GHG emissions, Australia's fossil fuel exports alone would be responsible for 46 $GtCO_2e$ between 1961 and 2035 (Figure 14).

[t] Excluding LNG import terminals

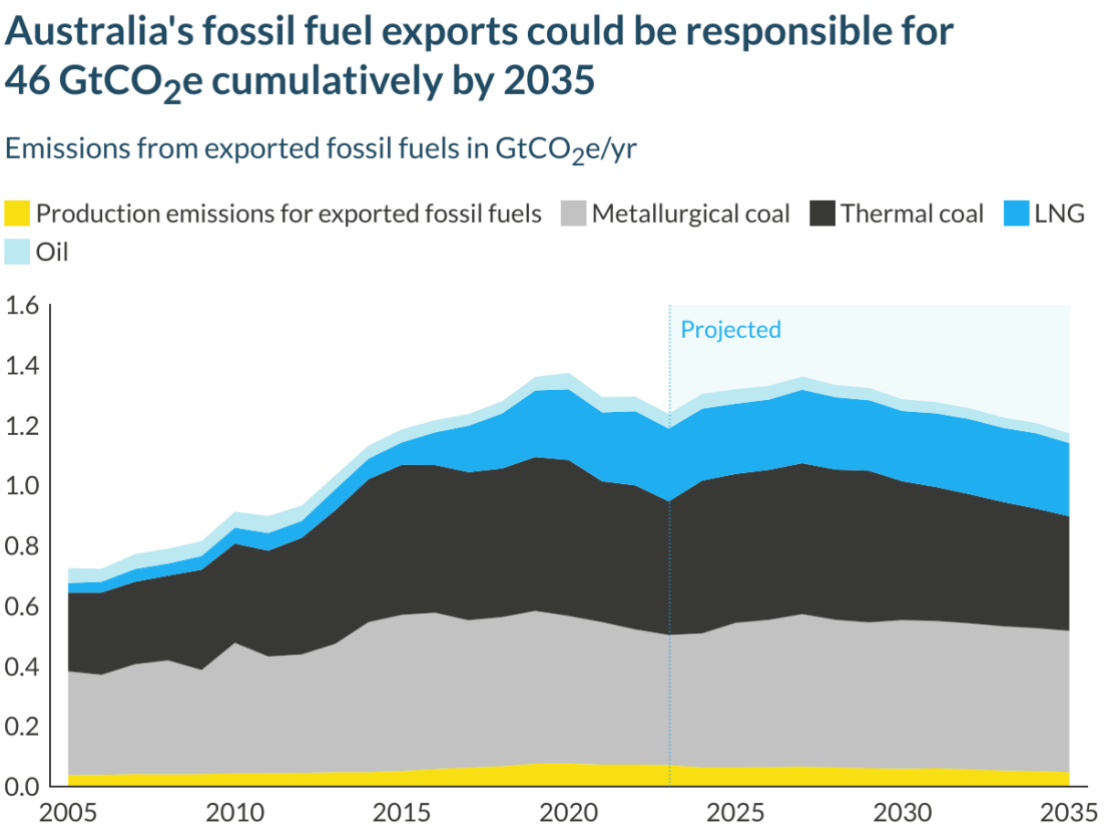

Figure 14: GHG emissions from combustion of exported fossil fuels and export-share of domestic fossil fuel industry emissions, historical and projected. Sources: Australian Energy Update 2023[4], Resources and Energy Quarterly March 2024[5], Australia's emissions projections 2023,[17] Quarterly Update of Australia's National Greenhouse Gas Inventory December 2023[1], and Australia's National Greenhouse Accounts[27]

Taking Australia's total global GHG footprint as domestic plus exported emissions, and assuming that fossil fuel exports are consistent with government plans and projections, as above, Australia's annual global footprint would remain at 1.5 $GtCO_2e$/yr by 2035, only down slightly from 1.7 $GtCO_2e$/yr in 2023. This is due to a projected fall in demand for Australia's thermal coal exports as the rest of the world decarbonises, not effective government climate policy.

This would result in a total cumulative global GHG emissions footprint, both domestic and exported, of 77 $GtCO_2e$ between 1961 and 2035.

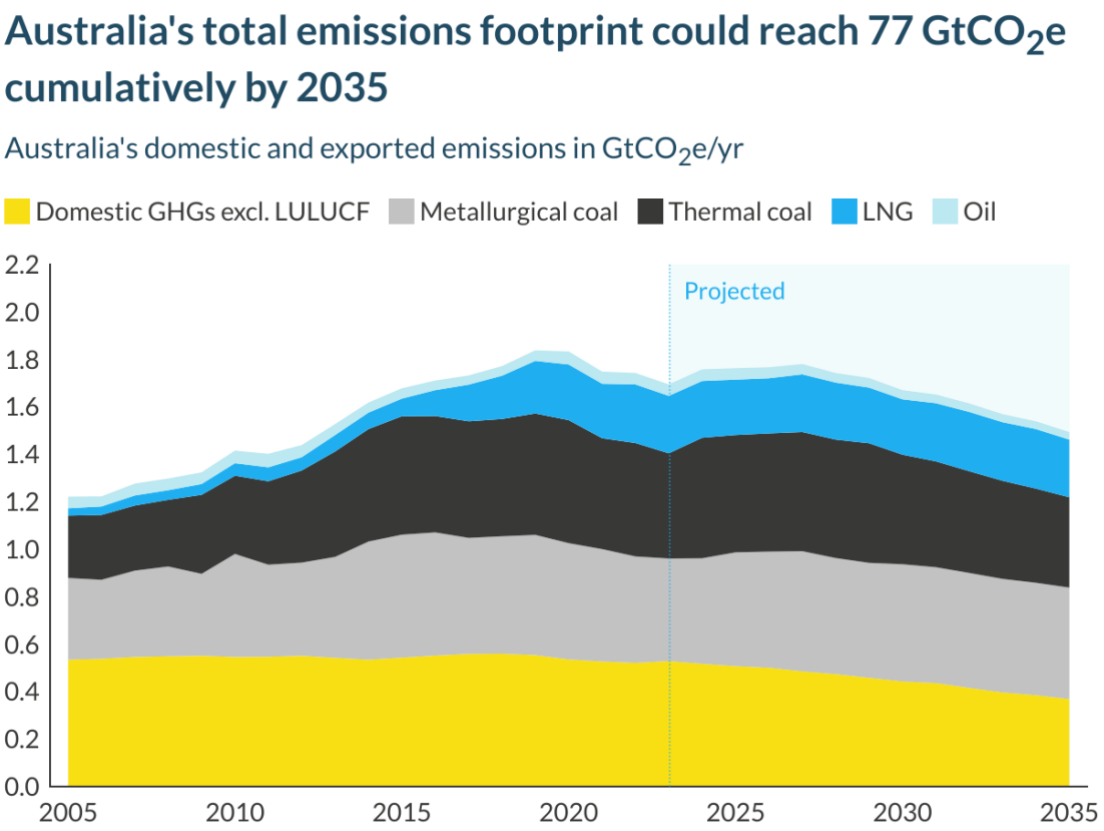

Figure 15: GHG emissions from combustion of exported fossil fuels and total domestic emissions excluding LULUCF, historical and projected. Sources: Australian Energy Update 2023[4], Resources and Energy Quarterly March 2024[5], Australia's emissions projections 2023,[17] Quarterly Update of Australia's National Greenhouse Gas Inventory December 2023[1], and Australia's National Greenhouse Accounts[27]

Table 6 summarises the cumulative historical and projected CO_2 and GHG emissions related to Australia's direct actions. These are:

1. domestic excluding LULUCF i.e. the emissions that occur within Australia's territorial borders as reported to the UNFCCC,
2. emissions from exported fossil fuels, i.e. the emissions that occur when Australia's exported fossil fuels are combusted overseas, plus the share of domestic emissions that arise in the extraction, processing and distribution of these fossil fuels for export, and
3. total footprint, i.e. Australia's total domestic emissions, plus exported fossil fuel CO_2 emissions.

			Domestic excl. LULUCF	Emissions from exported fossil fuels	Total footprint
Cumulative 1961-2023	CO_2	$GtCO_2$	18	30	47
	GHGs	$GtCO_2e$	27	31	57
Cumulative 1961-2035	CO_2	$GtCO_2$	22	45	66
	GHGs	$GtCO_2e$	33	46	77

Table 6: Australia's cumulative historical and projected CO_2 and GHG emissions considering domestic and exported emissions

In contrast to the sustained emissions that would arise from the government's planned fossil fuel exports, 1.5°C compatible pathways would see GHG emissions from both production and end-use fall sharply in this critical decade.

Under the IEA's Net Zero scenario, CO_2 emissions from fossil fuel combustion, including those from industry and flaring, would fall 35% by 2030 and 64% by 2035, relative to 2022 levels. The emissions that would arise from the Australian government's projected fossil fuel exports, in terms of both domestic production and end-use emissions, are clearly not falling consistent with a global 1.5°C compatible trajectory (Figure 16).

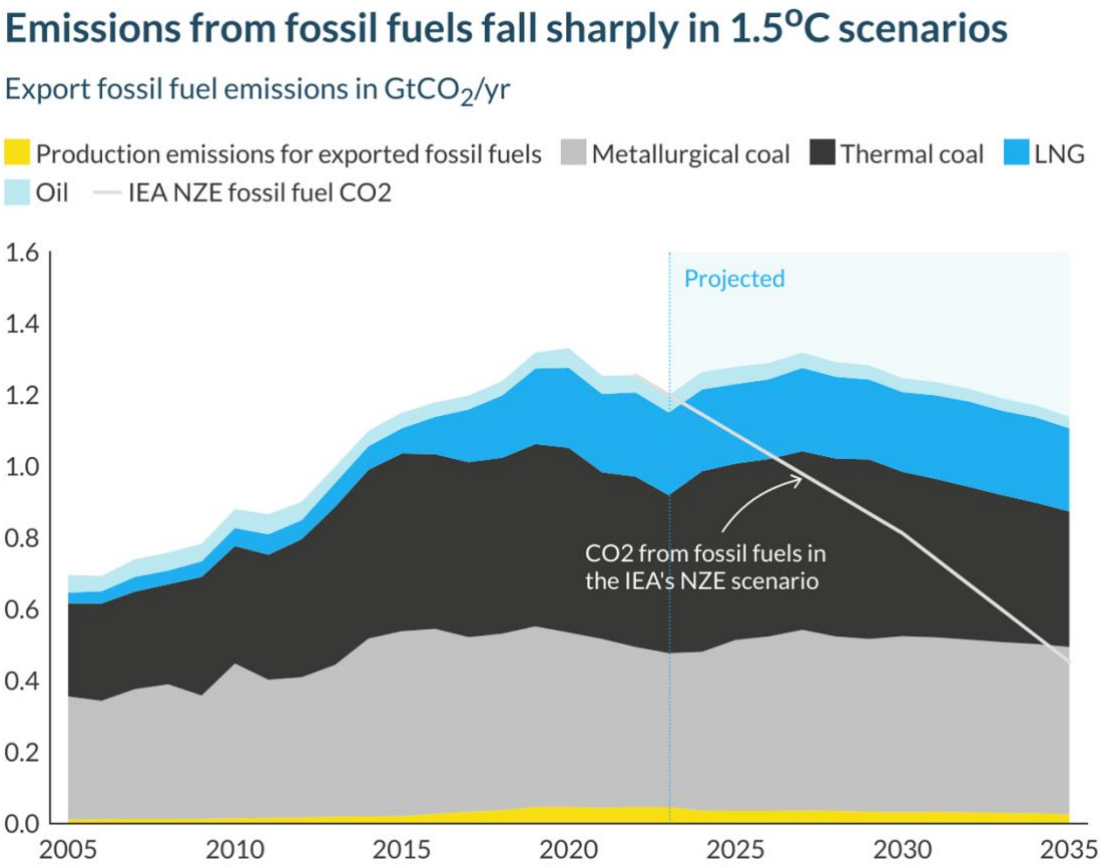

Figure 16: CO_2 emissions from combustion of exported fossil fuels and export-share of domestic fossil fuel production emissions, historical and projected, compared against IEA NZE scenario.
Sources: Australian Energy Update 2023[4], Resources and Energy Quarterly March 2024[5], Australia's emissions projections 2023,[17] Quarterly Update of Australia's National Greenhouse Gas Inventory December 2023[1], and Australia's National Greenhouse Accounts[27]

Conclusion

This analysis has shown that, far from being an inconsequential emitter, Australia is playing a major role in sustaining elevated global emissions, threatening the goals of the Paris Agreement.

Australia produces fossil fuels far in excess of its domestic consumption, making it one of the biggest exporters of fossil fuels and associated end-use emissions. Australia has not set targets for the phase-out of fossil fuel exploration, production and export, and is continuing to approve new gas and coal developments. While thermal coal exports are expected to slightly decline by 2035 from their all-time high in 2023, exports of metallurgical coal and LNG are expected to be about the same in 2035 as they are today.

With approximately 80% of Australia's global fossil fuel carbon footprint occurring overseas, Australia's contribution to global warming can only be understood by considering Australia's fossil fuel exports in addition to its domestic emissions. If Australia's fossil fuel exports evolve, consistent with government plans and projections, then Australia's total global GHG footprint could reach a cumulative 77 $GtCO_2e$ by 2035.

The relationship between cumulative CO_2 emissions and global warming has been studied extensively by climate scientists over many decades. In its latest assessment report (AR6), the IPCC reaffirmed, with high confidence, that there is a near-linear relationship between cumulative anthropogenic CO_2 emissions and the increase in global average temperature caused by CO_2 over the course of this century relative to 1850-1900.[62]

This near-linear relationship between cumulative CO_2 and global warming implies that reaching net zero anthropogenic CO_2 is a requirement to stabilising human-induced global temperature increase at any level, but that limiting global temperature increase to a specific level would imply limiting cumulative CO_2 emissions to within a carbon budget.[62]

Cumulative CO_2 emissions between 2024 and 2035 are projected to reach 15 $GtCO_2$ from Australia's fossil fuel export industry and 18 $GtCO_2$ when accounting for Australia's total CO_2 footprint. The remaining global 2024 carbon budget consistent with limiting global mean warming to 1.5°C with 50% probability is now estimated at 200 $GtCO_2$.[63]

Australia's fossil fuel exports alone would consume around 7.5% of the remaining global carbon budget by 2035, and around 9.1% considering Australia's total carbon footprint until that time.

With no sign of government-projected fossil fuel exports starting to drop, this fraction of the global carbon budget consumed by Australia's domestic use of fossil fuel and its fossil fuel exports would continue to increase disproportionately in terms of both Australia's population and its economic size.

References

1. Department of Climate Change, Energy, the Environment and Water. Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2023. (2024).
2. Energy Institute. Statistical Review of World Energy, 72nd edition. (2023).
3. BP. Statistical Review of World Energy, 71st edition. (2022).
4. Department of Climate Change, Energy, the Environment and Water. Australian Energy Update 2023. (2023).
5. Department of Industry, Science and Resources. Resources and Energy Quarterly March 2024. (2024).
6. Colclough H. & Pheeney J. Australian Operating Mines Map 2023. *Geoscience Australia* (2024) doi:10.26186/149157.
7. Geoscience Australia. *Australia's Energy Commodity Resources 2023*. https://www.ga.gov.au/digital-publication/aecr2023 (2023).
8. *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* (2022). doi:10.1017/9781009157926.
9. IEA. Net Zero Roadmap (2023 update): A Global Pathway to Keep the 1.5 °C Goal in Reach – Analysis. *IEA* https://www.iea.org/reports/net-zero-roadmap-a-global-pathway-to-keep-the-15-0c-goal-in-reach (2023).
10. IEA. *World Energy Outlook 2023*. https://www.iea.org/reports/world-energy-outlook-2023 (2023).
11. Climate Analytics. 2030 targets aligned to 1.5°C: evidence from the latest global pathways. https://climateanalytics.org/publications/2023/2030-targets-aligned-to-15c-evidence-from-the-latest-global-pathways/ (2023).
12. Department of Industry, Science, Energy and Resources. Australia's Long-Term Emissions Reduction Plan. (2021).
13. Department of Industry, Science, Energy and Resources. Australia's Long-Term Emissions Reduction Plan: Modelling and Analysis. (2021).
14. Department of Climate Change, Energy, the Environment and Water. Net Zero. https://www.dcceew.gov.au/climate-change/emissions-reduction/net-zero (2024).
15. The Australia Institute. Fossil fuel subsidies in Australia 2024. (2024).
16. Department of Industry, Science, Energy and Resources. Australia's Nationally Determined Contribution Communication 2022. (2022).

17. Department of Climate Change, Energy, the Environment and Water. Australia's emissions projections 2023. (2023).
18. Hare, B. Sleight of hand: Australia's Net Zero target is being lost in accounting tricks, offsets and more gas. *The Conversation* https://theconversation.com/sleight-of-hand-australias-net-zero-target-is-being-lost-in-accounting-tricks-offsets-and-more-gas-229479 (2024).
19. Climate Analytics. 1.5˚C National Pathway Explorer. *1.5˚C National Pathway Explorer* https://1p5ndc-pathways.climateanalytics.org (2023).
20. Climate Action Tracker. Australia. December 2023. *Climate Analytics*, *NewClimate Institute* https://climateactiontracker.org/countries/australia/ (2023).
21. Welder, L., Hörsch, J., Gidden, M., Schaeffer, M. & Hare, B. 1.5°C National Pathways Explorer - Methodology. https://1p5ndc-pathways.climateanalytics.org/methodology/ (2021).
22. Climate Action Tracker. *Scaling up Climate Action in Australia*. https://climateactiontracker.org/publications/scalingupaustralia/ (2020).
23. Gütschow, J., Pflüger, M., & Busch, Daniel. The PRIMAP-hist national historical emissions time series (1750-2022) v2.5.1. Zenodo https://doi.org/10.5281/zenodo.10705513 (2024).
24. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects, The 2022 Revision. (2022).
25. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. (2006).
26. IPCC. *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*. (2019).
27. Department of Climate Change, Energy, the Environment and Water. Australia's National Greenhouse Accounts.
28. Clean Energy Regulator. Safeguard facility reported emissions data 2022-23. (2024).
29. Clean Energy Regulator. Safeguard facility reported emissions data 2021-22. (2023).
30. Clean Energy Regulator. Greenhouse and energy information by controlling corporation 2022-23. (2024).
31. Assan, S. *Tackling Australia's Coal Mine Methane Problem*. (2022).
32. IEA. Global Methane Tracker 2024. https://www.iea.org/reports/global-methane-tracker-2024.
33. World Business Council for Sustainable Development & World Resources Institute. A Corporate Accounting and Reporting Standard, Revised Edition. (2015).
34. United Nations' High-Level Expert Group on the & Net Zero Emissions Commitments of Non-State Entities. *Integrity Matters: Net Zero Commitments by Businesses*, *Financial Institutions*, *Cities and Regions*.

https://www.un.org/sites/un2.un.org/files/high-levelexpertgroupupdate7.pdf (2022).

35. Climate Analytics. *Why Offsets Are Not a Viable Alternative to Cutting Emissions*. www.climateanalytics.org (2023).
36. UNFCCC. Outcome of the first global stocktake. (2023).
37. Department of Climate Change, Energy, the Environment and Water. Australian National Greenhouse Accounts Factors. (2023).
38. IEA. Methane Tracker. https://www.iea.org/data-and-statistics/data-tools/methane-tracker (2024).
39. European Commission, Joint Research Centre (JRC). IEA-EDGAR CO2, a component of the EDGAR (Emissions Database for Global Atmospheric Research) Community GHG database version 8.0. (2023).
40. IEA. World Energy Balances 2023. IEA (2023).
41. SEI, Climate Analytics, E3G, IISD, & UNEP. *Production Gap Report 2023*. https://www.productiongap.org/2023report (2023).
42. Stockholm Environment Institute, Climate Analytics, E3G, International Institute for Sustainable Development, & UN Environment Programme. *Online Appendix to the 2023 Production Gap Report: Phasing down or Phasing up? Top Fossil Fuel Producers Plan Even More Extraction despite Climate Promises*. https://productiongap.org/wp-content/uploads/2023/11/PGR2023_Appendix.pdf (2023).
43. Department of Industry, Science and Resources. Resources and Energy Quarterly December 2023. (2023).
44. Climate Action Tracker. Japan. November 2023. *Climate Analytics, NewClimate Institute* https://climateactiontracker.org/countries/japan/ (2023).
45. Climate Action Tracker. China. November 2023. *Climate Analytics, NewClimate Institute* https://climateactiontracker.org/countries/china/ (2023).
46. Climate Action Tracker. South Korea. July 2023. *Climate Analytics, NewClimate Institute* https://climateactiontracker.org/countries/south-korea/ (2023).
47. Climate Action Tracker. India. December 2023. *Climate Analytics, NewClimate Institute* https://climateactiontracker.org/countries/india/ (2023).
48. Ministry of Economy, Trade and Industry. *Outline of 6th Strategic Energy Plan*. https://www.enecho.meti.go.jp/en/category/others/basic_plan/pdf/6th_outline.pdf (2021).
49. IEEFA. *Global LNG Outlook 2024-2028*. https://ieefa.org/resources/global-lng-outlook-2024-2028 (2024).
50. IEEFA. *The Future of Australian LNG*. https://ieefa.org/resources/future-australian-lng (2024).

51. Tom Rabe. WA emissions are big and rising, and it's good for the world: premier. *Australian Financial Review* (2023).
52. Michael Smith. McGowan reassures Japan on WA gas supply. *Australian Financial Review* (2023).
53. Mercer, Daniel. Japan's Inpex says Australia risks unintended consequences as it 'quietly quits' LNG. *ABC* (2023).
54. Department of Industry, Science, Energy and Resources. *Future Gas Strategy*. https://www.industry.gov.au/publications/future-gas-strategy (2024).
55. Climate Analytics. *Fossil Gas: A Bridge to Nowhere. Phase-out Requirements for Gas Power to Limit Global Warming to 1.5°C*. (2022).
56. Climate Action Tracker. Paris-aligned benchmarks for the power sector. (2023).
57. IEA. Renewables 2023 – Analysis. *IEA* https://www.iea.org/reports/renewables-2023 (2024).
58. Department of Climate Change, Energy, the Environment and Water. Australia's emissions projections 2022. (2022).
59. IEA. *The Oil and Gas Industry in Net Zero Transitions*. https://www.iea.org/reports/the-oil-and-gas-industry-in-net-zero-transitions (2023).
60. Department of Industry, Science and Resources. Resources and Energy Major Projects 2023 Report. (2023).
61. Department of Industry, Science and Resources. Resources and Energy Major Projects 2022 Report. (2022).
62. IPCC. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/ (2021).
63. Forster, P. M. *et al.* Indicators of Global Climate Change 2023: annual update of key indicators of the state of the climate system and human influence. *Earth Syst. Sci. Data* **16**, 2625–2658 (2024).
64. Department of Climate Change, Energy, the Environment and Water. Guide to the Australian Energy Statistics. (2023).
65. Howarth, R. W. The Greenhouse Gas Footprint of Liquefied Natural Gas (LNG) Exported from the United States. (2024).

Methodology

To calculate Australia's historical and projected fossil fuel production and exports, and the domestic and exported emissions associated with those fossil fuels we combine data from:

- *Australian Energy Statistics 2023*[4]
- *Resources and Energy Quarterly (REQ) March 2024*[5]
- *Australia's Emissions Projections 2023*[17]
- *Quarterly Update of Australia's National Greenhouse Gas Inventory (NGGI) December 2023*[1]
- Australia's UNFCCC National GHG Inventory, available from *Australia's National Greenhouse Accounts (ANGA)*
- *Guide to the Australian Energy Statistics 2023*[64]
- *Australian National Greenhouse Accounts (ANGA) Factors 2023*[37]

All years cited for Australian government data are financial years. For example, data given for 2023 refers to the 2022-23 financial year.

Fossil fuel production and export

Historic production, imports, exports, and consumption of fossil fuels are given in the *Energy Statistics*[4] in physical units (Tables G1, I1, M, and N) or energy units (Table D1 and J).

National	Production	Imports	Consumption	Exports
Mass balance	Table I1	Table M	Table G1	Table N
Energy balance	Table J	Table J	Table D1	Table J

Relevant fossil fuel data reported in the *Energy Statistics* is compiled from several sources and is originally reported in physical units (with the exception of gas stock changes), then converted to energy units (by DCCEEW).[64] Data in Table J and Table G1 is only available from 1974. All other tables above commence from 1961.

Fossil gas

Historical fossil gas exports and domestic consumption in energy units [PJ] were taken directly from the *Energy Statistics*. Historical and projected exports, in physical units [kt LNG exports], were taken from *REQ* for years 1990 to 2004, and from the *Quarterly NGGI* for years 2005 to 2035. LNG export data was checked for consistency across *REQ*, *Energy Statistics*, *Quarterly NGGI* and *Emissions Projections*. The energy content factor was calculated as the five-year historical average of LNG exports reported in energy units [PJ] and physical units [kt] from the *Energy Statistics*, Table J and Table N.

Since methane is a potent GHG, LNG emission factors were calculated by considering gas leakage during shipping, regasification and downstream distribution to end-users using the methodology proposed in Howarth (2024).[65] Methane leakage during shipping was calculated for a short duration return trip, similar to Australia-Asia shipping routes, equating to 1.3 g CH_4/kg LNG, relative to exported LNG. Methane leakage rates were assumed for regasification and final distribution as 0.18 g CH_4/kg LNG and 3.2 g CH_4/kg LNG, respectively, relative delivered LNG.[65]

The remaining LNG was assumed to be combusted, either consumed as fuel during shipping or by end-users, for which the stationary combustion factors given in *ANGA Factors 2023*, Table 5 were applied. Fugitive emissions occurring upstream and during the liquefaction process are accounted for separately in domestic production emissions (see below) and are therefore not included here. The resulting emission factors are reported below.

Coal

Historical coal exports and domestic consumption in energy units [PJ] were taken directly from the *Energy Statistics*. Historical exports of metallurgical and thermal coal, in physical units [Mt], were taken from the *Energy Statistics* for years 1961 to 1989, and from *REQ* for years 1990 to 2023.

A complete timeseries for projected exports was constructed as follows: taking data directly from *REQ* for years 2024 to 2029; taking discrete data points for run-of-mine (ROM) coal production from *Emissions Projections* for 2025, 2030 and 2035; assuming the projected ratio between ROM production and exports in 2025 also applies in 2030 and 2035; and interpolating linearly for years 2031 to 2034.

Historical and projected data was checked for consistency and tested against data from *REQ*, *Energy Statistics*, *Quarterly NGGI* and *Emissions Projections*. The level of disaggregation of government data into coal grades i.e. black/brown coal, and metallurgical/thermal coal varies between sources. Energy content and emissions factors were taken from *ANGA Factors 2023*, Table 4 for bituminous [27 GJ/t] and coking coal [30 GJ/t].

Oil

Historical exports, by fuel, in physical units [ML], were taken directly from the *Energy Statistics* for years 1961 to 1989 and *REQ* for years 1990 to 2023. Projected exports

(for crude, LPG and combined petroleum products) were constructed by taking data directly from *REQ* for 2024 to 2029, and applying the 5-year average growth rate for years 2030 to 2035.

Energy content factors were taken from the *Guide to the Australian Energy Statistics*, Table 9 and emission factors [CO_2/GJ] were taken from *ANGA Factors 2023*, Table 8. Projected emissions from combined petroleum products were calculated by applying 5-year weighted average factors for energy content and emission factors (from individual petroleum products) to projected exports.

Summary of factors applied

A summary of energy content and emission factors are given below. Where multiple energy content factors were given across the *Energy Statistics* and *ANGA factors*, factors were selected based on their correlation with historical data for each fuel (*Energy Statistics* Table J / Table N).

	Energy content	Emissions factor		Other
		kg CO_2/GJ	kg CO_2e/GJ	
LNG	55.3 GJ/t[u] (25.4 GJ/kL)	51.2	53.5	1 Mt LNG = 1.36 bcm fossil gas[11] 1 L LNG = 0.625 m^3 fossil gas[4] 1 t LNG = 2174 L LNG
Thermal coal	27 GJ/t[37]	90.0	90.2	
Metallurgical coal	30 GJ/t[37,v]	91.8	92.0	
Crude	37 GJ/kL	69.6	69.9	1 bbl = 159 L
LPG	27 GJ/kL	60.2	60.6	1 bbl = 159 L

Domestic fossil fuel industry emissions

Domestic emissions were taken directly from Australia's UNFCCC national inventory data, available from *Australia's National Greenhouse Accounts (ANGA)*,[27] *in CO_2 and CO_2e*, and from the *Emissions Projections*. Data is categorised/disaggregated slightly differently between the two sources.

[u] Taking the five-year historical average of LNG exports reported in energy units [PJ] and physical units [kt] from the *Energy Statistics*, Table J and Table N

[v] Although the *Guide to the Australian Energy Statistics,* Table 7 states that 29 GJ/t is used for metallurgical coal exports, this results in greater historical difference between Table J and Table N

The export-share of domestic fossil fuel production emissions was calculating also using data from *ANGA* and the *Emissions Projections*. Fossil fuel production emissions are calculated by fuel combustion emissions (also called stationary energy emissions), fugitive emissions, and emissions from electricity use.

Oil & gas production emissions

In the *Emissions Projections*, combustion and fugitive emissions for LNG are reported separately from other domestic gas and oil. For combustion, this data split is available from 2016 to 2035, and for fugitives it is available from 2018 to 2035.

Timeseries' for the export-share of O&G combustion and fugitive emissions from 1990 to 2035 were constructed by taking the data directly from the *Emissions Projections* for available years, and, for earlier historical years, splitting the total O&G extraction stationary emissions[w] and total fossil gas fugitive emissions by the LNG export-share of total gas production from *Energy Statistics* (Table J, Export/Production). Historical fugitive emissions were also derated based on the recent (4-year) average of LNG fugitives to total O&G fugitives since domestic gas distribution and use accounts for a greater share of O&G fugitives.

A timeseries for the export-share of O&G electricity emissions for years 2003 to 2022 was constructed as follows: taking total O&G electricity consumption from the *Energy Statistics* (Table F, ANZSIC Div. B, 07 Oil and gas extraction); multiplying by the 'Off-grid' emissions factor from *ANGA Factors*, Table 3; taking the export-share of total gas production from *Energy Statistics* (Table J); and harmonising with discrete data points for LNG electricity emissions from the *Emissions Projections*, Table 24. Electricity emissions were not extended over the complete timeseries range due to data limitations.

Where required, CO_2 was derived from CO_2e by applying the historical % CO_2 from *ANGA*, categories '1.A.1.c.ii Oil and Gas Extraction', '1.B.2 Oil and Natural Gas' and '1.A.1.a Public Electricity and Heat Production' categories for combustion, fugitives, and electricity emissions, respectively; and applying the 5-year historical average from 2022 onwards.

Coal mining emissions

Combustion emissions from coal mining are not disaggregated from other mining in the *Emissions Projections*; however, they are reported separately in the *ANGA* data, according to IPCC categories.

A timeseries for the export-share of coal mining combustion emissions for 1990 to 2035 was calculated as follows: taking data directly from *ANGA* category '1.A.1.c.iii Coal Mining' for the years 1990 to 2021; and for years 2022 to 2035, multiplying total mining combustion emissions in the *Emissions Projections* by the historic coal mining

[w] Note that within combustion emissions, only the LNG-share of 'oil & gas extraction emissions' are attributed to exports. Emissions from 'gas production and distribution' and 'petroleum refining' emissions are attributed entirely to domestic consumption.

share from *ANGA*, categories '1.A.1.c.iii Coal Mining' and '1.A.2.g.iii Mining (excluding fuels) and quarrying'. Fugitive emissions from coal mining were taken directly from the *Emissions Projections* for years 1990 to 2035.

A timeseries for the export-share of coal mining electricity emissions for years 2003 to 2022 was constructed as follows: taking coal mining electricity consumption from the *Energy Statistics* (Table F, ANZSIC Div. B, 06 Coal mining); and multiplying by the 'Off-grid' emissions factor from *ANGA Factors*, Table 3. Electricity emissions were not extended over the complete timeseries range due to data limitations.

For combustion, fugitive and electricity emissions, total coal mining emissions, as described above, were multiplied by the export-share of total coal production from the *Energy Statistics* (Table J, Export/Production), and applying the 5-year historical average from 2023 onwards.

Where required, CO_2 was derived from CO_2e by applying the historical % CO_2 from *ANGA*, categories '1.A.1.c.iii Coal Mining', '1.B.1 Solid Fuels' and '1.A.1.a Public Electricity and Heat Production' categories for combustion, fugitives, and electricity emissions, respectively; and applying the 5-year historical average from 2022 onwards.

Global comparison

To benchmark Australia's fossil fuel exports globally, we combine data from:

- *PRIMAP-hist National Historical Emissions Time Series v2.5.1*[23]
- IEA *World Energy Balances 2023*[40]
- UN *World Population Prospects 2022*[24]
- Factors derived in *Production Gap Report 2023*[41]

To compare fossil fuel exports, export flow data was taken from IEA *World Energy Balances*[40] for all available countries (2021 is last complete historical year), and individual fuels were aggregated into fuel groups (coal and coal products; fossil gas; crude and feedstocks; oil products) consistent with grouping specified in *World Energy Balances Database Documentation 2023*.[40]

To calculate exported emissions, emission factors were applied from the *Production Gap Report*[41] for "extraction-based emissions", which are calculated for each fuel as the ratio of global annual sum of GHG emissions from fuel production and combustion to the global annual sum of fuel production based on IEA statistics for 2016-2020. These factors inherently account for domestic fossil fuel industry emissions, in addition to combustion emissions, as well as the share of non-energy use e.g. oil as a feedstock for making petrochemicals. Refer *Production Gap Report Appendix*[42]

A comparison between the Australian government factors for fossil fuel combustion and the *Production Gap Report* factors encompassing both production and end-use (including non-energy use) is provided below.

ANGA Emissions factors			**Production Gap Report factors**	
Fuel	kg CO_2/GJ	kg CO_2e/GJ	**Fuel group**	Gt CO_2e/EJ
LNG	51.4	51.5	Gas	0.058
Thermal coal	90.0	90.2	Coal	0.098
Metallurgical coal	91.8	92.0		
Crude	69.6	69.9	Oil	0.069
LPG	60.2	60.6		

Appendix

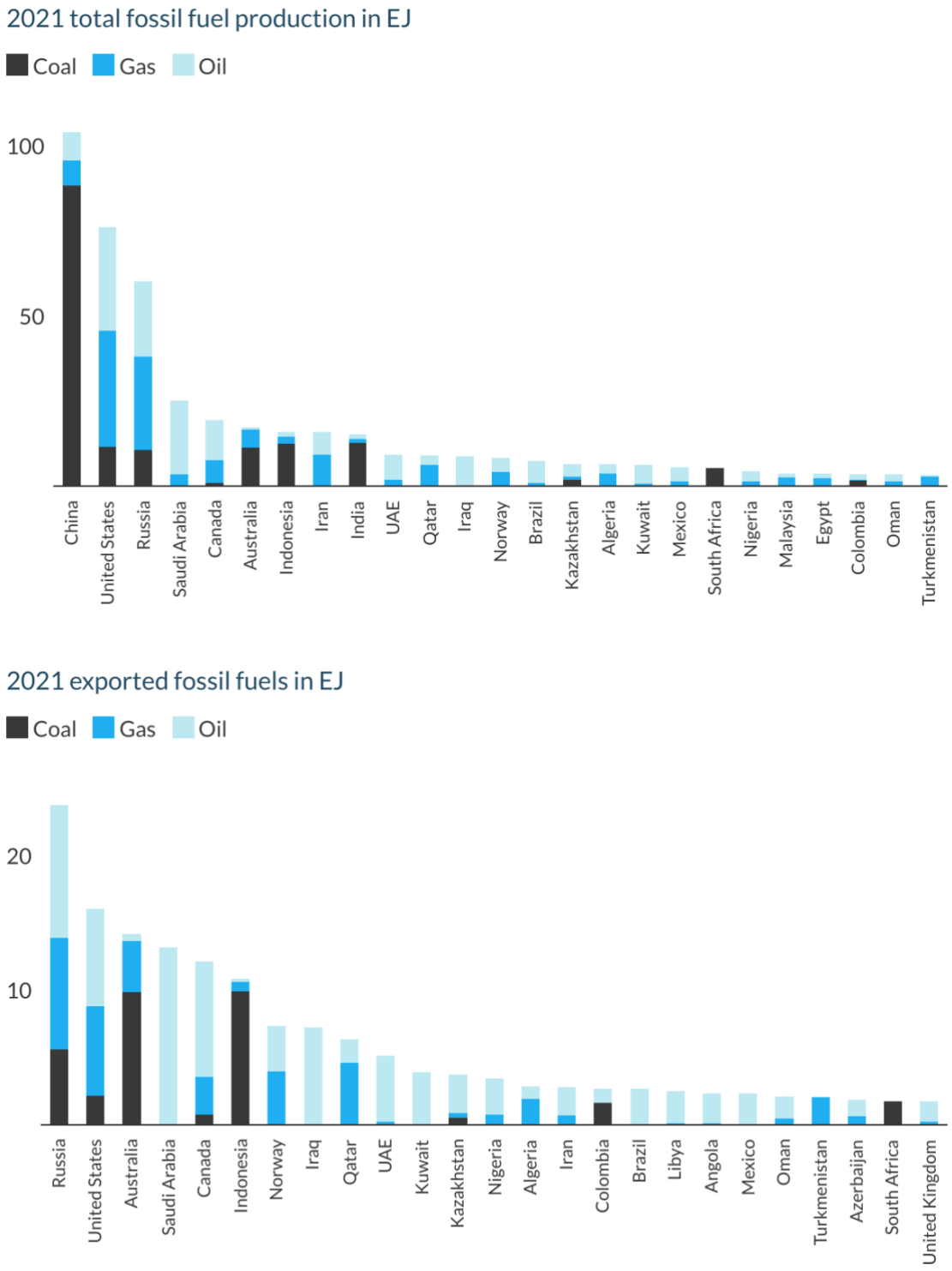

Figure 17: Primary fossil fuel production exports, by country, 2021. Source: IEA World Energy Balances 2023[40]

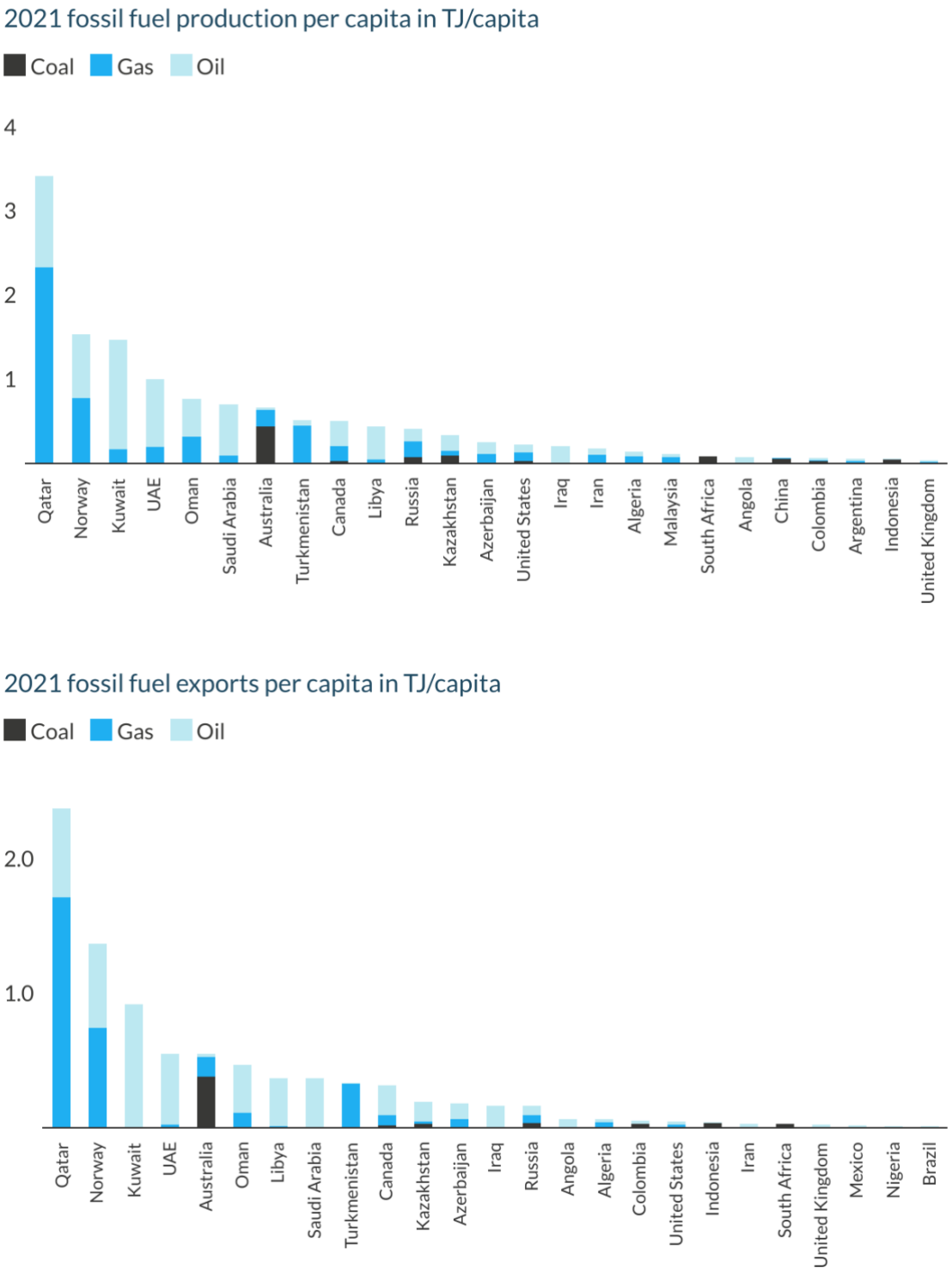

Figure 18: Primary fossil fuel production and exports per capita, by country, 2021. Source: IEA World Energy Balances 2023[40] and UN World Population Prospects 2022[24]

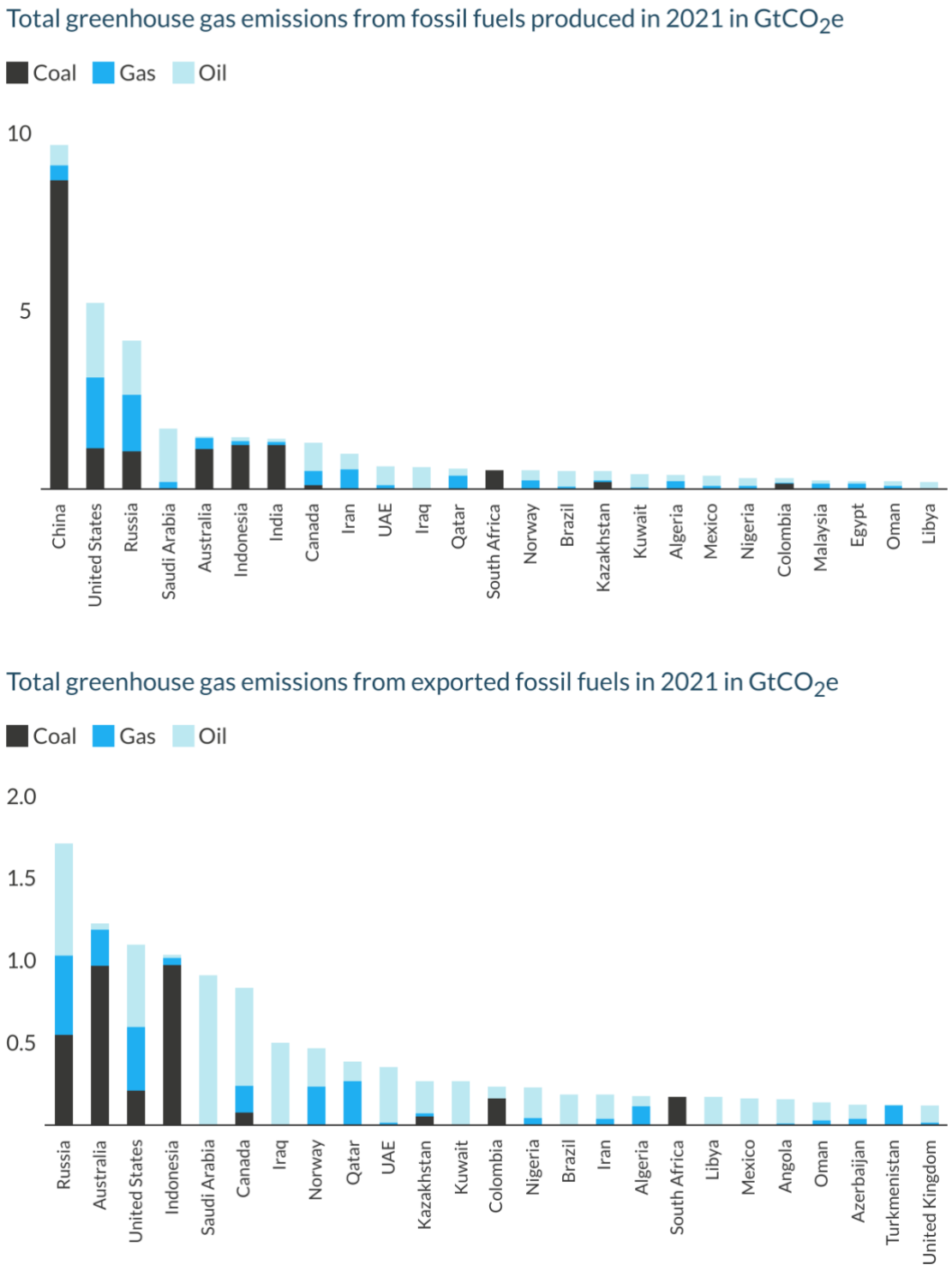

Figure 19: Total GHG footprint from production and end-use of fossil fuels, allocated to the producer country (total production and exports), applying Production Gap Report[41] factors. Source: IEA World Energy Balances 2023[40] and Production Gap Report 2023[41]

www.climateanalytics.org