Maritime
EMISSIONS REDUCTION
Coalition

Australian Domestic Maritime Emissions Review

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Now updated with National Greenhouse Accounts Team feedback.

Contents

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Executive Summary

Australia has committed to reducing our greenhouse gas (GHG) emissions by 43% by 2030 as an interim point on our progress towards net zero emissions by 2050. The energy transition needed to deliver on these targets is considerable and focus must be made where it is most important – whilst not neglecting the impact on any part of the economy.

Since those targets were announced, Australia's Paris Agreement inventory emissions from fuel use in domestic maritime has remained recorded as around **2 Megatons** of CO_2-equivalent gaseous emissions[1].

Unfortunately, this grossly underestimates the GHG emissions from the maritime sector, both because it ignores Scope 2 and Scope 3 emissions (such as fuel transport, refrigerant leakage, shoreside electricity use, etc.) and because it does not actually match the likely emissions when derived through bottom-up calculations using published industry numbers.

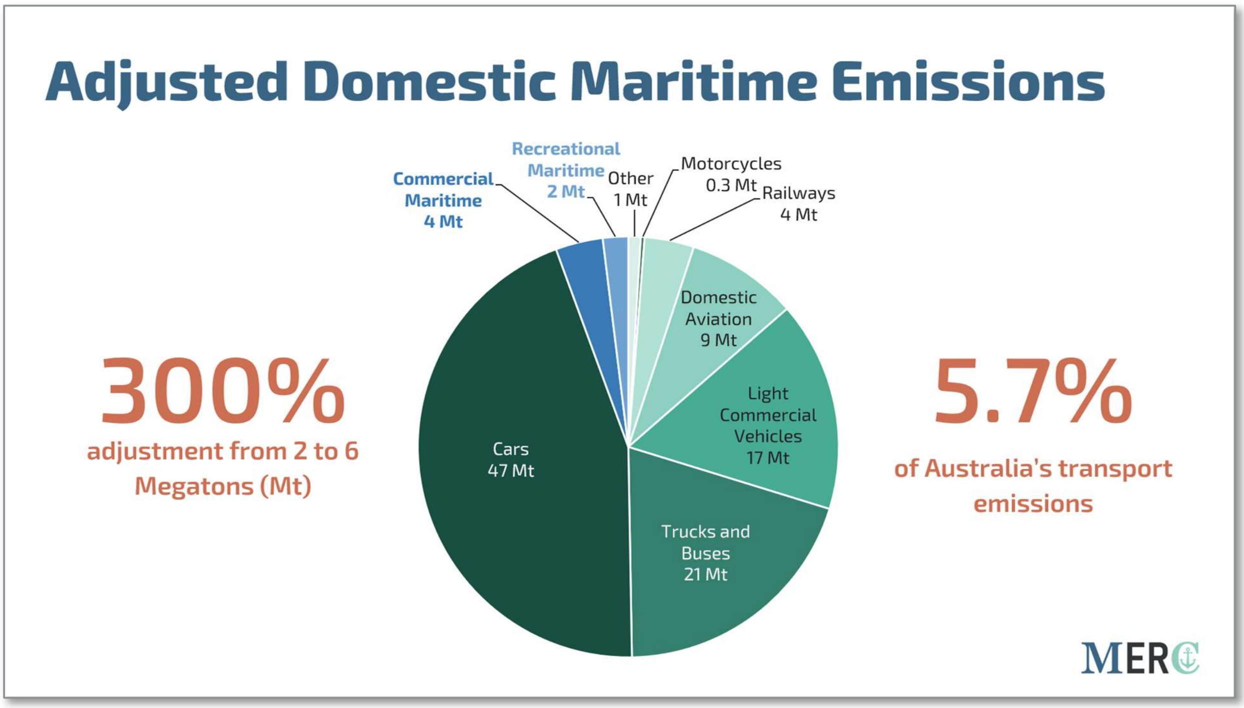

Figure 1: Adjusted Domestic Maritime Emissions

Our analysis shows that Australian domestic maritime GHG emissions from fuel use alone should actually be over **6 Megatons** of CO_2-equivalent gases annually. An adjustment of 300% to the original number! It could even be higher, up to **7.4 Megatons** of CO_2-equivalent gases annually.

This document details how we performed that analysis, in order to derive these numbers. We are making these public so that others can confirm our calculations and, if necessary, correct or further improve upon them.

The result of adjusting these numbers is that domestic maritime leaps from 2% to 5.7% of Australia's transport emissions, putting it just below domestic aviation in terms of the importance to address. It is also likely that the fuel is already counted in various road vehicle categories,

[1] https://greenhouseaccounts.climatechange.gov.au/

which if true might reduce the contribution of trucks, buses and cars, but in any case, the analysis shows it should be much higher than the current inventory reports say it is.

Method

When looking at Australian's domestic maritime activity there are two main divisions. On the one hand, there are commercial vessels, smaller in number, but generally larger in size and usage; and on the other, there are recreational vessels, large in number, but generally smaller in size and only occasionally used.

The **Australian Maritime Safety Authority (AMSA)** is responsible for registering and managing the regulation of domestic commercial vessels (DCVs). Their *Domestic Commercial Vessels Fleet Profile*[2] identifies that there are 31,000 DCVs active, of which 7,000 are human powered and sail vessels (e.g. hired rowboats). That leaves us with 24,000 DCVs that are powered craft.

The **Boating Industry Association (BIA)** is the premier industry group for domestic recreational vessels. Their *2023 Boating Data Report Card*[3] identifies that there are 905,000 registered boats (i.e. with an engine) and another 95,000+ registered personal watercraft (again, with engines).

There is no mandatory registration information for either commercial or recreational vessels about their engine size.

For commercial vessels, AMSA still does have a lot of information about engine sizes – although it may be more common in larger vessel registrations. To cater for potential bias upwards, this data was used in two forms. For each set of vessels grouped by length, the median was used to give engine sizes that were more commonly recorded, while the average was used to give what should be the average engine size. This is reported as a range in engine size and derived values.

For recreational vessels the length of vessels is recorded, and this was used as a proxy for determining engine size. An estimate for potential average engine sizes was made for each set of vessels grouped by length, and the numbers were sense-checked with the BIA.

Most domestic vessels use either petrol or diesel engines. Petrol outboards are mostly used in smaller vessels, and diesel inboards in larger vessels (diesel is also used in larger vessels for generators). We applied this as an assumption across the vessel sizes provided by AMSA and BIA.

The number of vessels, their fuel type, and their engine size is only part of the equation needed to derive the annual GHG emissions for the domestic maritime industry. A simple version of the equation for a single vessel is:

Annual GHG Emissions (Mt CO_2-e)
=
Engine Size (kW)
x Duration (h)
x Average Power Used (%)
÷ Thermal Efficiency (%)
x GHG Emissions Per kWh (CO_2-e g/kWh)

[2] https://www.amsa.gov.au/domestic-commercial-vessels-fleet-profile
[3] https://bia.org.au/news/2023-boating-data-report-card-released/

Duration is the number of hours that engine is run per year. For commercial vessels, there are wide ranging differences here, some are used every day of the year, for a whole working day, whilst others might run for 24 hours non-stop for weeks on end, but then sit unused for months at a time. We assumed that the average is 8 hours a day, 5 days a week, 48 weeks of the year. That allows for vessels that are not used every day, and some downtime for repairs or maintenance.

For recreational vessels, we used numbers from the *Pathways to Propulsion Decarbonisation for the Recreational Marine Industry - Synopsis Report*[4] from the **International Council of Marine Industry Associations (ICOMIA)**. They used data from engine manufacturers that stated recreational vessels used their engines on average 35 to 48 hours per year. This extraordinarily low number is explained by the large number of vessels that sit unused for weeks at a time, only to be driven for an hour to a bay, sit unused at anchor, then drive back an hour to their berth. We have heard some criticism of relying on manufacturers' information, and so for the sake of this report we have assumed an annual duration of use of 52 hours for each vessel (basically 1 hour per week).

Average Power Used represents what portion of the engine's theoretical capacity is actually used on average. Diesel engines generally have an ideal operating range around 85% of capacity, and petrol engines are more flexible, but we assumed 70% of capacity was used on average. This impacts their fuel consumption and assuming less than 100% reduces the emissions generated.

Thermal Efficiency describes how much *exergy* is provided by the engine based on the available *energy* in the consumed fuel. **Figure 2** shows how the energy potential of the diesel fuel is wasted by a diesel generator on the way to creating work done. Kilowatt ratings for engines are output based, meaning the power generated on the crankshaft, not the energy in the fuel they consume. Thermal Efficiency ranges are well known for petrol and diesel engines, and we have assumed 40% thermal efficiency for diesel engines and 30% thermal efficiency for petrol engines.

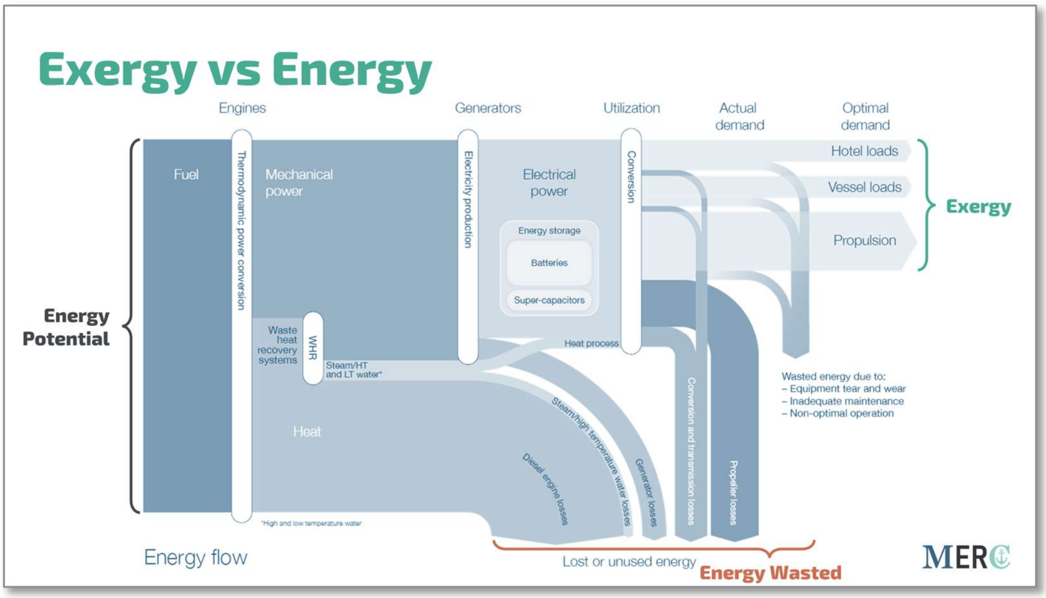

Figure 2: SANKEY Diagram of energy use by a diesel generator (Source: ABB)

[4] https://www.icomia.org/content/pathways-propulsion-decarbonisation-recreational-marine-industry-synopsis

Greenhouse Gas (GHG) Emissions Per Kilowatt Hour is the well-to-wake GHG emissions for each kilowatt hour of potential energy in the fuel consumed. GHG emissions are usually expressed per litre of fuel, so we need to convert those numbers to per kilowatt hour. For diesel we have used the approximation of 10.7 kilowatt hours per litre of fuel, which gives 253 CO2-equivalent grams/kilowatt hour. For petrol we have used the approximation of 9.5 kilowatt hours per litre of fuel, which gives 243 CO2-equivalent grams/kilowatt hour. In comparison to the previous version of this report, we no longer are using well-to-wake emissions, but the same Scope 1 emissions numbers used by the National Greenhouse Accounts team.

Having researched our vessel information and made assumptions about fuel used and engine sizes, we then applied the equation across the data set.

Results

Commercial Vessels

The duration of use for commercial vessels is assumed to be 8 hours x 5 days x 48 weeks = 1,920 hours/year. Note that All Engines is listed as there are often multiple engines or generators on board each vessel.

Table 1: Commercial Vessel Fleet Numbers

By Size	% of Fleet	# of Vessels	All Engines (Median)	All Engines (Avg)	Annual Hours	Annual GWh (Median)	Annual GWh (Avg)
0-7.5 m	58.8%	14,112	45 kW	69.5 kW	27,095,040 h	1,219 GWh	1,883 GWh
7.5-12 m	18.3%	4,392	186 kW	216.4 kW	8,432,640 h	1,568 GWh	1,825 GWh
12-24 m	19.1%	4,584	330 kW	445.1 kW	8,801,280 h	2,904 GWh	3,917 GWh
24-35 m	3.0%	720	736 kW	1,351.1 kW	1,382,400 h	1,017 GWh	1,868 GWh
35-45 m	0.5%	120	596 kW	1,016.9 kW	230,400 h	137 GWh	234 GWh
45+ m	0.3%	72	1345 kW	1,630.9 kW	138,240 h	186 GWh	225 GWh
				Totals:	**46,080,000 h**	**7,031 GWh**	**9,952 GWh**

Commercial vessels from 0-7.5 m are assumed to be using petrol engines, and the others are all assumed to be diesel engines. We can calculate the emissions using the *median* engine sizes.

Table 2: Commercial GHG Emissions (Mt CO2-e) Using Median Engines Sizes

Petrol Engines	Diesel Engines
1,219,000,000 kWh x 70% ÷ 30% x 243 CO_2-e g/kWh	(7,031,000,000 kWh – 1,219,000,000 kWh) x 85% ÷ 40% x 253 CO_2-e g/kWh
691,173 tons of CO_2-e	**3,124,677 tons of CO_2-e**
or 0.7 Mt of CO_2-e	or 3.1 Mt of CO_2-e
Commercial GHG Emissions Annual Total:	**3.8 Mt of CO_2-e**

The same calculation can be done using the *average* engine sizes from AMSA's data.

Table 3: Commercial GHG Emissions (Mt CO2-e) Using Average Engine Sizes

Petrol Engines	Diesel Engines
1,883,000,000 kWh x 70% ÷ 30% x 243 CO_2-e g/kWh	(9,952,000,000 kWh – 1,883,000,000 kWh) x 85% ÷ 40% x 253 CO_2-e g/kWh
1,067,661 tons of CO_2-e	**4,338,096 tons of CO_2-e**
or 1.1 Mt of CO_2-e	or 4.3 Mt of CO_2-e
Commercial GHG Emissions Annual Total:	**5.4 Mt of CO_2-e**

Recreational Vessels

With recreational vessels the duration is assumed to be 1 hour x 52 weeks = 52 hours/year.

Table 4: Recreational Vessel Fleet Numbers

By Size	% of Fleet	# of Vessels	All Engines	Annual Hours	Annual GWh
PWC		95,000	119 kW	4,940,000 h	588 GWh
0-4 m	39.8%	360,190	19 kW	18,729,880 h	356 GWh
4-5 m	32.8%	296,840	45 kW	15,435,680 h	695 GWh
5-6 m	14.4%	130,320	75 kW	6,776,640 h	508 GWh
6-8 m	8.2%	74,210	149 kW	3,858,920 h	575 GWh
8-10 m	1.7%	15,385	224 kW	800,020 h	179 GWh
10+ m	3.1%	28,055	522 kW	1,458,860 h	762 GWh
			Totals:	**52,000,000 h**	**3,663 GWh**

Recreational vessels from 0-8 m and personal watercraft (PWC) are assumed to be using petrol engines, and the others are all assumed to be diesel engines.

Table 5: Recreational GHG Emissions (Mt CO2-e) Using Average Engine Sizes

Petrol Engines	Diesel Engines
2,722,000,000 kWh x 70% ÷ 30% x 243 CO_2-e g/kWh	(3,663,000,000 kWh – 2,722,000,000 kWh) x 85% ÷ 40% x 253 CO_2-e g/kWh
1,543,374 tons of CO_2-e	**505,905 tons of CO_2-e**
or 1.5 Mt of CO_2-e	or 0.5 Mt of CO_2-e
Recreational GHG Emissions Annual Total:	**2 Mt of CO_2-e**

Conclusion

Australia's Paris Agreement inventory emissions from fuel use in domestic maritime is currently recorded as around **2 Megatons** of CO_2-equivalent gaseous emissions[5].

Using bottom-up analysis from industry bodies like the Australian Maritime Safety Authority (AMSA), the Boating Industry Association (BIA), and the International Council of Marine Industry Associations (ICOMIA) we have shown how the greenhouse gas emissions can be assessed for both domestic commercial and recreational vessels.

Table 6: Summary of Results

Declared	Likely	Possible
1 Mt from Commercial	3.8 Mt from Commercial	5.4 Mt from Commercial
1 Mt from Recreational	2 Mt from Recreational	2 Mt from Recreational
2 Mt Total	**5.8 Mt Total**	**7.4 Mt Total**

The analysis we have performed in this document shows that in fact Australia's Paris Agreement inventory emissions from fuel use in domestic maritime is likely to be much higher. It is likely to be at least **6 Megatons** of CO_2-equivalent gaseous emissions but could be as high as **7.4 Megatons** of CO_2-equivalent gaseous emissions.

[5] https://greenhouseaccounts.climatechange.gov.au/

About the Maritime Emissions Reduction Coalition

The Maritime Emissions Reduction Coalition (MERC) is a program initiated by Maritime Impulse Pty Ltd, a firm dedicated to advancing maritime sustainability. MERC exists to accelerate the reduction of Australia's maritime greenhouse gas (GHG) emissions.

We are uniting leading organisations in the maritime, manufacturing, government, and education sectors to drive emissions reduction in the Australian maritime industry for a greener, more sustainable future.

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