Exhaust Emissions from Ship Engines in Australian Waters Including Ports - Focus on NSW Ports

Laurie Goldsworthy* and Brett Goldsworthy**

*Honorary Research Fellow
National Centre for Maritime Engineering and Hydrodynamics
Australian Maritime College
University of Tasmania

** PhD student
National Centre for Ports and Shipping
Australian Maritime College
University of Tasmania

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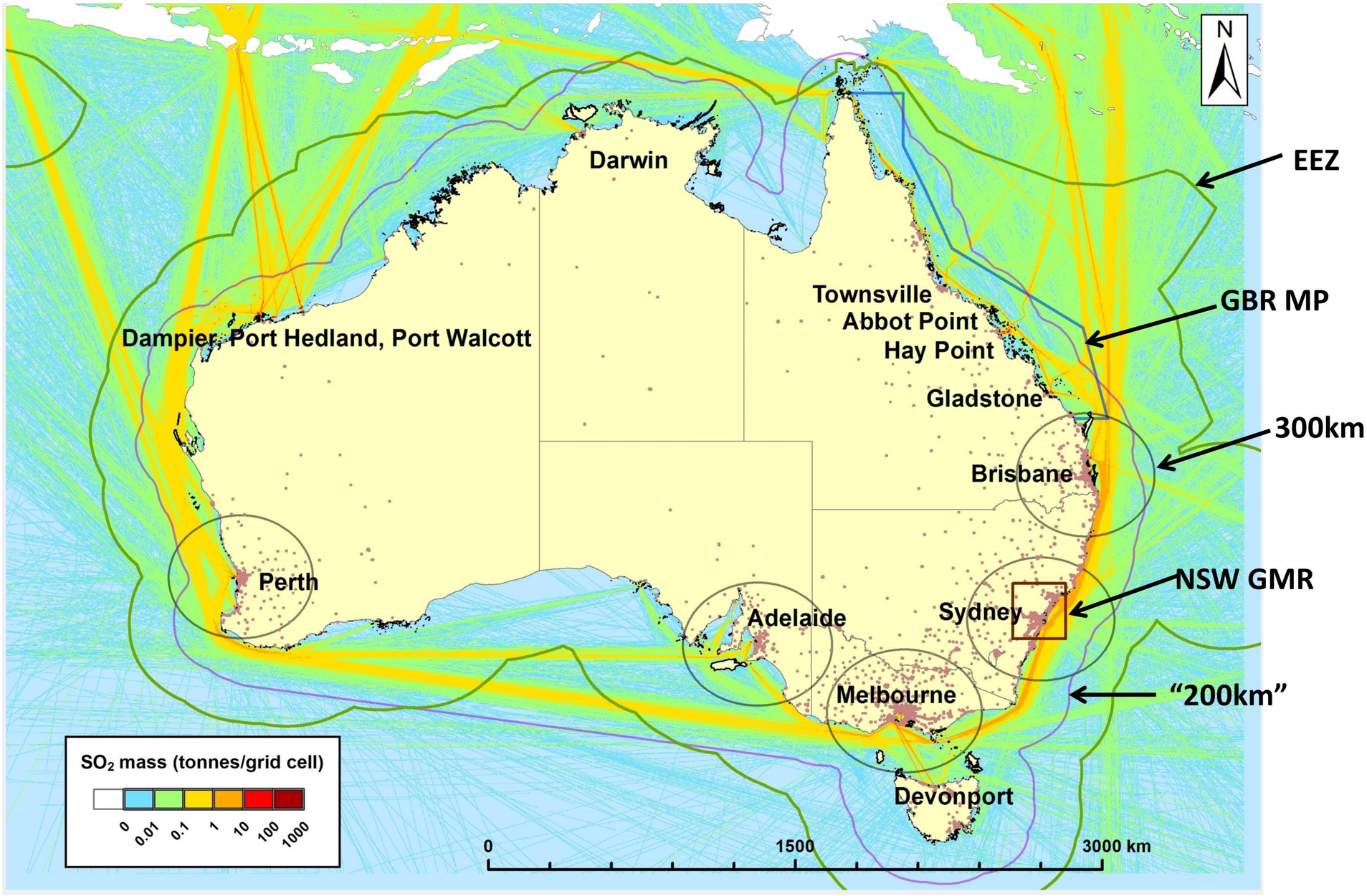
Image: www.trustedluxurycruises.com

Overview

- Ships are primarily propelled by large diesel engines
- Smaller engines are used to generate electricity
- Auxiliary boilers are used for heating tasks
- Almost all fuel used in ocean going vessels in Australia is based on the residue from the crude oil refining process (RO)
- RO has high sulfur content – global average around 2.6% by mass - increased fine particle emissions
- Terrestrial air emission controls outpacing controls on ship emissions – reducing shipping's contribution may be relatively cost effective
- EEZ 200nm (370km) – US/Canadian ECA



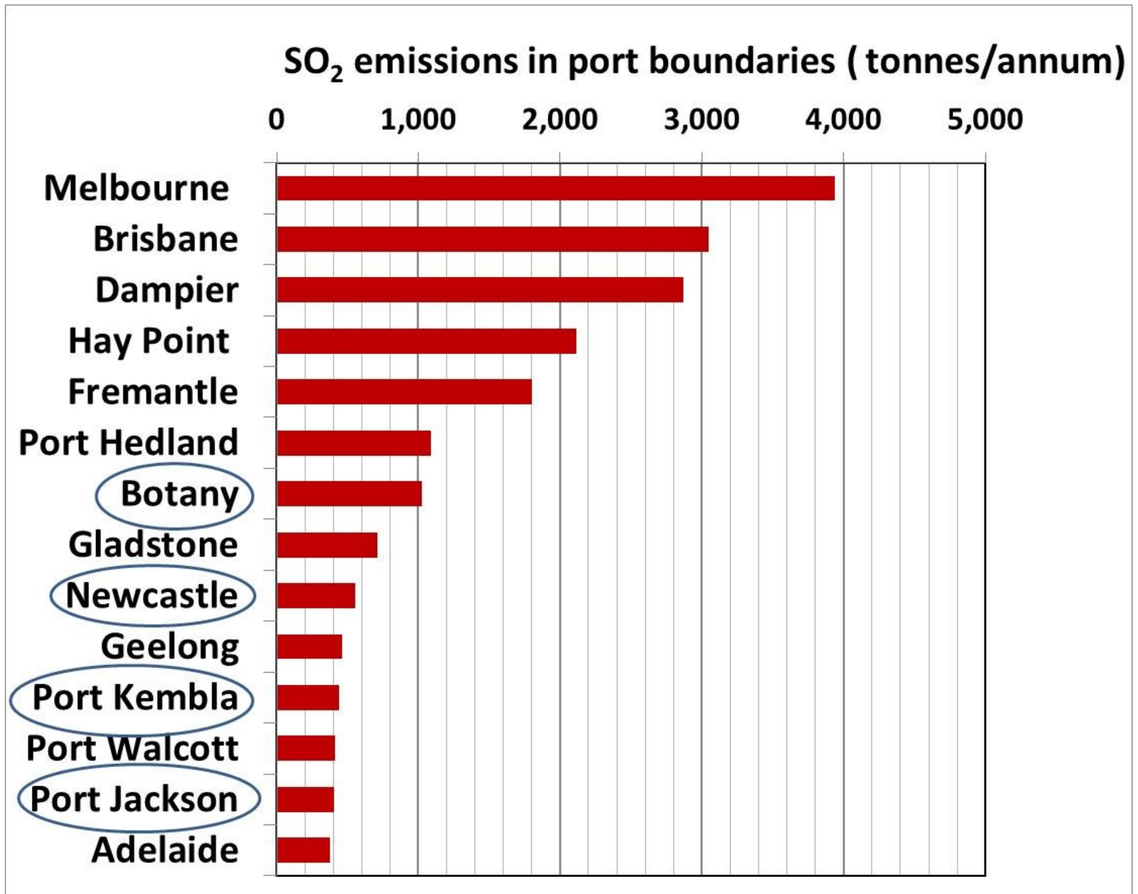
Modelled SO_2 emissions from ships around Australia in 2010/11 (total emissions in each 2km x 2km grid cell over 1 year)

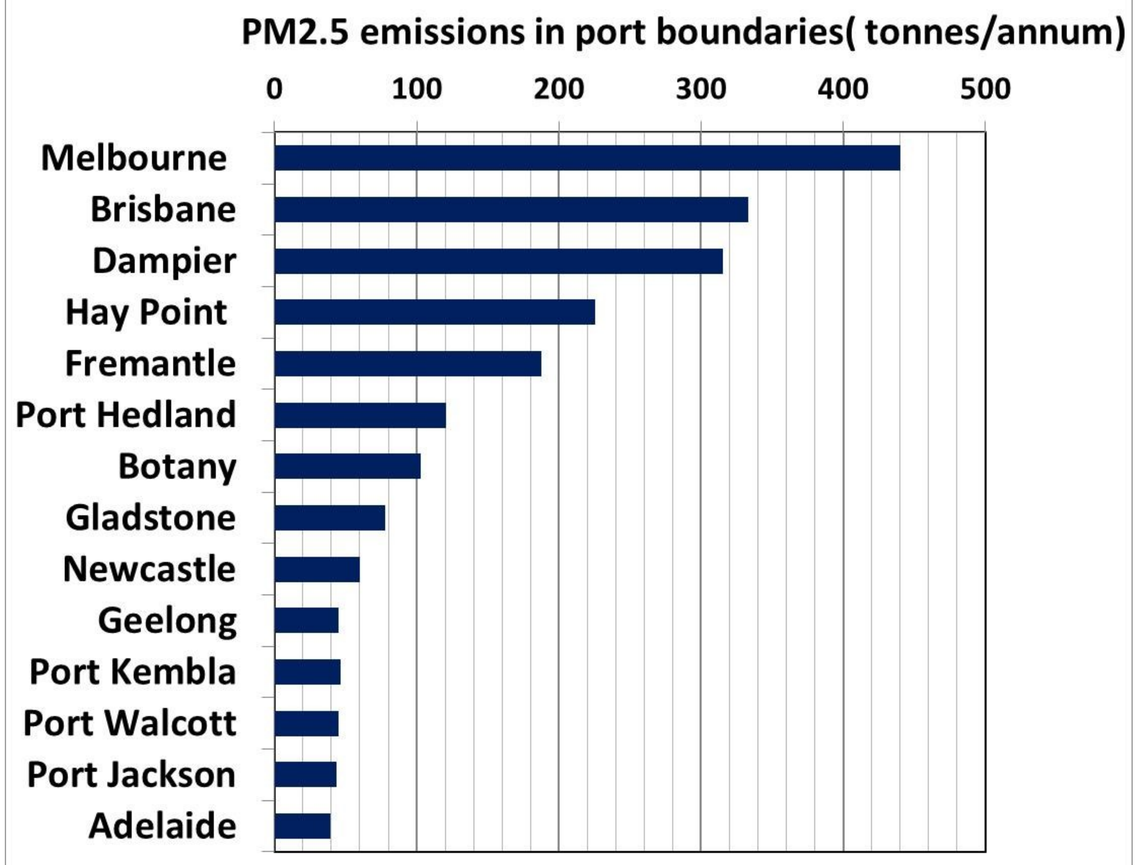
Laurie Goldsworthy and Brett Goldsworthy, *Modelling of ship engine exhaust emissions in ports and extensive coastal waters based on terrestrial AIS data - an Australian case study*, Environmental Modelling & Software, 63 (2015) 45-60

Populated regions shown in pink

Emissions by Port

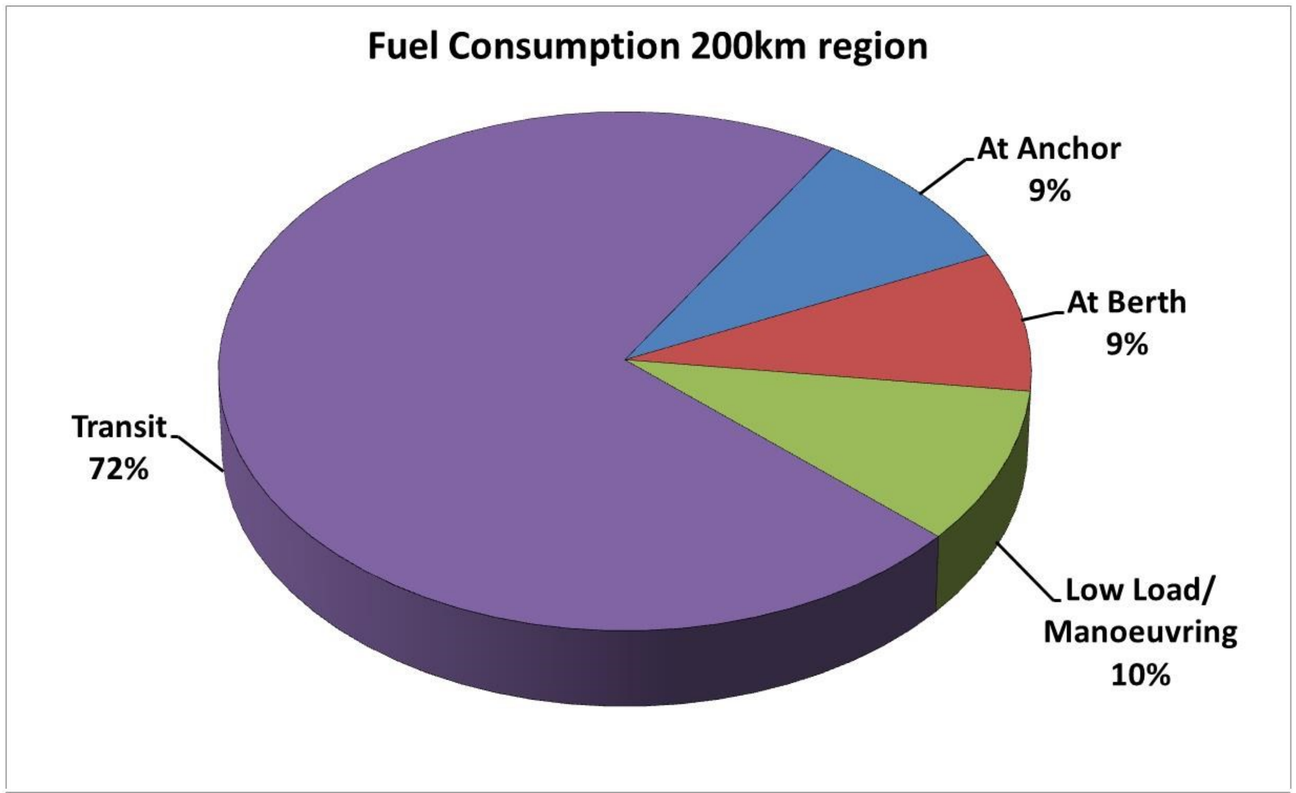
- Evaluated 34 ports covering 99% of total Australian cargo throughput, 2010/11
- Top 14 ports shown at right
- Figures include emissions in all operating modes within port legal boundaries (transit, low-load/manoeuvring, anchored, berthed)
- Emissions calculated at fine spatial and temporal resolution (Automatic Identification System)
- All ports modelled using a consistent methodology
- Estimated overall confidence range about ±30%, individual components may be less certain
- Port boundaries may or may not encompass significant transit distances - Melbourne and Brisbane port boundaries include long transits –Newcastle, Botany and Port Kembla have limited transits within their boundaries
- Emissions from outside port boundaries including ships approaching the port and from anchorage areas may have a significant impact.
- Of the major bulk ports the port boundaries of Dampier and Hay Point include the main anchorage areas, while those of Port Hedland, Gladstone, Newcastle and Port Kembla do not
- USEPA recommends ship emissions for a port be evaluated out to 25nm (46km)

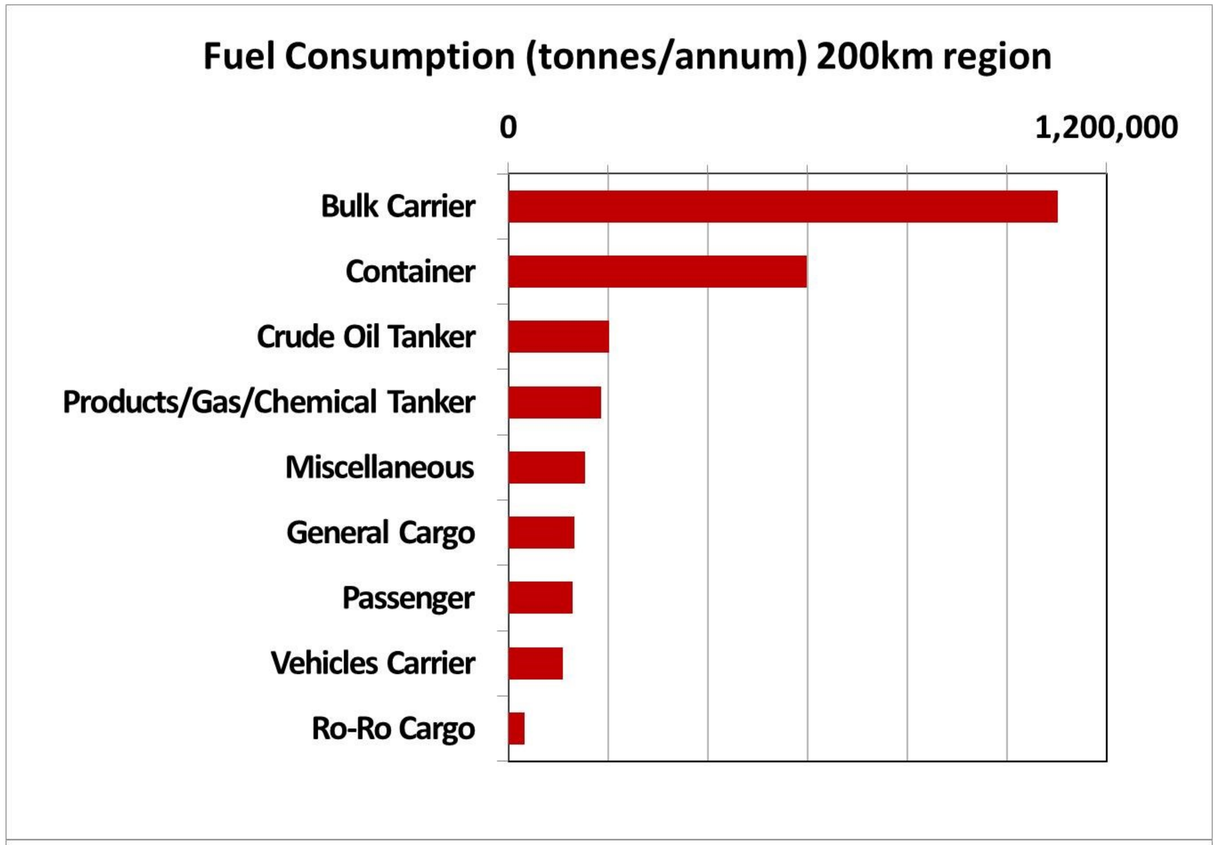


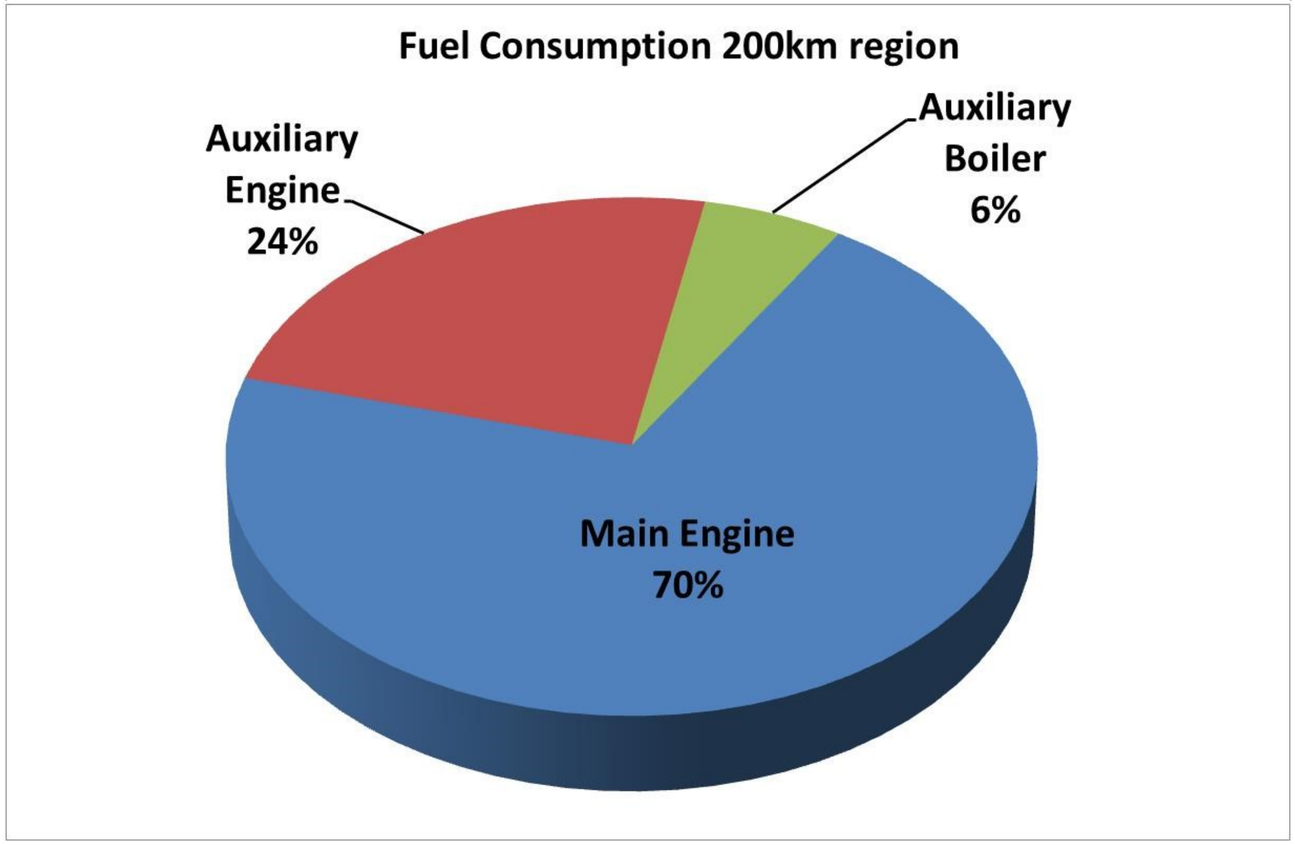


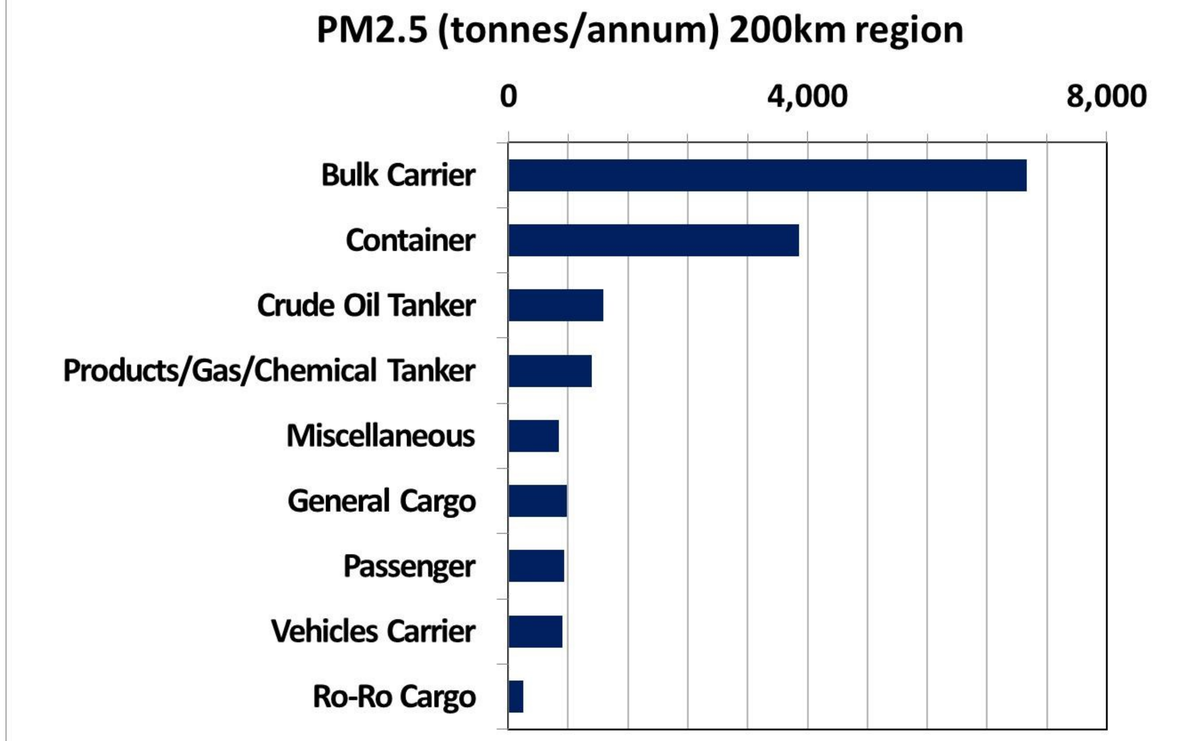
Australia Wide

Bulk carriers dominate,
anchorage times at bulk ports significant

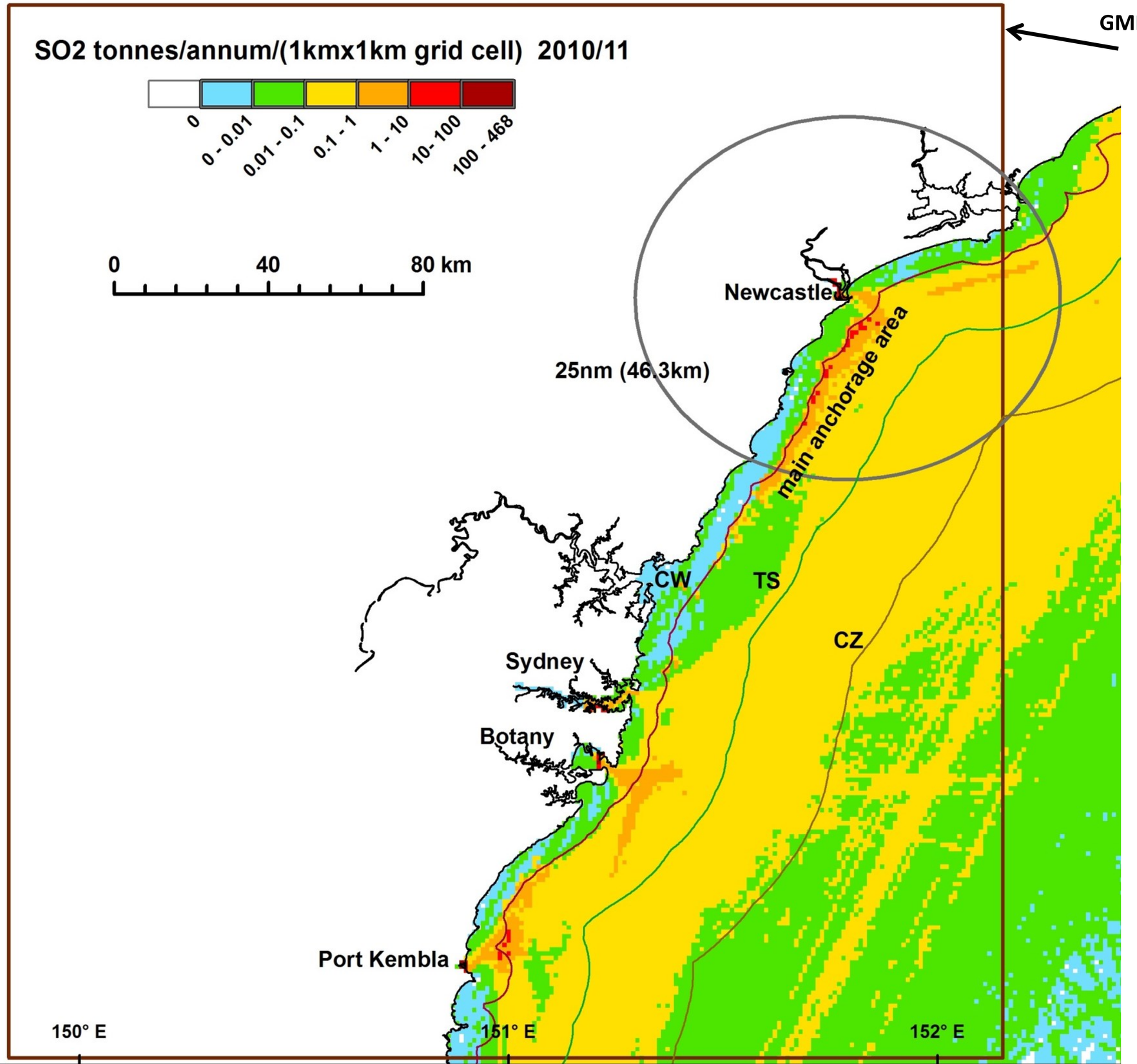








NSW Greater Metropolitan Region



The anchorage areas off the coast are apparent for Newcastle and Port Kembla - the anchorage areas lie outside the port boundaries.

USEPA recommends ship emissions for a port be evaluated out to 25nm

CW – Coastal Waters, 3nm, State jurisdiction

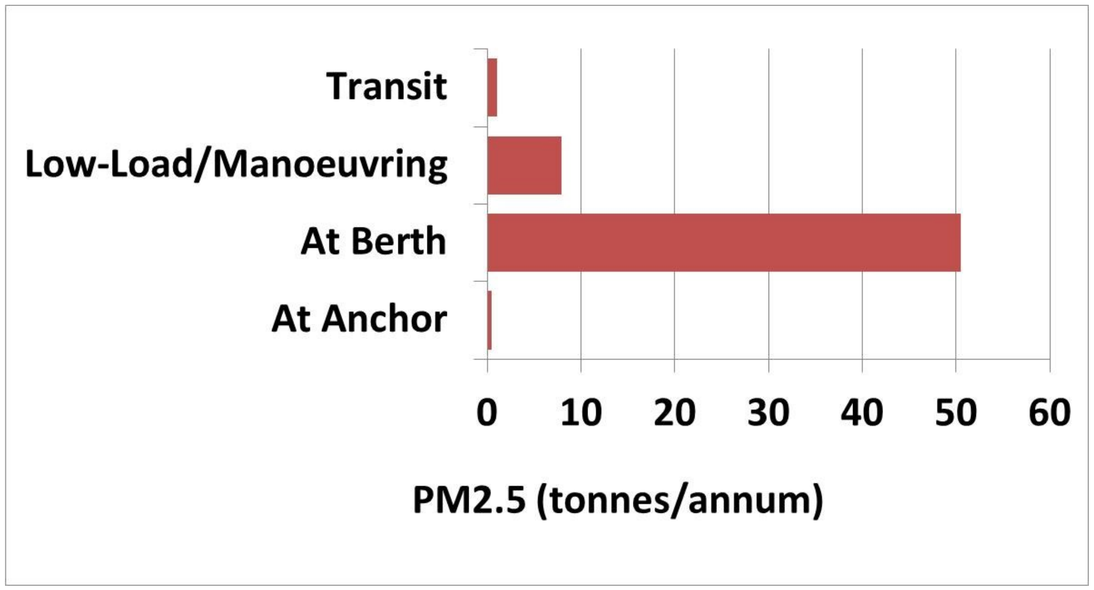
TS – Territorial Seas, 12nm, Australia's sovereign territory

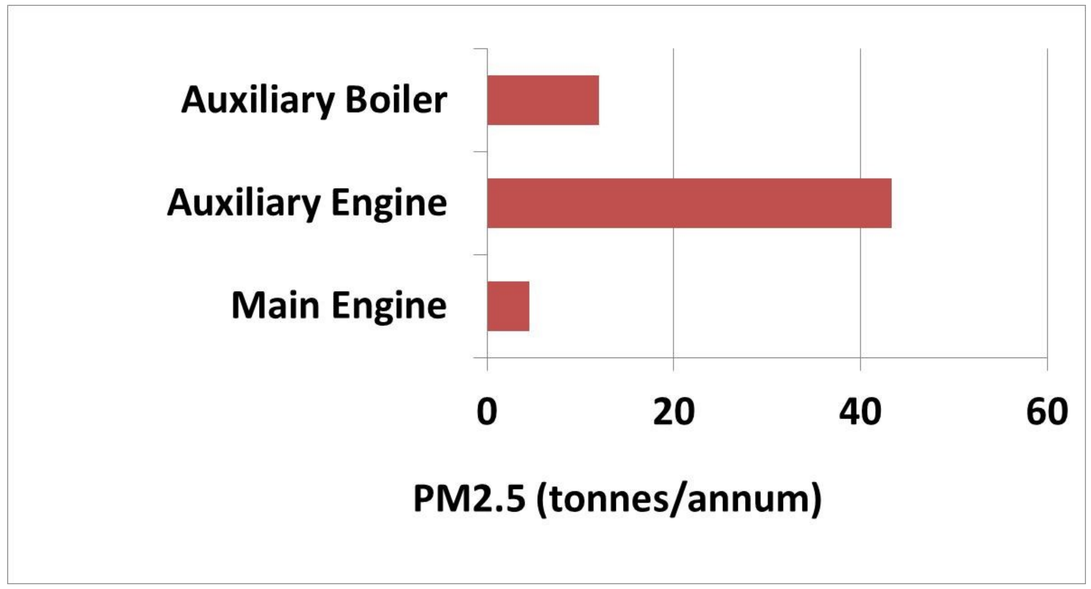
CZ – Contiguous Zone, TS +12nm, customs, etc

12nm = 22km
3nm = 5.6km

Newcastle

Fine particle (PM2.5) emissions 2010/11 in Newcastle port boundaries

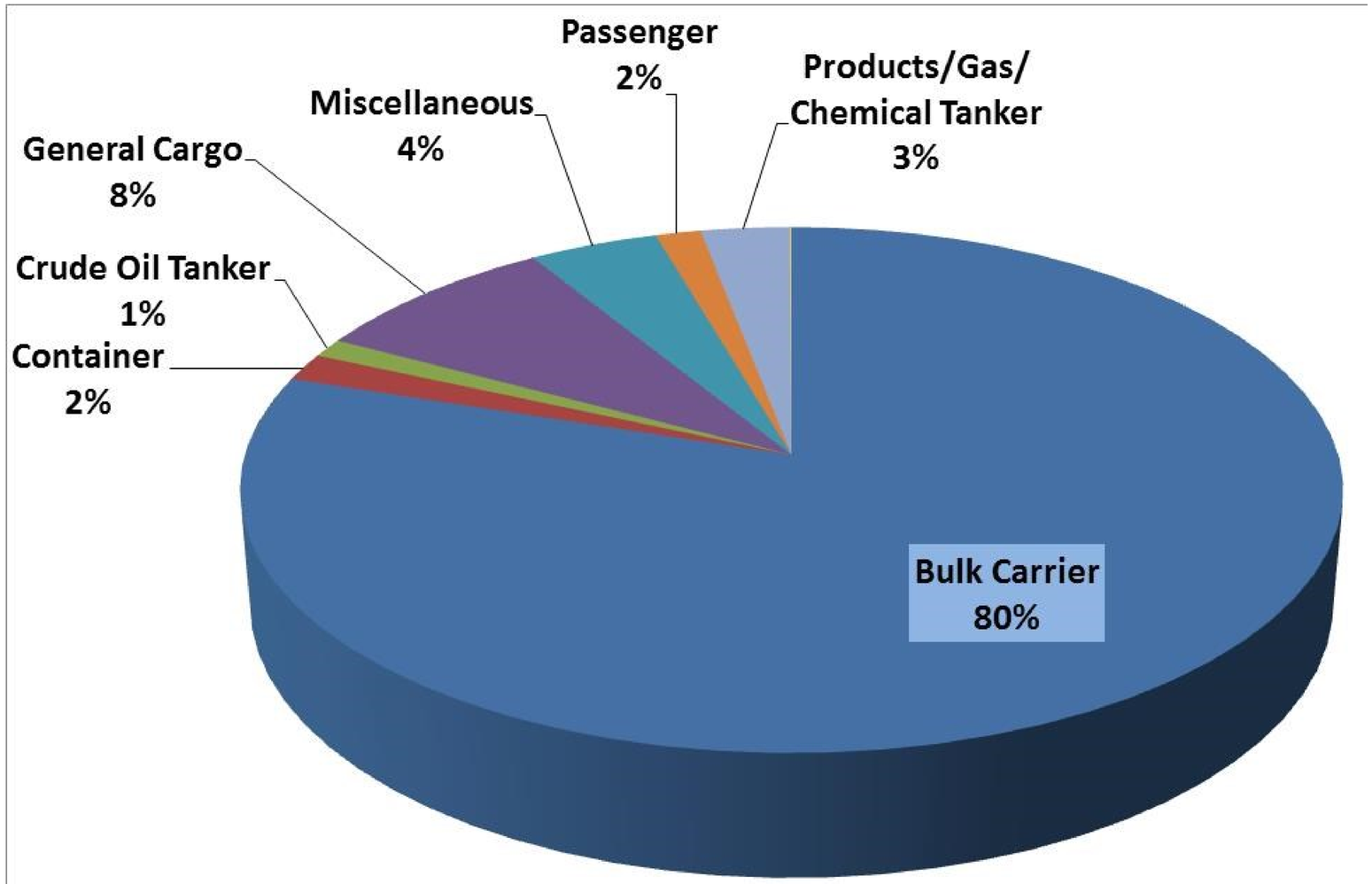




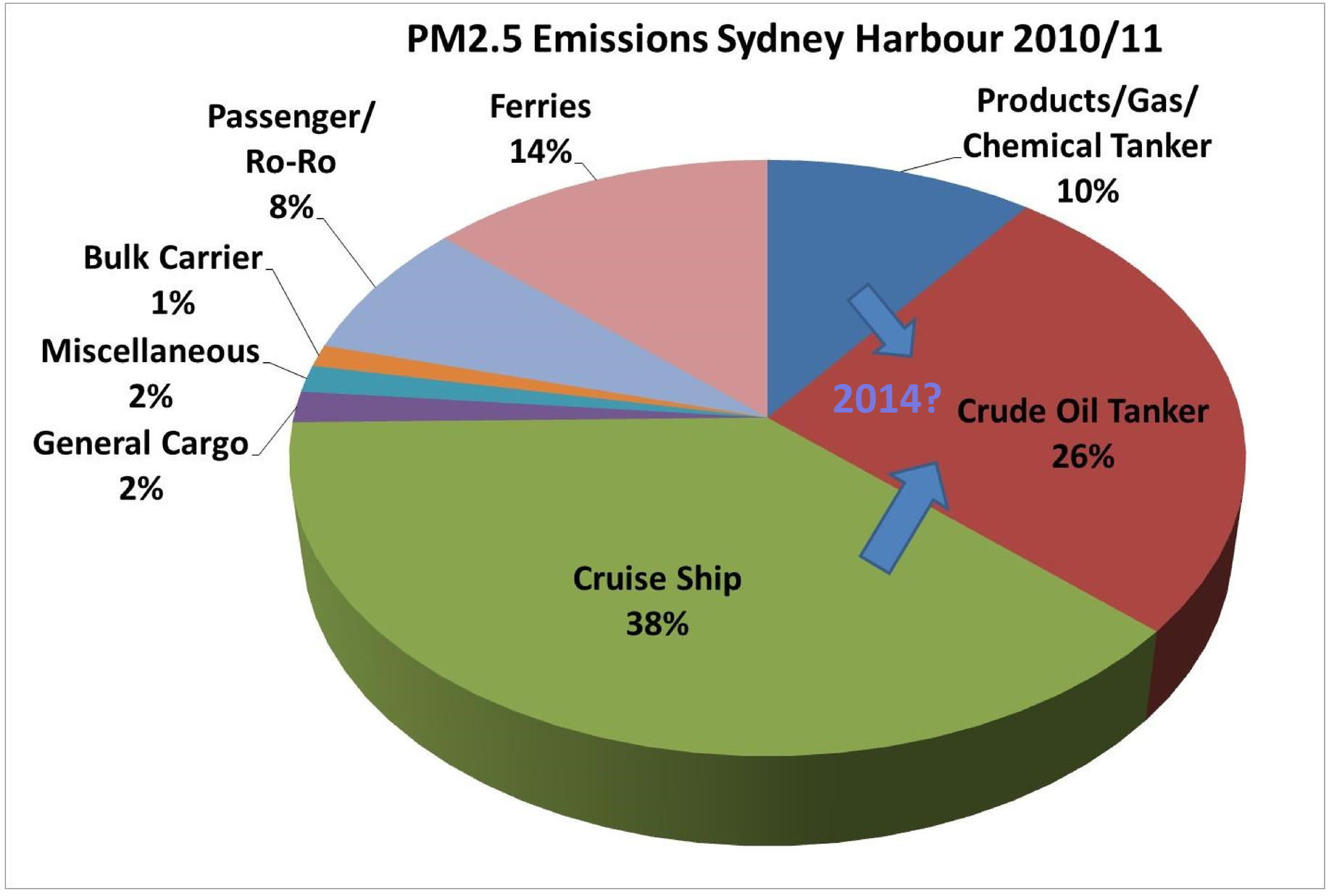
Emissions dominated by Bulk Carriers and at berth

For Newcastle, emissions in anchorage and harbour entry areas are double the emissions in the port boundaries by 2012/13

- **approx 30% increase in bulk exports**
- **approx doubling of imports of oil and petroleum**
- **Recent Virtual Traffic Arrival System potentially moderating anchorage and transit emissions**
- **Average age of vessels has reduced which will moderate fuel consumption and emissions**



Sydney Harbour

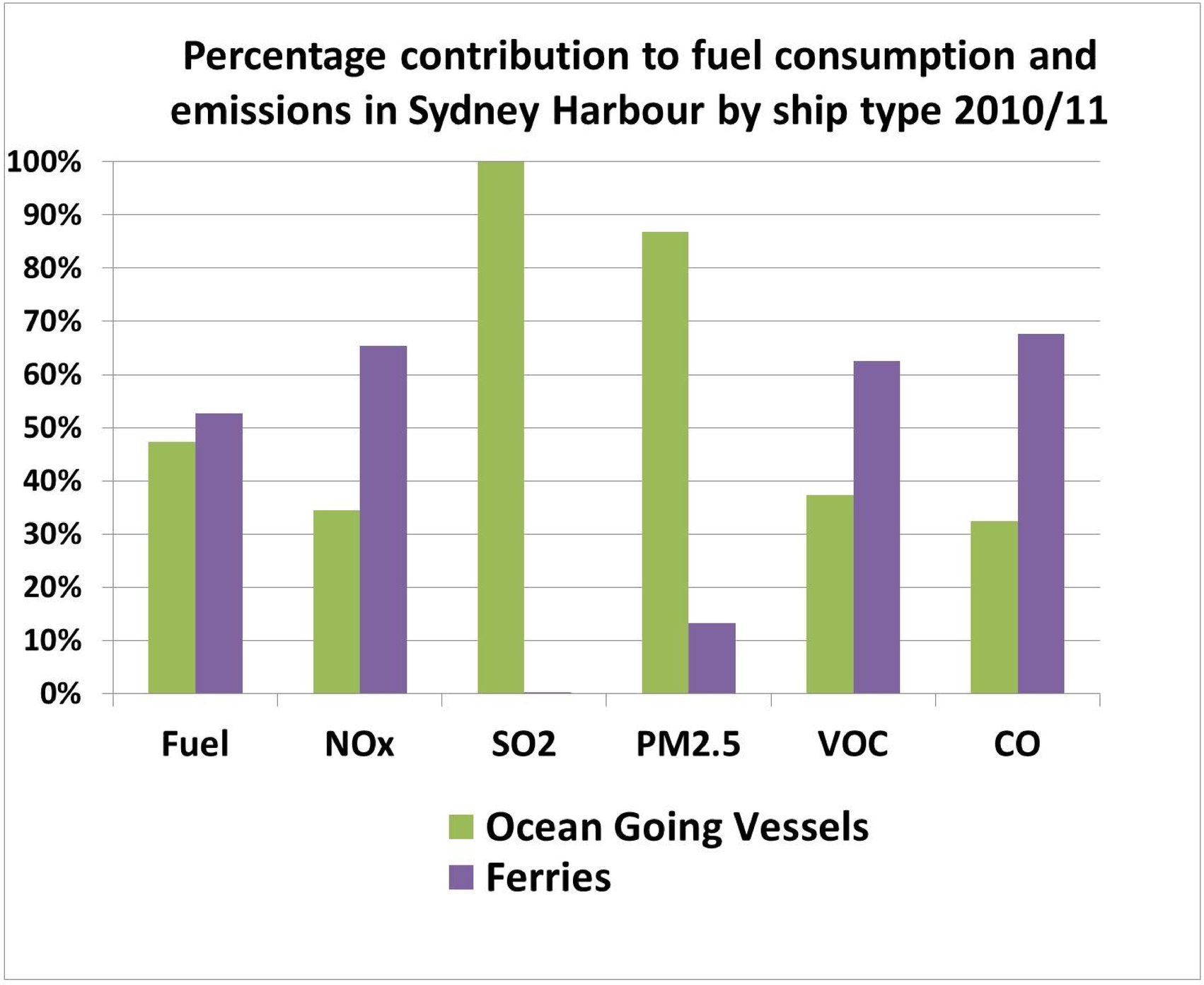


Ship fine particle emissions (PM2.5) dominated in 2010/11 by Cruise Ships and Tankers

Since 2010/11, Crude Oil tankers no longer visit Gore Bay, Cruise ship numbers have increased by 72% and the White Bay Cruise ship terminal has replaced the Darling Harbour terminal

– net result may be a change in totals, along with important local effects due to different locations of emissions sources

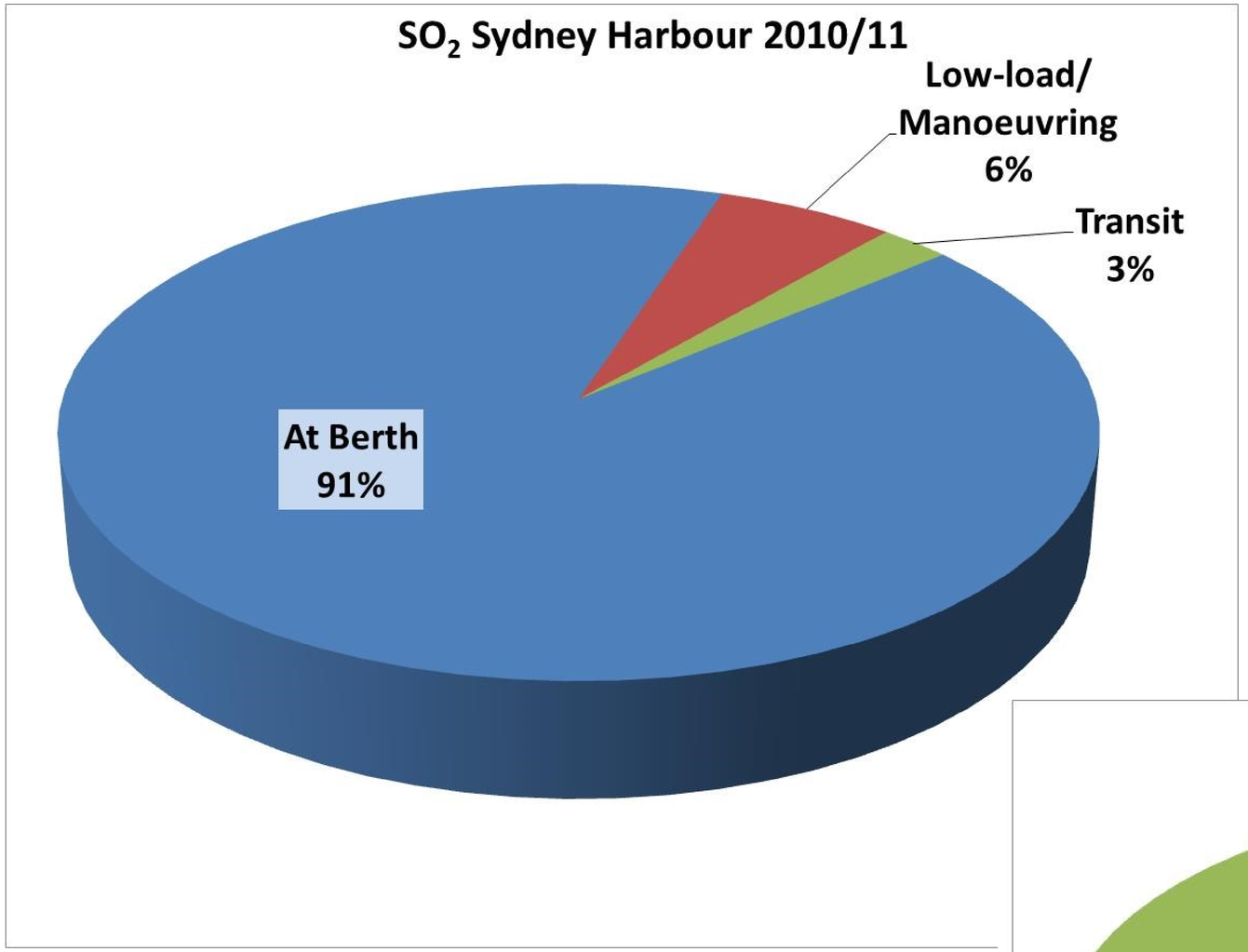
Sydney Harbour Fuel Consumption and Emissions – Ferries and Ocean Going Vessels



Ferries produce relatively little SO_2 and PM2.5 because they operate on Ultra Low Sulfur Diesel (ULSD)

Ferries' percentage contribution to NOx, VOC and CO is higher than indicated by fuel consumption because other vessel types consume some of their fuel in boilers which produce less NOx, VOC and CO per tonne of fuel compared with diesel engines

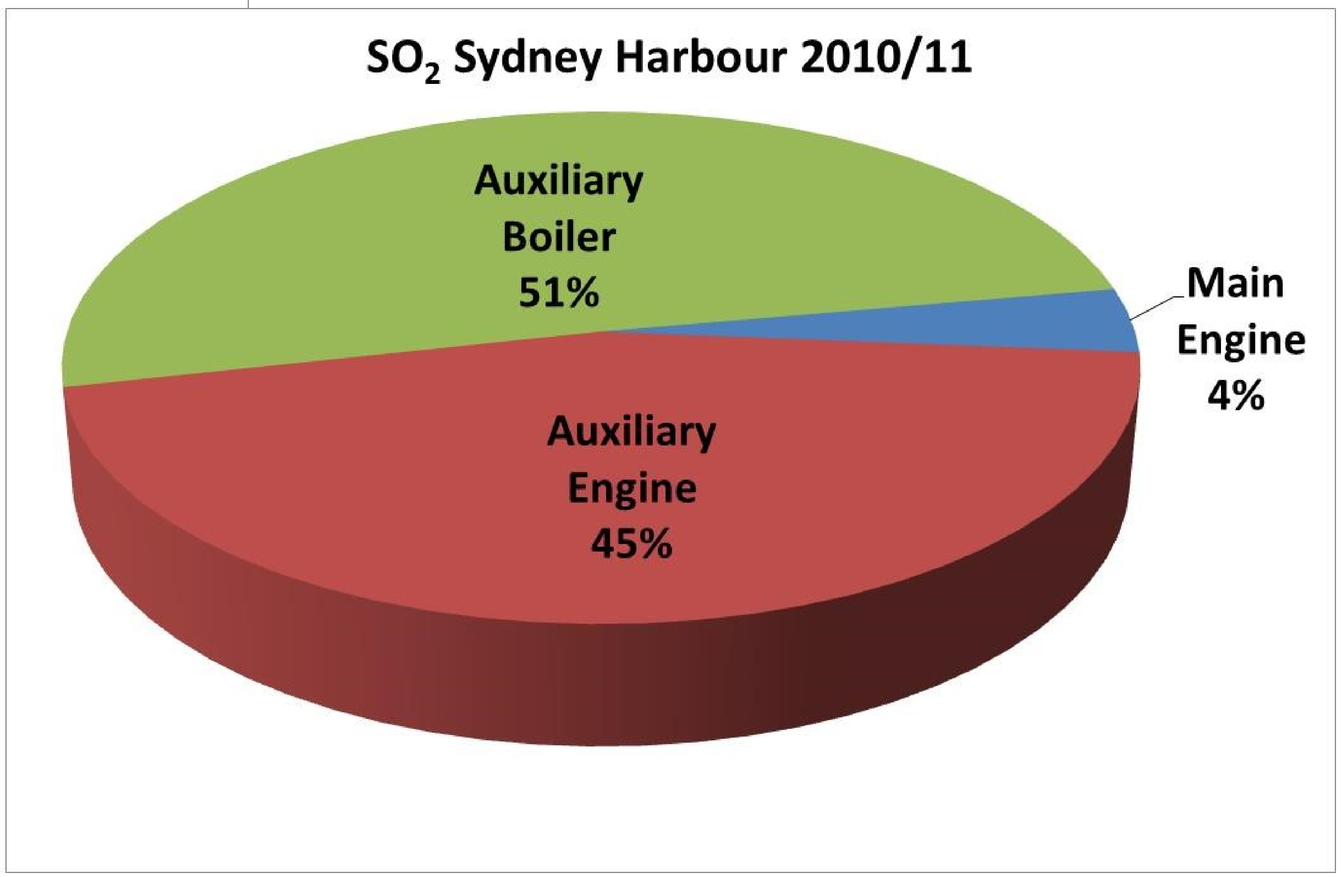
Sydney Harbour Ocean Going Vessels



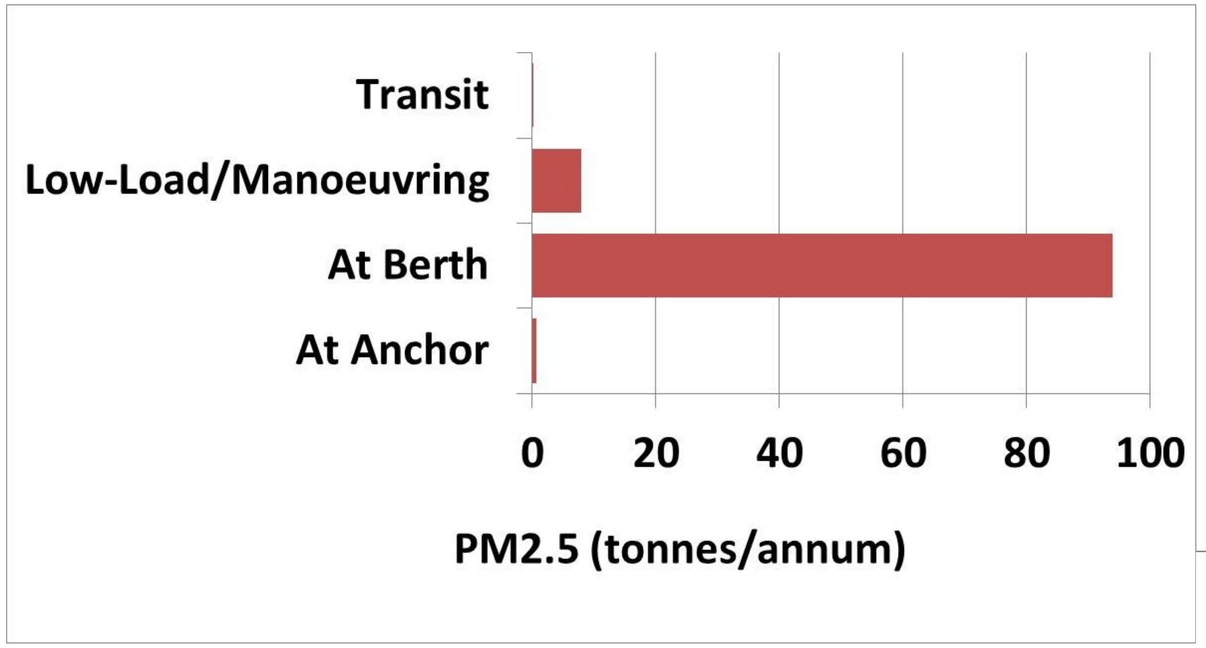
Showing SO_2 to effectively remove ferries

Almost all emissions at berth, from auxiliary engines and auxiliary boilers

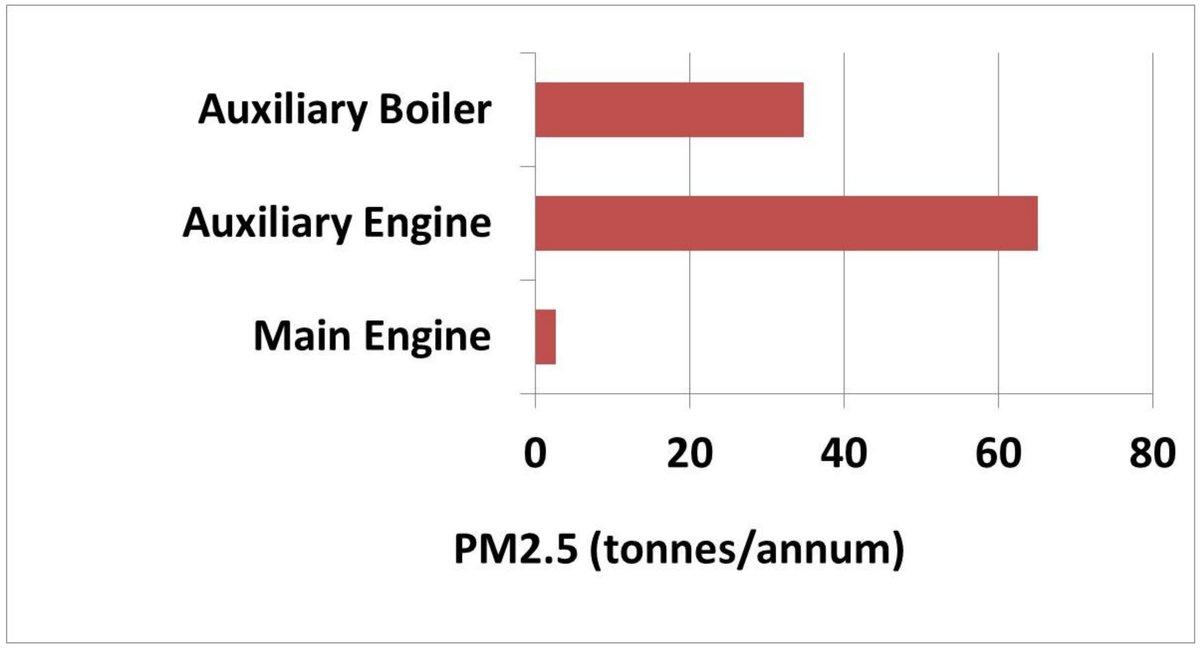
Auxiliary boiler percentage will probably reduce in absence of crude oil tankers

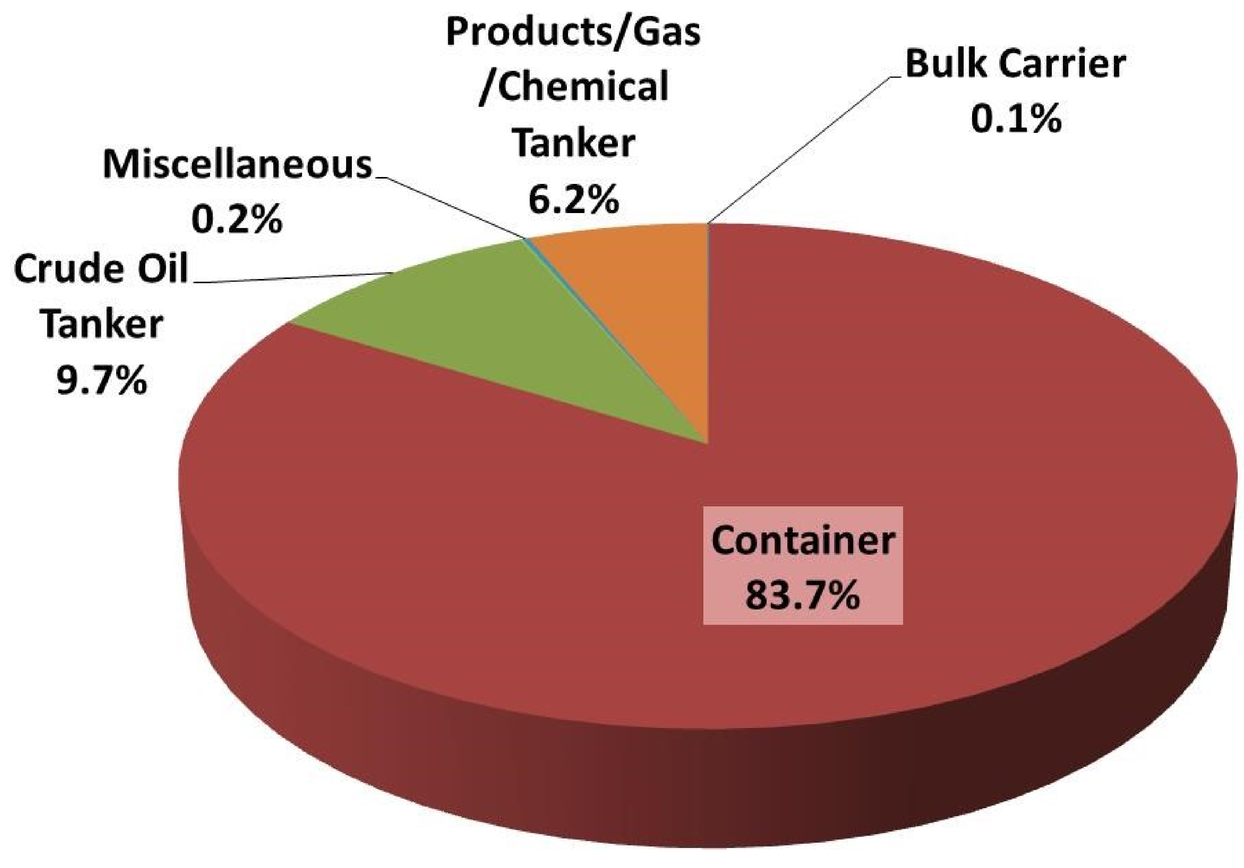


Port Botany



Fine particle (PM2.5) emissions 2010/11 in Port Botany port boundaries



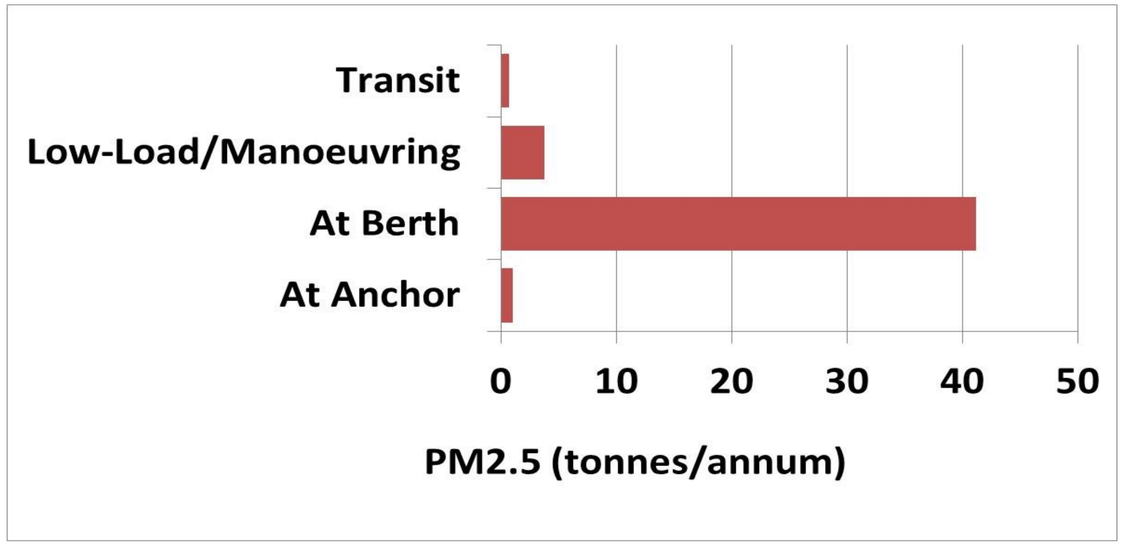


Emissions dominated by Container ships at berth

No more crude oil imports to Kurnell Refinery – auxiliary boiler proportion of emissions likely to reduce

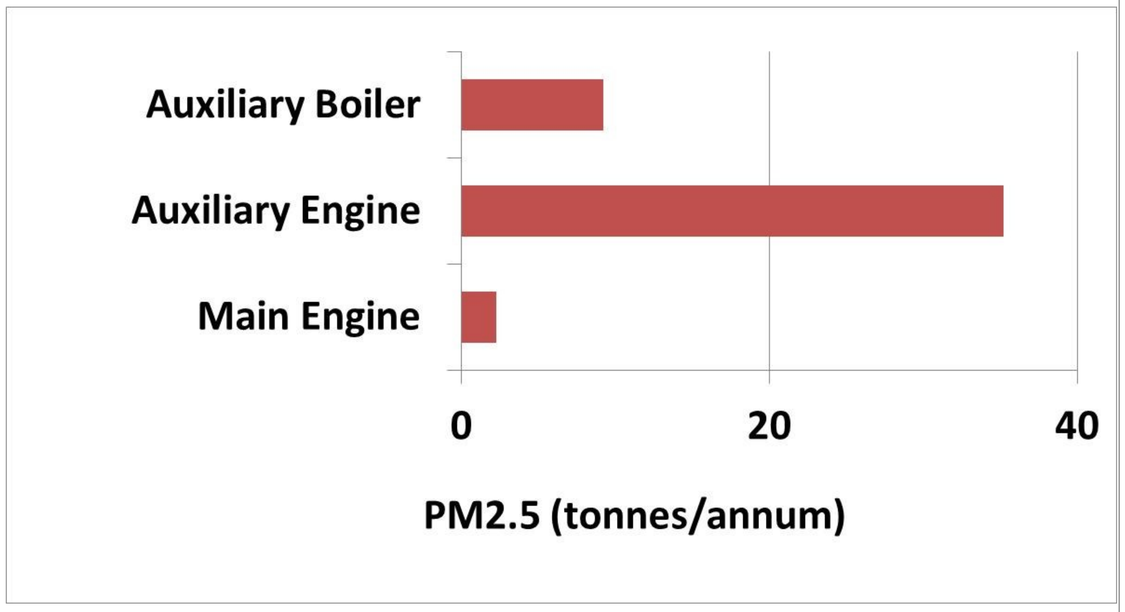
Port Kembla

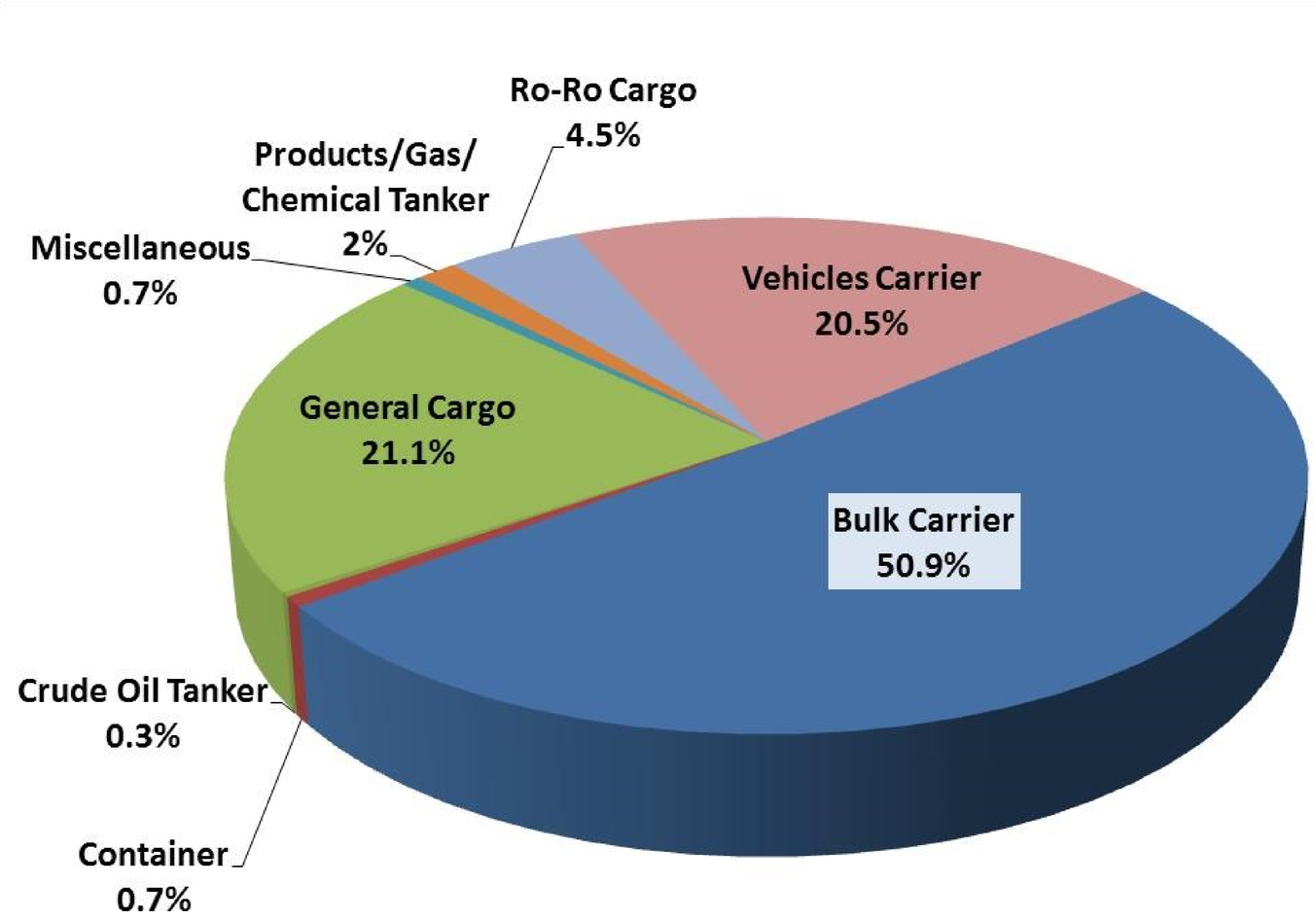
Fine particle (PM2.5) emissions 2010/11 in Port Kembla port boundaries



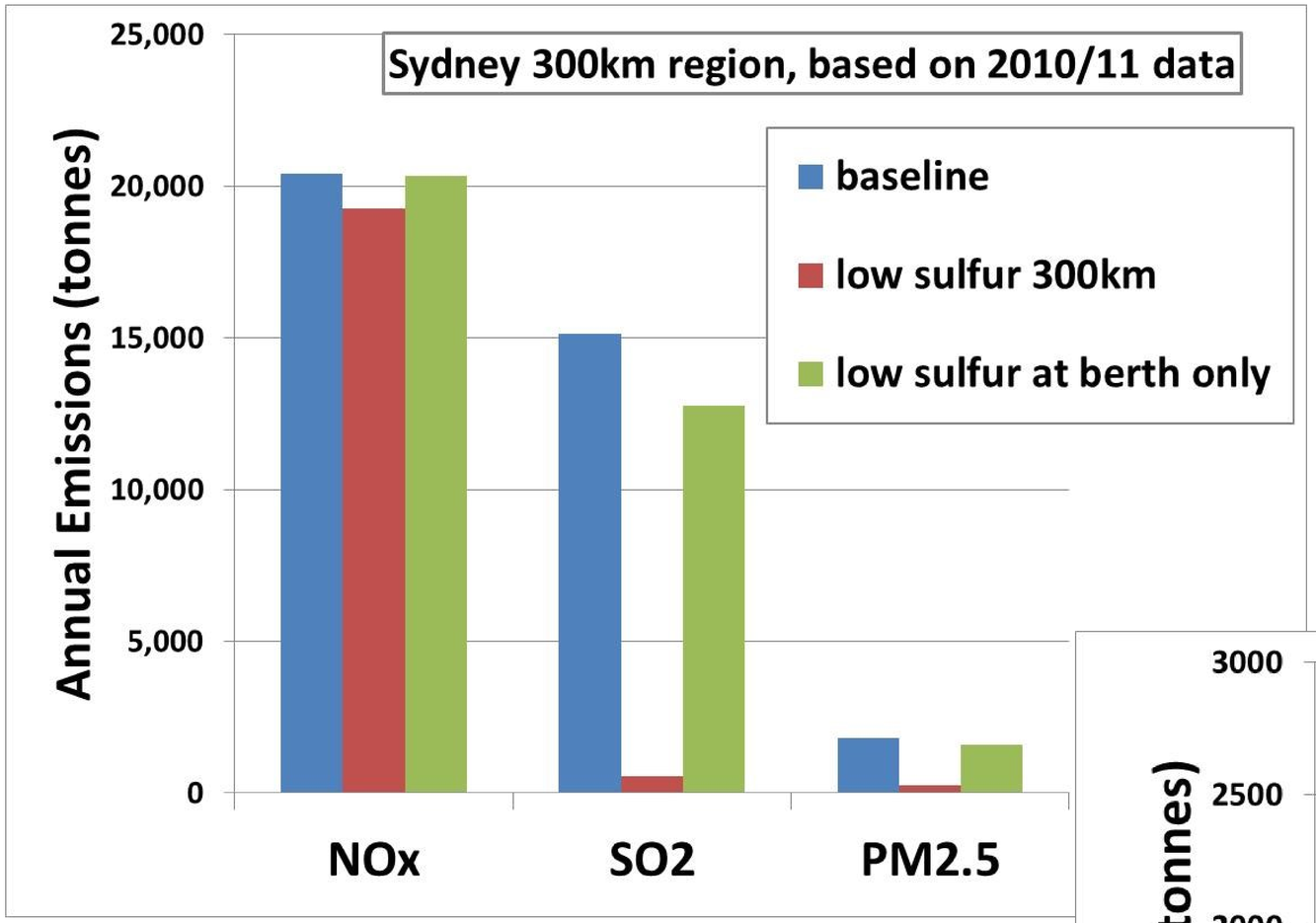
Most anchorage associated with Port Kembla is outside port boundaries

by 2012/13
- Little change in bulk exports
- General cargo reduced by factor of 4 approx



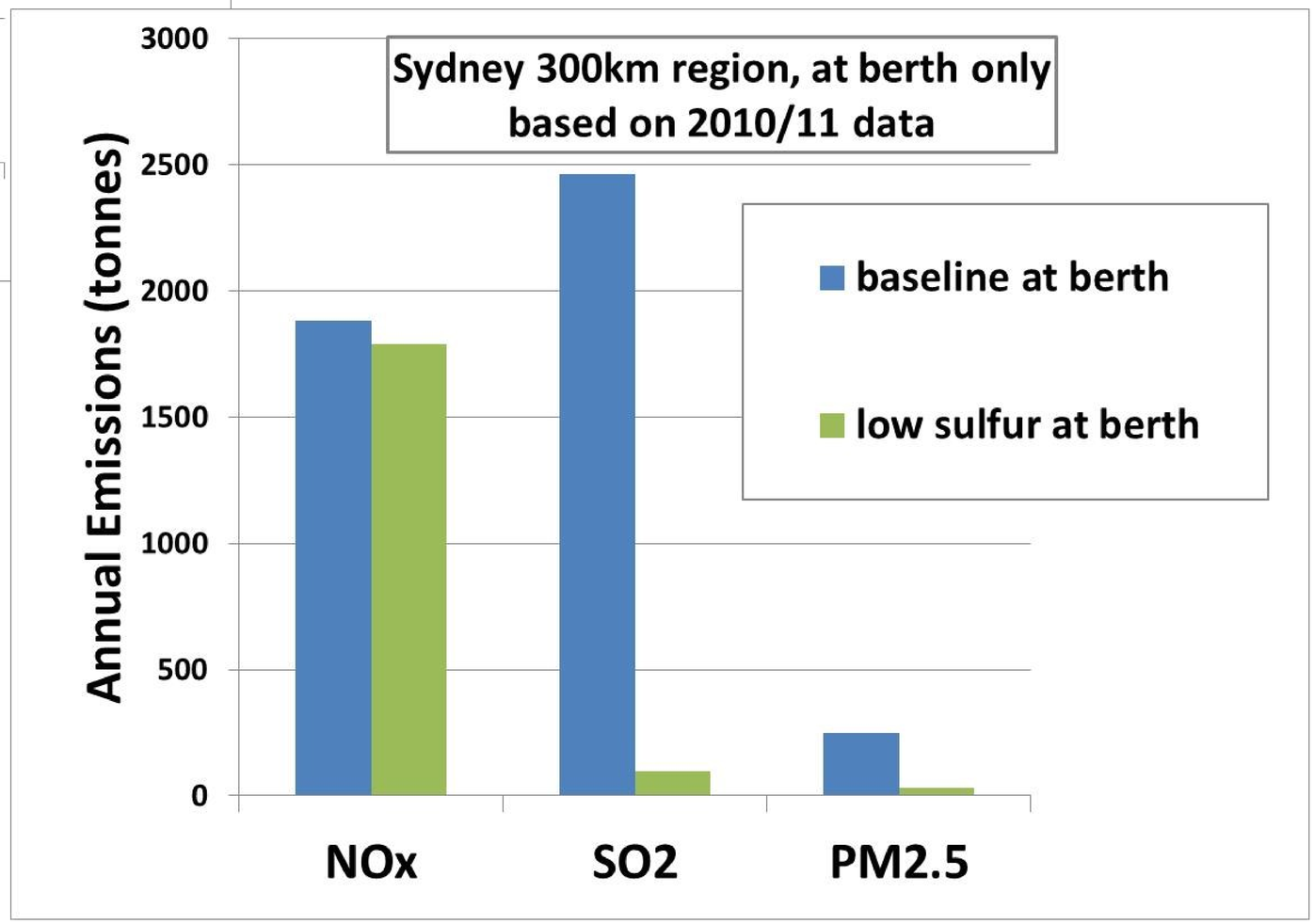


Low Sulfur Fuel (0.1%), within 300km radius of Sydney



300km region includes Newcastle, Sydney Harbour, Port Botany and Port Kembla

Movement of ship emissions through the atmosphere - what distance is important? (US/Canadian Emission Control Area extends out to 370km)



Most in-harbour emissions are at berth

Substantial NOx reduction at berth could be achieved with extensive use of shore power

(PM2.5 mass includes the water associated with the sulfate)

Concluding Remarks

Accurate inventories are a basis for good planning

Need resources to regularly update inventories

Our methodology:

- can quantify all Australian ports with a consistent approach

- can be used for analysis of emissions control scenarios in ports and on the coast

- is complementary to the NSW EPA methodology for ship emissions inventories

Local authorities, ports and ship operators can provide valuable data for improving the accuracy of inventories

Thank You

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