PATHWAYS TO NET ZERO

FOR THE SPENCER GULF AND WEST COAST PRAWN ASSOCIATION

THIS GUIDE IS GENEROUSLY SUPPORTED BY GREEN INDUSTRIES SA

Government of South Australia
Green Industries SA

SPENCER GULF & WEST COAST
Prawn Association Inc.

Harvesting with care in South Australia

Acknowledgement of Country

We acknowledge and respect the Traditional Custodians whose ancestral lands and seas we live and work upon and we pay our respects to their Elders past, present and emerging. We acknowledge and respect their deep spiritual connection and the relationship that Aboriginal and Torres Strait Islanders people have to Country. We extend our respect to all Aboriginal and Torres Strait Islander people and their nations in South Australia and across Australia.

Illustration by Brittany March, hello@brittanymarch.com.au

FOREWORD

Across Australia and the world, there is significant attention on pathways to net-zero carbon. Throughout our history, the Spencer Gulf and West Coast Prawn Association has always been forward-thinking and innovative, ensuring that we harvest with care. This ongoing progressive thinking initiated this project in early 2021, aiming first to understand our carbon footprint and then explore opportunities to reduce it. With the support and research assistance of our partners at 2XE and Green Industries SA, our team has advanced this project from its infancy to the detailed guide you are reading today.

For members of the association, this guide presents a unique opportunity. During its creation, the team collaborated with several members to understand our daily business practices and how our carbon footprint is generated. This guide is designed to support you in adopting more sustainable practices, unlocking cost-saving opportunities through resource optimisation, and integrating these practices into our business-as-usual operations.

Our goals have always been to provide premium, sustainable, wild-caught seafood harvested with care. As you explore this guide, remember that progress towards sustainability is a journey, not an overnight transformation. As your industry association, we are here to support you on this journey.

Enjoy the guide and this pathway to net zero.

Tim Ferrell
Executive Officer
Spencer Gulf and West Coast Prawn Association Incorporated

I am pleased to introduce you to the Spencer Gulf and West Coast Prawn Association's *Pathways to Net Zero* guide.

This guide, made possible through funding from the South Australian Government via Green Industries SA's Lead-Educate-Assist-Promote (LEAP) Grants program, underscores South Australia's commitment to advancing a resource-efficient, sustainable, and circular economy for the state.

Industry associations, such as the Spencer Gulf and West Coast Prawn Association, play a pivotal role as agents of change, and can drive meaningful transformation within their sectors. They possess a unique ability to amplify industry voices, foster collaboration, and unite stakeholders towards common objectives.

This guide services members of the Spencer Gulf and West Coast Prawn Association, providing practical steps, recommended actions and case studies specific to the industry to improve sustainability and economic outcomes, ultimately helping South Australia move towards its goal of achieving net zero.

South Australia has a proud history of environmental stewardship. Our fisheries are also recognised globally and have a reputation for leading the way with fisheries management – so it is fitting that this guide will support the prawn industry to maintain and build on this leadership.

Congratulations to the Spencer Gulf and West Coast Prawn Association. I commend their commitment and contribution to a sustainable South Australia.

Hon. Susan Close MP
Deputy Premier of South Australia
Minister for Climate, Environment and Water

CONTENTS

WELCOME TO THE GUIDE

The Spencer Gulf and West Coast Prawn Association (the association) engaged Adelaide-based net zero experts, 2XE, to develop this guide with the support of Green Industries SA. If you are a licence holder and are interested in sustainability and greenhouse gas emissions, then this guide is for you.

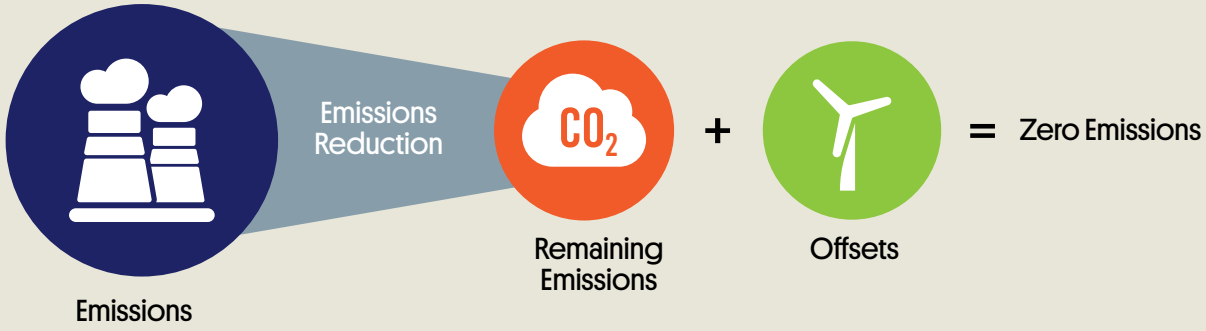
SECTION 1

OVERVIEW

WHAT DOES NET ZERO EMISSIONS MEAN?

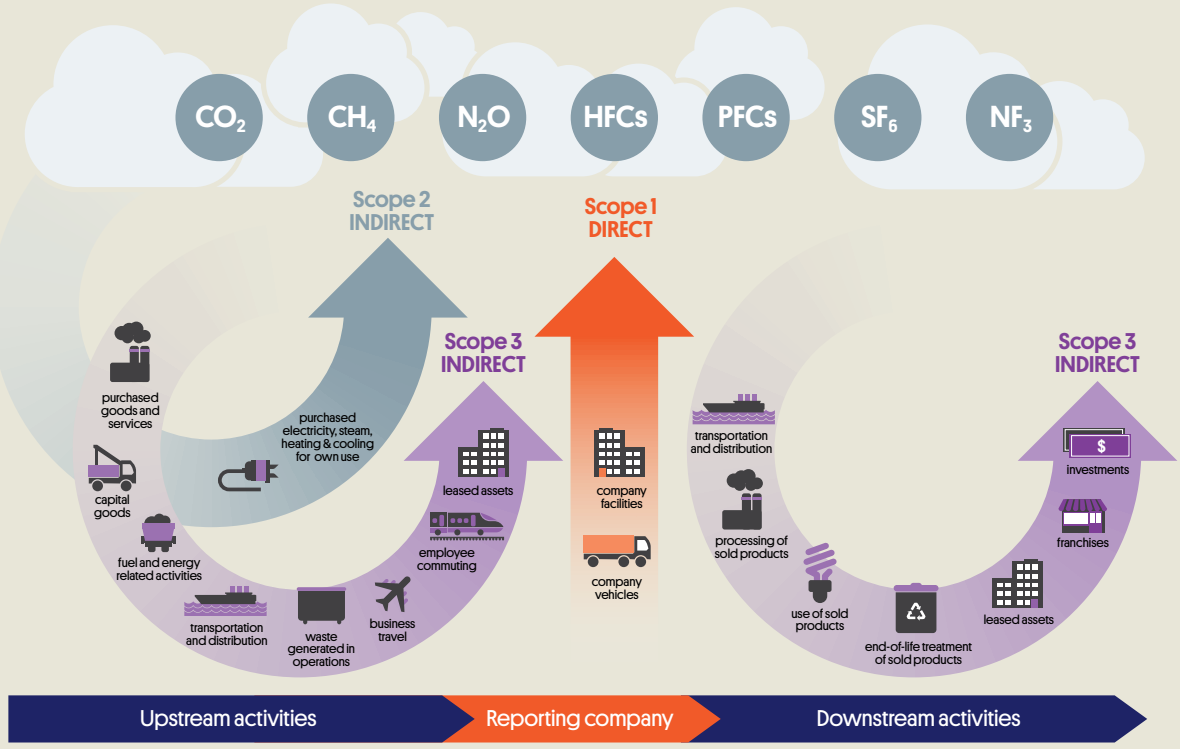
"Net zero emissions" refers to achieving an overall balance between greenhouse gas emissions produced and greenhouse gas emissions taken out of the atmosphere. (Climate Council)

Figure 1: Net Zero Emissions



The important first step in developing a net zero pathway is understanding where your emissions come from. Emissions are those greenhouse gases (mostly carbon dioxide, but also methane and nitrous oxide) emitted through human activities, and there has been a global agreement to classify them into three 'scopes' depending on levels of responsibility:

Figure 2: Scopes of Emissions



Source: GHG Protocol: https://ghgprotocol.org/blog/you-too-can-master-value-chain-emissions

WHY DOES NET ZERO MATTER FOR YOUR BUSINESS?

Prioritising net zero supports the sustainability of prawn populations, the health of the ocean, and the long-term success of fishing operations while meeting consumer demand for responsibly sourced seafood.[1]

Fundamentally, sustainability is driven by the aspiration to mitigate humanity's impact on the planet while ensuring prosperity for future generations. Prawn fishermen can prioritise achieving net zero to preserve marine ecosystems, comply with regulations, ensure economic viability, access sustainable markets, and fulfil their social responsibility.

1 See reference in Appendix B.

DRIVERS & BARRIERS FOR SUSTAINABLE ACTION

DRIVERS

Environmental benefits
Minimise the depletion of natural resources, reduce pollution, promote nature regeneration, and mitigate the impacts of climate change.

Cost savings
Efficient use of equipment and avoiding waste will reduce your energy, fuel and waste costs.

Enhanced reputation
Ethical business practices foster trust and positive relationships.

Risk mitigation
By using less and using it better, you can mitigate risks around resource scarcity, environmental regulations, and supply chain disruptions.

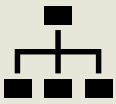
Economic & social benefits
Keeping materials circulating in the economy and supporting local business and industry boosts the State's economy, provides meaningful employment, and supports a healthy environment for improved social wellbeing

Talent retention
A commitment to sustainability can set you out from the crowd. In fact, 71% of workers say that environmentally sustainable companies are more attractive.

BARRIERS

Financial
Having a clear return on investment is crucial. Prioritise your actions and start with the 'quick wins' – low effort, high impact. It is also important to recognise the return on investment beyond financial wins, such as meeting customer expectations for sustainable initiatives.

Commitment and engagement
New initiatives will always require changes in operational practices and behaviours, sustainability is no different. Involving and engaging your entire team will encourage ownership and determination. So, repeat your sustainability vision often, highlight this with the team, and encourage passionate individuals.



Control and ownership
If you do not fully control your assets, it can be difficult to make changes. Engaging early and often with owners and landlords can help bring them onboard your sustainability journey.

Knowledge
Some initiatives can be quite technical in nature; this guide aims to give you enough knowledge to identify potential opportunities and have informed conversations with your service providers.

Time
Skippers and operators are incredibly busy running day-to-day operations both onshore and onboard. Getting your team on-board can help share the load.

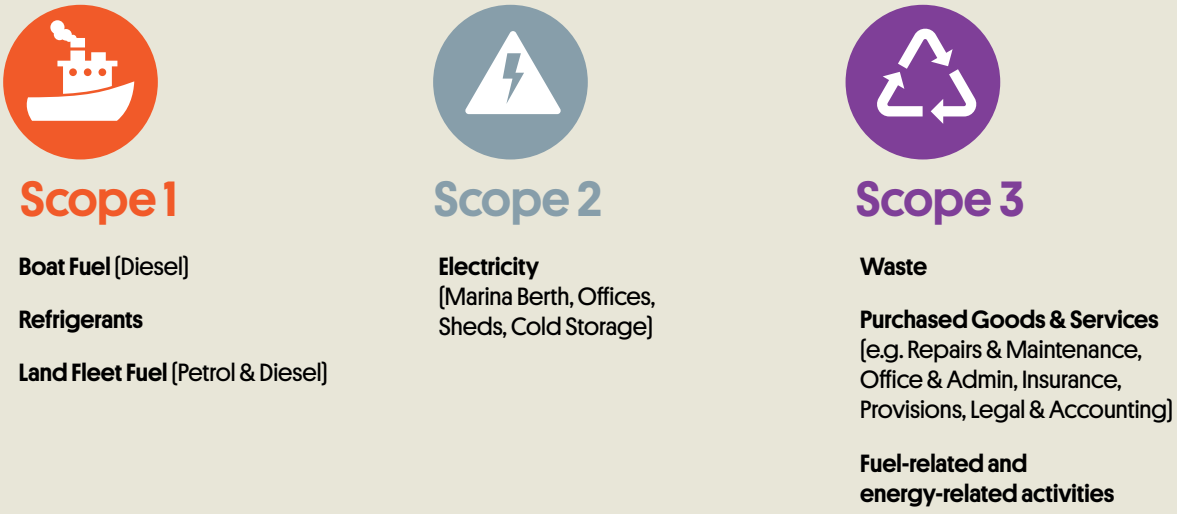
SECTION 2

UNDERSTANDING EMISSIONS FROM OPERATIONS

EMISSIONS BOUNDARY

A relevancy test was conducted to determine an appropriate emissions boundary, shown below for SGWCPA members. This emissions boundary was defined according to the Greenhouse Gas Protocol[2] guidelines and considers key factors such as size, climate risk, ability to influence, and relevance to stakeholders.

Figure 3: Emissions Boundary for the association members



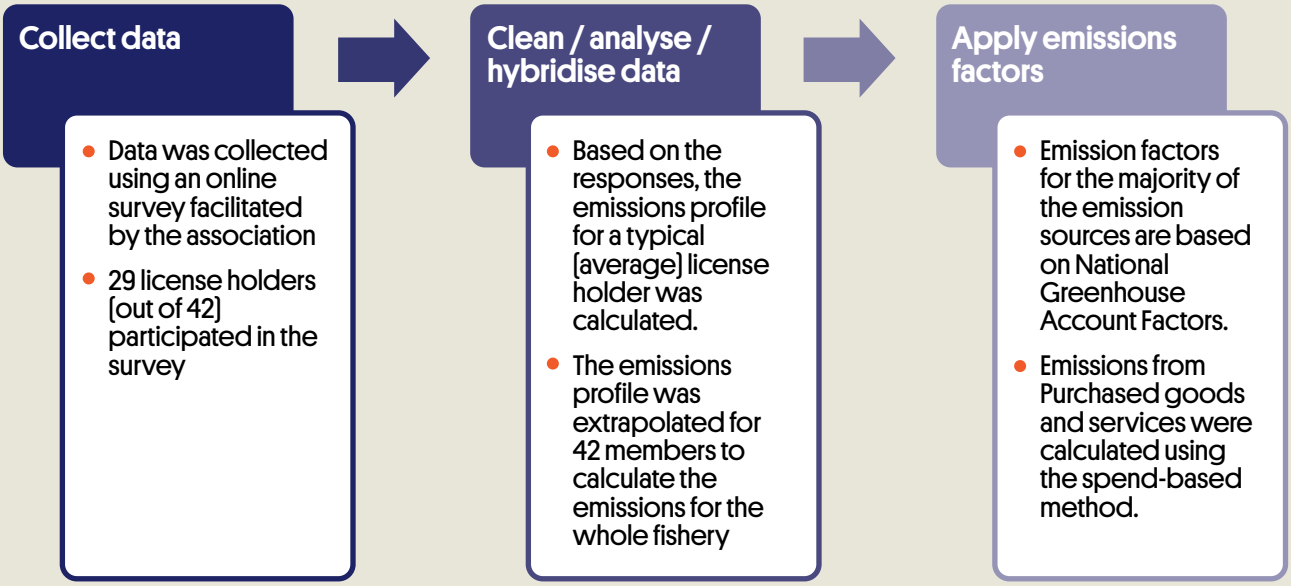
2 Corporate Standard | GHG Protocol

METHODOLOGY

Once the emissions boundary was determined, the key steps below were taken to calculate the emissions profile for association members.

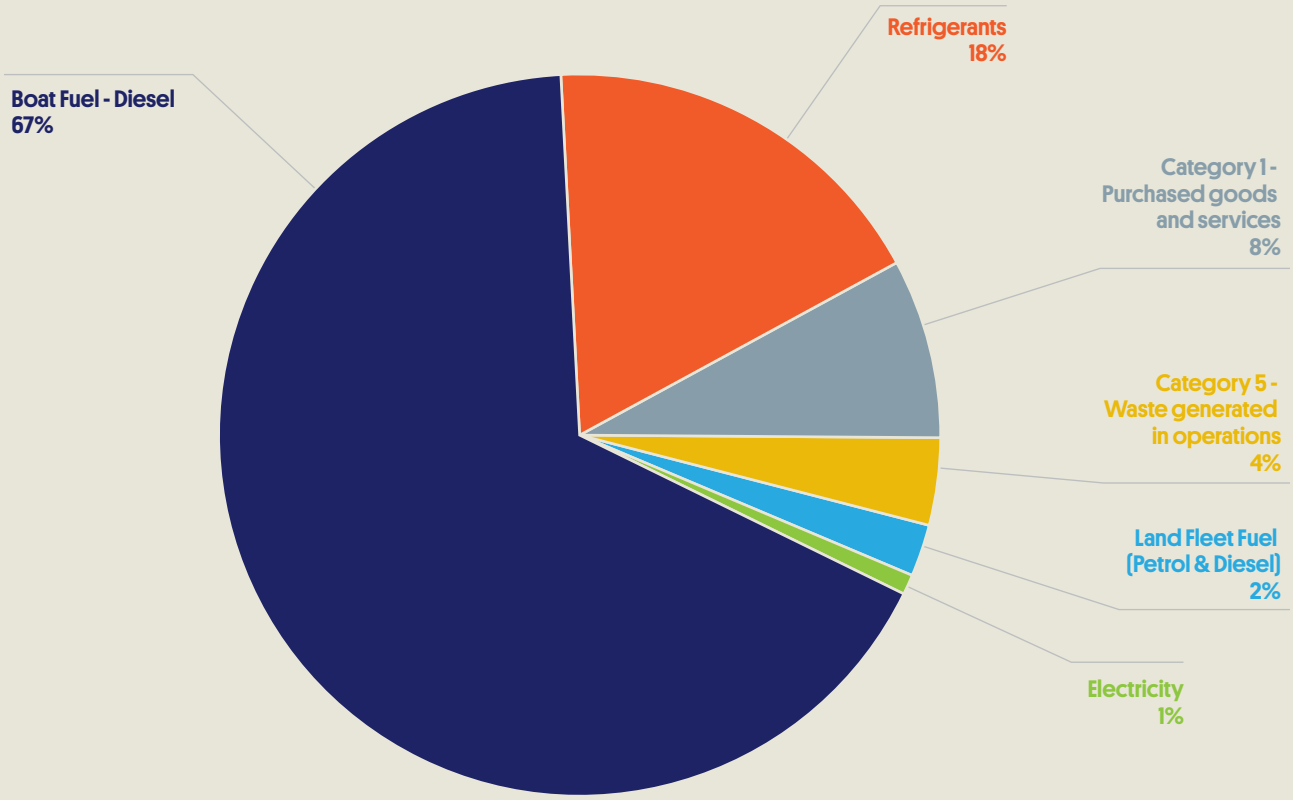
A workshop was also held with the association members to identify and discuss opportunities to reduce emissions onboard (see Appendix A for all onboard opportunities identified).

Figure 4: Methodology for emissions calculation



TYPICAL EMISSIONS PROFILE

The typical emissions profile for the association members is shown to the right. This graph shows that boat diesel and fugitive refrigerants were the largest emissions sources at 67% and 18%, respectively. The next highest category was purchased goods and services at 8% for which the largest emissions source is repairs and maintenance services provided to each trawler. The fourth highest is waste-to-landfill generated in operations, followed by land fleet fuel (petrol and diesel) at 2%, and electricity for land infrastructure such as sheds, offices and cool rooms at 1%.



300tCO_2-e p.a.

The collected data showed that, on average, each prawn trawler produced 300tCO_2-e per annum. This value is prone to shifting up and down each year depending on the season and the number of trips taken, but it provides a good baseline for assessment.

Often, comparing these emissions to other metrics is worthwhile, to help gauge this value. 300tCO_2-e per annum is equivalent to:

~135 passenger cars on the road in Australia p.a.

The sequestration of **~18.8** hectares of blue mallee eucalyptus [3]

3 Survey of Motor Vehicle Use, Australia | Australian Bureau of Statistics
Carbon Dioxide Emissions Intensity for New Australian Light Vehicles 2021.pdf
Liew_2009.pdf (uwa.edu.au)

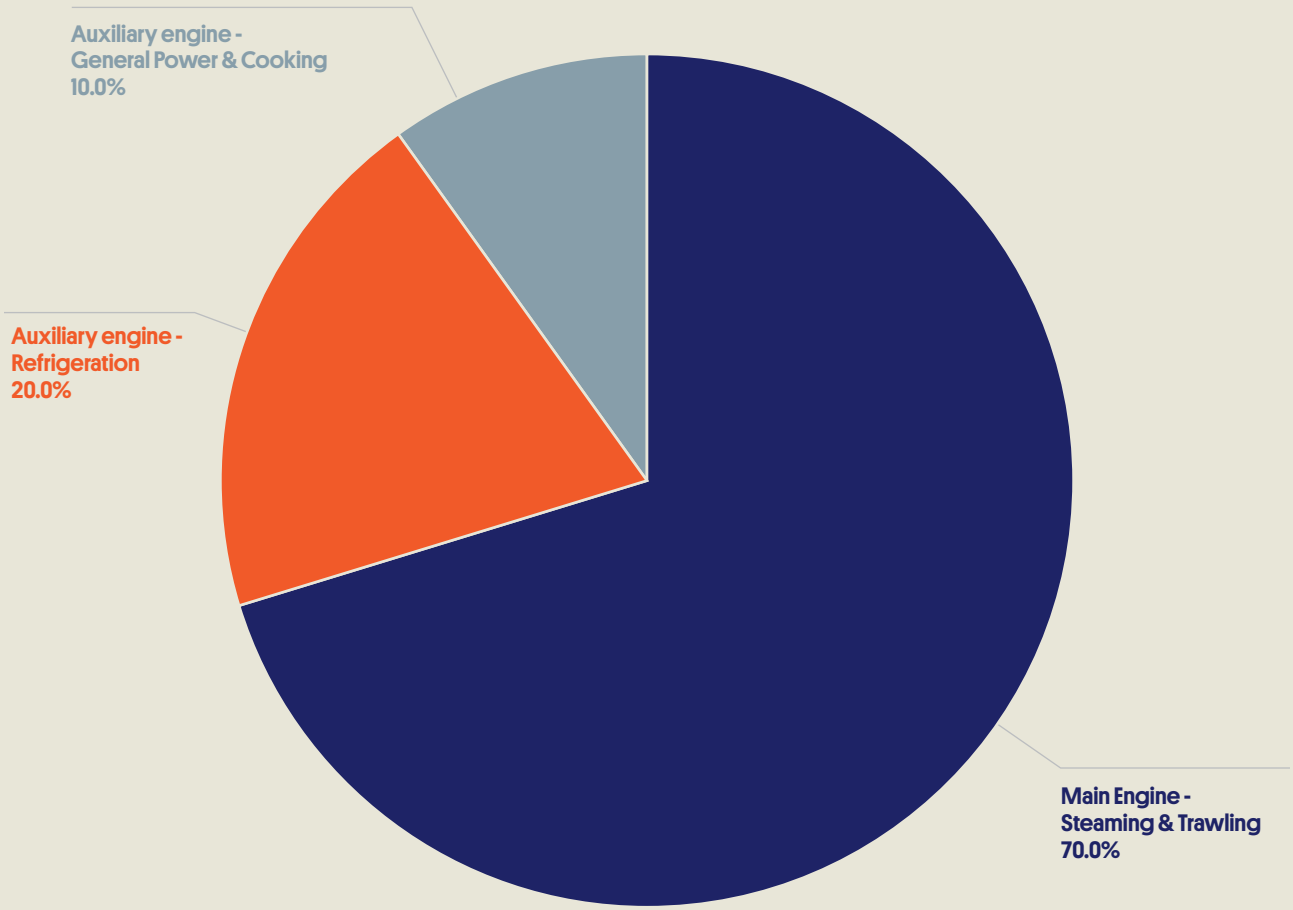
HOW IS DIESEL USED?

Boat diesel, used in engines onboard, accounts for the greatest emissions at 67%. The boats usually have 3 engines:

- 1 x Main inboard engine for propulsion
- 2 x Diesel auxiliary engines for ship power (one running at a time)

The estimated breakdown of boat diesel use is shown below and is based on published data[4] and discussions with members. This breakdown is an average estimate only and will vary from vessel to vessel depending on age, engine configuration, equipment fit-out and more.

Figure 5: Estimated boat diesel consumption breakdown



4 Empowering Industry: Energy Audit of Prawn Trawler with Auxiliary Sail Power, Giles Thomas & Rowan Frost'

SECTION 3

PATHWAYS TO NET ZERO

THEME 1:
TRAWLER MAINTENANCE & OPERATION

- Hull cleaning & maintenance
- Propellor cleaning & optimisation
- Speed optimisation
- Engine maintenance
- Refrigeration maintenance

THEME 2:
TRAWLER CAPITAL UPGRADES

- Upgrade lighting to LED
- Refrigeration upgrade
- Refrigeration changeover
- Engine replacement
- Hull modification / extension

THEME 3:
ONSHORE OPPORTUNITIES

- Waste management
- Land fleet fuel
- Purchased goods and services
- Renewable electricity procurement

THEME 1: TRAWLER MAINTENANCE AND OPERATION

By considering key maintenance and operation opportunities, skippers can improve the efficiency of their vessels and reduce emissions.

HULL CLEANING & MAINTENANCE

Removal of barnacles from a badly fouled hull can improve fuel economy by up to 15%.

Regular hull cleaning and maintenance practices include:

- scraping the hull multiple times per year to remove barnacles
- deep cleaning and painting the hull every 2-3 years to reduce drag (sandblasting can be considered too). A deep clean and paint cost varies with boat size and can range between $15k and $50k.

The impact of hull cleaning is more noticeable during trawler steaming rather than trawling due to the relationship between speed and drag. The payback period for undertaking regular maintenance is less than 6-months, and deep cleaning and painting is less than 2-years.

PROPELLOR CLEANING & OPTIMISATION

A well-maintained and optimised propeller can improve fuel efficiency by up to 5%.

Using a well-designed and maintained propeller can reduce fuel usage. This includes ensuring the propeller is the right size and pitch for the boat and regularly maintaining it to prevent damage and fouling. It is recommended that you:

- regularly inspect and maintain propellers to ensure they are in optimal condition
- consider upgrading to high-efficiency propellers with nozzle designs to improve thrust and reduce fuel consumption
- consider variable pitch propellers if steaming distances are long (given the difference in optimal pitch between steaming and trawling).

SGWCPA trawlers' current practice is to clean the propeller between each trip given its impact on vessel performance. Upgrading old and damaged propellers will generally have a payback period of 5 years or less.

SPEED OPTIMISATION

A reduction in speed by 10-20% can lead to fuel savings of 10-30%.

Speed optimisation is a simple way to reduce fuel consumption while steaming to and from trawling locations. Key considerations include:

- As fuel use increases exponentially with speed, reducing speed by 10-20% can lead to fuel savings of 10-30%.
- Mechanical propulsion is particularly efficient at design speed, which is normally between 80% - 100% of top speed.
- Modern electronically controlled engines will provide exact fuel consumption figures allowing real-time optimisation.

SGWCPA skippers are aware of speeds impact on fuel consumption and will optimise speed where appropriate.

In many cases due to competition and time constraints, the potential to optimise speed is reduced.

ENGINE MAINTENANCE

Regular engine maintenance as compared to no maintenance can reduce fuel consumption by up to 20%.

Diesel consumption from onboard diesel engines, including both propulsion and ancillary, account for 67% of total emissions generated from license holders. Any improvements to engine performance will benefit the operations bottom line and reduce total emissions.

There are a range of recommended maintenance practices to be completed at different frequencies including daily, weekly, monthly, quarterly and seasonally. The best way to ensure you maintain a healthy, high-performance engine is to keep a maintenance log. A maintenance log will help to:

- identify potential problems before they develop
- log time and details of changes in performance
- record work done and equipment serviced
- record engine history.

Daily maintenance tasks include visual inspections, checking engine oil levels, belt tension, coolant and antifreeze levels, and battery charge. For a full list of recommended maintenance tasks, refer to your engine manual or head online for maintenance checklists.

REFRIGERATION MAINTENANCE

Onboard refrigeration systems account for ~20% of vessel diesel consumption (via the ancillary diesel engines).

All SGWCPA trawlers are fitted with large freezer systems, which are used to snap freeze, and store prawns. These systems can store up to 20 tonnes of prawns and are generally set to -40˚C, which results in very high energy consumption. Significant improvements can be made inexpensively by keeping on top of maintenance and tweaking system operation. Improving refrigeration system efficiency will decrease the load on your ancillary engine and reduce diesel consumption.

Without maintenance, refrigeration system performance gradually deteriorates over time, increasing operating costs, reducing equipment life, and increasing the risk of sudden breakdowns. Regular maintenance with a qualified refrigeration technician can prevent these issues. Key refrigeration maintenance practices for efficiency include:

- **Re-gas system if pressure drops:** Checking refrigerant pressure and re-gassing if it's low is important to maintaining system performance and efficiency.
- **Repair damaged cold room doors:** any damage to cool room doors or seals resulting in doors not closing properly will lead to significant energy loss and increased diesel consumption. Fix any air leaks as soon as possible.
- **Regularly clean heat exchangers:** Regularly cleaning heat exchangers improves heat transfer and refrigeration efficiency.
- **Replace damaged or missing insulation on pipework:** Replacing damaged insulation is a simple low cost, quick win which reduces energy loss and improves performance.
- **Ensure blast and evaporator fans turn off when freezer doors open:** By programming freezer fans to turn off when the door is opened, less cold air will escape, reducing heat loss.
- **Check freezer temperatures regularly and log electronically where possible:** Logging freezer temperatures will allow for the tracking of performance over time and optimisation based on required temperature setpoints. If the setpoint can be adjusted based on freezer status, significant savings may be achieved. For example, increase the freezer setpoint by a few degrees on the return trip (after the product has been frozen to -40˚C).

Efficiency rule of thumb:

A 1˚C change at either the evaporator or condenser will result in a 2-3% energy reduction at the compressor.

For example, if you can drop your freezer setpoint by 5 ˚C, you'll reduce energy consumption by 10-15%.

THEME 2: TRAWLER CAPITAL UPGRADES

There are opportunities to invest capital to upgrade trawlers and ancillary equipment to reduce diesel consumption, reduce refrigerant leaks and improve overall performance.

UPGRADE TO LED LIGHTING

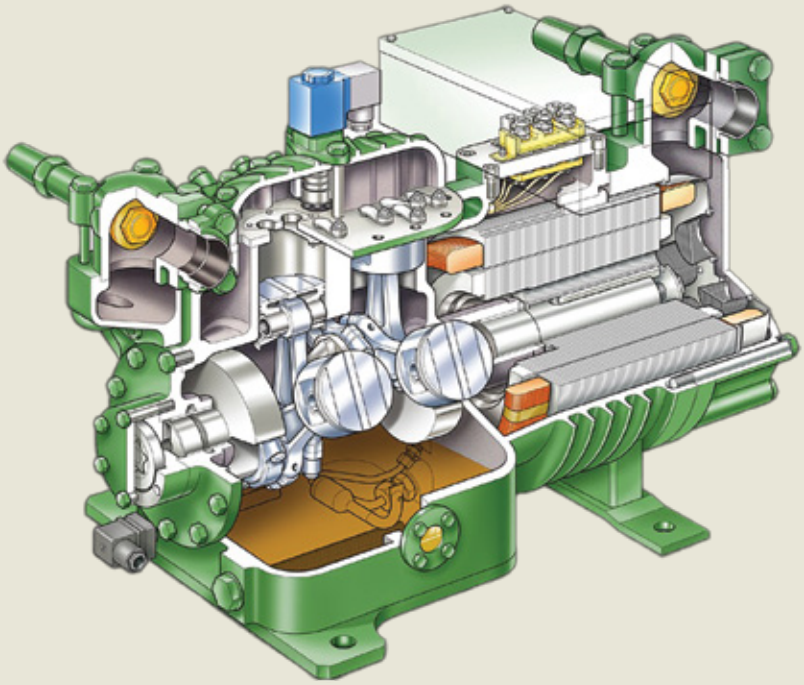
LEDs are 50-60% more efficient than fluorescent and halogen lighting.

Upgrading trawling light fittings to energy-efficient LEDs can substantially reduce energy consumption, resulting in reduced diesel use in ancillary engines. Some benefits of LED fixtures include:

- extended lifespan, leading to reduced maintenance costs
- higher light output and directionality.

Payback periods for upgrading fittings typically range from 2-4 years, depending on usage patterns. Prioritise upgrading fittings with high usage patterns and replace low usage lights upon failure.

Semi-hermetic compressor



REFRIGERATION UPGRADE

Diesel consumption and fugitive refrigerants associated with onboard refrigeration is estimated to account for a combined 31% of fishery emissions.

Refrigeration system upgrades can lead to a significant reduction in energy use and refrigerant leakage. Discuss the potential of the following key efficiency features with your refrigeration contractor:

- **Electronic expansion valves ($):** to optimise superheat and improve efficiency.
- **VSDs on compressors ($$):** to act as a soft starter to reduce instantaneous loading on the generator and improve the refrigeration system.
- **Computer monitoring ($$):** to track system performance & maintenance alert.
- **Switch from open-drive compressors to semi-hermetic compressors with VSDs ($$$):** to reduce refrigerant leakage from shaft seals and improve efficiency.
- **Increase seawater heat exchanger size ($$$):** to reduce head pressure and improve efficiency.

The capital cost of the above projects will vary based on the type, size and age of the refrigeration system; it is best to contact your refrigeration contractor to discuss these opportunities in more detail.

There is potential to implement these items in a bundled approach during system refurbishment. The payback period for upgrading refrigeration systems typically range from 3-6 years depending on existing system condition. Prioritising low-cost upgrades such as electronic expansion valves will provide the best return on investment.

REFRIGERATION CHANGEOVER

New refrigerants are becoming available that have the potential to reduce fugitive emissions.

All SGWCPA trawler refrigeration systems currently use R404a. This refrigerant has a high Global Warming Potential (GWP) of 3,943, meaning that for each kilogram that escapes, it is equivalent to 3,943kg of CO_2 emissions.

There are a range of refrigerants available with a lower GWP. However, they are not suitable for the temperatures and working environment required in the prawn industry. Namely, the refrigerant used must achieve very low temperatures, i.e. <-40°C, and pose little risks in the event of a catastrophic leak, i.e. non-toxic and non-flammable. Currently R404a is the most suitable option as it is non-toxic, non-flammable and able to achieve low temperatures.

Natural refrigerant options:

R744 (CO_2) & R717 (Ammonia, NH3)

Pros:

- Ultra Low GWP (CO_2 = 1, NH3 = 0)
- Comparable efficiency

Cons:

- Safety concerns related to leaks
- Requires custom-designed refrigeration system

New refrigerant blends are now entering the market, advertised as direct 'drop-in' replacements for R404a, such as R452a, a combination of three refrigerants.

R452a

A 'drop-in' replacement for R404a due to its comparable performance.

Pros:

- 45% Lower GWP (GWP2,140)
- Comparable efficiency

Cons:

- Expensive
- Difficult to source
- Some issues with performance when swapping as a retrofit (better implemented as a custom design)

The refrigerants offer opportunities to significantly reduce emissions. However, the barriers identified include cost, ability to source and maturity in the prawn industry. No one in the SGWCPA is using a new refrigerant blend yet, and as such, the first project should be approached with caution and treated as a trial.

ENGINE REPLACEMENT

Propulsion engines that hit 20-30,000 operating hours either require a full rebuild or replacement.

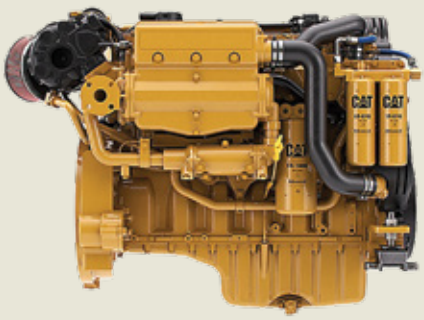
All engines will eventually reach the end of their useful life after a certain period. At this point, skippers must decide whether to fully rebuild the existing engine or replace it with a modern electronically controlled diesel engine. Older engines can be maintained more readily than modern alternatives, but parts are becoming harder to source and more expensive over time.

New diesel marine propulsion engines have improved fuel efficiency, reduced emissions, advanced controls and monitoring, and are lightweight in design.

Unfortunately, they are difficult to service, requiring specialist dealers, and are very expensive to purchase and install.

Fitting a new diesel engine generally requires cutting the boat in half, which is time-consuming and cost-prohibitive for most skippers.

The best time to install a new engine is in a project that involves hull modification, engine replacement, and significant upgrades.



Caterpillar

Scania

Volvo

Cummins

HULL MODIFICATION / EXTENSION

Boat design plays a major role in performance and fuel efficiency.

One way to significantly change and improve a vessel's performance is to modify its hull and extend it to the maximum length possible. Legislation dictates a maximum length of 24m. Increasing a vessel's length will improve its performance; however, it is a very high-cost project with limited Australian contractors capable of undertaking the work.

Additionally, many old boats in the fleet are 'grandfathered', meaning that any change to the shape or hull would require upgrades to electrical and fire systems to comply with the latest standards. This poses a significant barrier to undertaking the upgrade.

Case Study

One boat in the SGWCPA prawn fisheries fleet has recently undergone hull modification to extend the boat from 22m to 24m in length. Noted performance improvements include:

- improved streamlining
- reduced rocking and loss of momentum in waves
- reduced drag and improved fuel efficiency

THEME 3: ONSHORE OPPORTUNITIES

Onshore emissions account for 15% of total emissions associated with the fishery, and there are several recommendations to reduce these emissions.

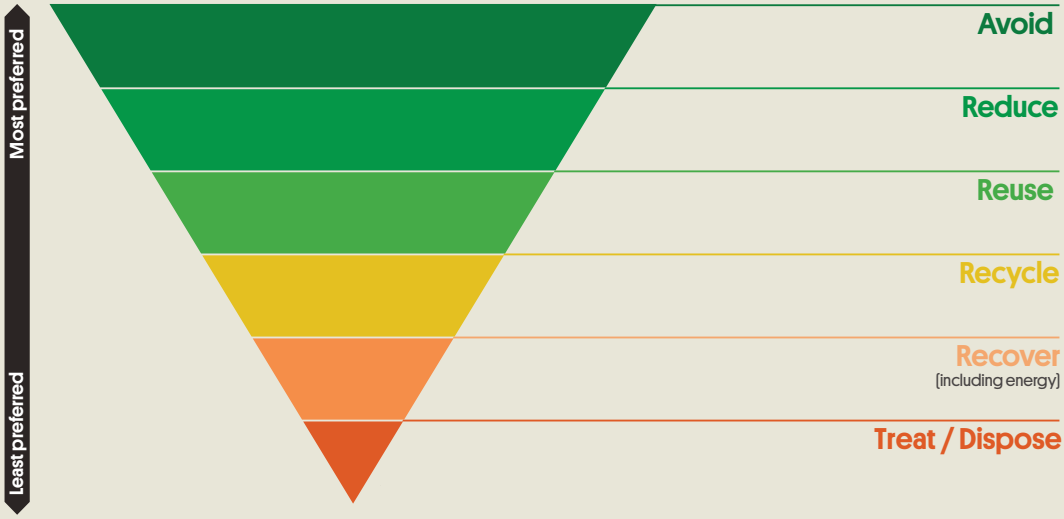
WASTE MANAGEMENT

Effective waste management is based on the principles of avoidance, recycling, recovery and responsible disposal of waste.

THE WASTE HIERARCHY

Regarding waste issues and opportunities, it is useful to consider the waste management hierarchy. The hierarchy gives us a way to prioritise how we tackle waste management. Essentially, we can think of it as four key steps:

- **Avoid and Reduce:** First, avoid creating waste in the first place. If complete avoidance is not possible, focus on reducing the amount of waste generated.
- **Reuse and Recycle:** Next, explore if the waste product can be reused for another purpose or recycled to create new products, thus extending the lifecycle of the materials.
- **Recover:** Then, consider if the waste can be recovered through processes such as converting waste to energy, extracting useful resources from the waste stream.
- **Disposal:** Finally, when all other options are exhausted, dispose of the waste in an environmentally responsible manner, ensuring minimal impact on the environment."



MINIMISING WASTE-TO-LANDFILL

The association will continue to assess the practicality of new products as they come to market to minimise waste sent to landfill and packaging waste over time.

It always makes good business sense to use less to do more. There is currently no segregation of onboard waste streams; however, this waste is limited to minor items involved in cooking and for staff. No direct organic waste is generated on board, i.e. from prawn shelling, and nets are repaired to reduce replacement intervals.

Proper waste management practices, including sorting, recycling, and responsible disposal, are essential to minimise the environmental impact of waste generated on fishing boats. Additionally, implementing strategies to reduce waste generation and promote sustainable practices can help mitigate waste-related issues and promote environmental stewardship in the prawn fishing industry.

The association continues to collaborate with researchers to investigate compostable and recyclable alternatives for items such as liners and prawn cartons. This research thus far has not resulted in a scalable change to the commonly used products due to the lack of performance of sustainable alternatives. The association will continue to assess the practicality of new products as they come to market to minimise waste sent to landfill and packaging waste over time.

LAND FLEET FUEL

New hybrid trucks with improved fuel efficiency and no "range anxiety" are soon entering the market.

There are currently limited options for fuel-efficient and electric trucks and commercial vehicles. However, the market is changing quickly, and fuel efficiency standards are constantly evolving. There are several hybrid trucks entering the market soon from leading brands. These trucks will provide the same features, with improved fuel efficiency and no 'range anxiety'.

PURCHASED GOODS AND SERVICES

Changes in procurement policy and engaging with suppliers will manage supply chain emissions.

There are two ways to reduce emissions from purchased goods and services, i.e. your supply chain.

Supplier engagement

Conduct supplier surveys to better understand emissions associated with purchased goods and services.

Update emissions estimates based on reported emissions from service providers (rather than by spend). This would improve the accuracy of emissions calculations and help to make more informed procurement decisions.

Procurement policy

Purchase low-weight, low-emission recyclable and compostable options where possible.

Purchase Australian made products where available (i.e., nets & ropes).

Adjust procurement policies to require carbon reporting and offsetting for contracts over a certain value.

RENEWABLE ELECTRICITY PROCUREMENT

Renewable electricity procurement is a low-cost way to reduce operating emissions.

Organisations can select to procure 100% renewable electricity to reduce electricity emissions from onshore activities. This can be achieved through the purchase of GreenPower. Purchasing GreenPower is easy and flexible, with most retailers offering renewable energy solutions. Currently, the additional cost of renewable electricity is ~5.5c/kWh, meaning that for a site that uses 1,000kWh p.a., it would cost $55 to purchase renewable electricity for the year.

APPENDICES

APPENDIX A ALL ONBOARD OPPORTUNITIES

A workshop was held with association members to identify and discuss opportunities to reduce emissions onboard. The table below lists all opportunities discussed and their status within the fleet.

Opportunity Category		Opportunity Title	Description	Status
	Boat Fuel Efficiency	**Hull Cleaning and Maintenance (as part of Slipping)**	Regular hull cleaning & maintenance to reduce drag and improve fuel efficiency.	Common practice / already implemented
		Propeller Optimisation	Using a well-designed and maintained propeller can reduce fuel usage. This includes ensuring the propeller is the right size and pitch for the boat and regularly maintaining it to prevent damage and fouling.	
		Speed Optimisation	Optimising speed for fuel efficiency while steaming. A reduction in speed by 10-20% can lead to fuel savings of 10-30%.	
		Engine Maintenance	Regular engine maintenance ensures efficient operation (fuel filters, air filters etc)	
		Engine Upgrade	Upgrading engine upon end of life to modern electronically controlled alternatives can provide significant fuel savings.	Some trawlers fitted with modern engines - Newer engines provide real time fuel consumption
		Fuel Monitoring Systems (Fuel flow meter for most efficient speed)	Installing systems to monitor and optimise fuel usage can help identify inefficiencies and reduce fuel consumption.	
		Use of Energy-Efficient Equipment	Installing energy-efficient equipment for lighting, refrigeration, and other onboard systems to reduce electrical load.	Boats transitioning to LEDs and low power equipment
		Trawl Gear Modification	Modifying trawl gear to reduce drag and lower fuel usage. Options include using smaller nets, more hydrodynamic shapes, and lighter materials.	Current legislation limits gear selection
		Lighter Gear and Equipment	Minimise unnecessary gear and equipment on board to reduce weight, leading to improved fuel efficiency. Invest in lightweight materials for gear and equipment without compromising functionality.	Some good products available and used. Lighter equipment often has a shorter life
		Hull modification / extension	Modify the vessel and extend the hull to increase boat length and performance.	One or two ships modified. Modifications are expensive and limited by legislation
		Alternative Trawling Methods	Consider alternative trawling methods that can be more energy-efficient and environmentally friendly.	Limited by legislation
	Refrigeration	**Retrofitting / overhaul of refrigeration systems**	Opportunity to transition to modern high-efficiency refrigeration systems with low GWP refrigerants. Currently using R404A (very high GWP) and a bit of R22 (high GWP and being phased out), recommended to transition to other refrigerants (i.e. R452a, R747, R717)	Only common refrigerants used
	Alternative Fuels	**Hydrogen as a Marine Fuel**	Hydrogen has potential as a marine fuel due to its high energy content and zero carbon emissions when used in fuel cells. It can be produced from various sources, including renewable energy, making it a potentially sustainable option.	Not considered - no infrastructure yet
		Biodiesel as a Marine Fuel	Biodiesel's compatibility with existing diesel engines varies, and it can have issues like higher viscosity and lower energy content compared to regular diesel. Storage stability and cold weather performance are also concerns.	
		Liquefied Natural Gas (LNG)	Key challenges include the need for specialised fuel storage and handling systems, higher initial investment costs, and the development of LNG bunkering infrastructure. Safety concerns with LNG storage and handling also need to be addressed.	
		Battery-Electric Systems	The main challenges include limited energy density of batteries, resulting in lower range and payload capacity, high initial costs, and the need for charging infrastructure. Battery lifecycle and disposal are also concerns.	Low economic feasibility for large scale batteries

Implemented Somewhat implemented Not implemented

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