

Reducing emissions from maritime transportation

An initial study as part of the Staff Technical Assistance Exchange program for the Kingdom of Tonga



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Summary

The partnership between the Kingdom of Tonga and the Kingdom of the Netherlands aims at mutual cooperation and technical assistance to reducing the emissions of greenhouse gasses from maritime transportation. The technical assistance aims at providing the Tongan ministry with priority measures which are most applicable to the Tongan situation to be implemented on a relatively short term. A longlist of measures was constructed by using external sources and information such the International Maritime Organisation and the GLOMEEP project and out of this longlist, four priority measures have been selected. These are:

- I) A fuel levy on traditional fuels combined with a fuel subsidy on more environmental friendly alternatives such as biodiesel
- II) Introduction of slow steaming and a maximum speed zone in Tongan waters
- III) Compulsory hull cleaning and propeller polishing on a more frequent base
- IV) Feasibility study on an emission control area for the Pacific Islands including Tonga and its neighbouring islands.

Besides the four priority measures, four normal/supporting measures have been determined. These measures are however more expensive, or more suitable to be implemented on the mid- and/or long term. These are active stimulation of meeting Energy Efficiency Design Index and Ship Energy Efficiency Management Plan standards, trim and draft optimisation, hybridisation and the use of shore power. Rather than implementing measures solely for the maritime transportation in Tonga, the measures should be integrated into an integral approach for Tonga. Cooperation with other ministries such as MEIDECC, with other public institutions such as the Ports Authority Tonga but also with private operators should be actively pursued.

Introduction

In 2017 the Kingdom of the Netherlands and the Kingdom of Tonga have signed a partnership approach aimed at mutual cooperation and technical assistance. The partnership approach is being proposed as one of the elements of the shipping high ambition coalition. The coalition was formed within an International Maritime Organisation context to ensure that shipping contributes towards the achievement of stabilisation of global temperatures well below 2 degrees and aiming for 1.5 degrees celsius. Within the shipping high ambition coalition, the partnership approach was established in order to ensure contribution of evidence and to enable progressive and inclusive debates, as well as ambitious submissions within the International Maritime Organisation on the subject of shipping greenhouse gas emission reduction.

This study provides the first results of the technical assistance program and aims to provide an overview of priority measures that the Kingdom of Tonga could start implementing to reduce the greenhouse gas emissions from maritime transportation. With Tonga being an island state, maritime transportation is vital for the country. Whether it is import of cargo to the country or short sea cargo and passenger shipping between the islands; maritime transportation functions as the vital link between the different islands of the archipelago. But with increasing attention for climate change worldwide and specifically within the International Maritime Organisation, it is important to consider the environmental impact of this maritime transportation and these ships. This study provides an overview of the maritime situation in Tonga and determines a selection of priority measures that are most applicable to the Tongan situation. These priority measures will be analysed within an international context. Final component consists of preliminary implementation support, including framing of the study within a national context. This report is written from a perspective of the Marine & Ports Division of the Ministry of Infrastructure (from now on: MPD) and discusses the role MPD could have within the implementation of these measures. However, since the port of Nuku'alofa is managed and operated by the Ports Authority Tonga (from now on: PAT), their perspective will be taken into account as well, in order to provide a solution for the maritime transportation in Tonga as a whole.

The following stakeholders have been interviewed for this study:

- Port Authority Tonga
- Ministry of Education
- Ministry of meteorology, energy, information, disaster management, environment, climate change and communications (MEIDECC) – department of energy, department of environment (including Oceans 7) and the department of climate change
- Ministry of Tourism
- Tofa Ramsay Shipping
- Ministry of Fishery
- Total
- Several industry experts, such as a captain and/or other professionals working in the field (NREL)

Their knowledge and insights have been taken into account whilst elaborating this study, however the report does not necessarily represent their views. Several other stakeholders, such as for example the ministry of Finance and Micronesian Sustainable Transport Centre have been approached to participate within this study, however the request for an interview was not answered. Therefore their insights and perspectives could only to a limited extent be taken into account.

Maritime situation in Tonga

In order to determine which measures are most applicable to the Tongan situation, the initial step within the analyses consists of an overview of the maritime situation in Tonga. Which are the primary types of vessels operating in the Tongan waters, what type of cargo do they transport and what does the situation within the respective ports look like?

There are two international ports in Tonga, Nuku'alofa and Vava'u, with Nuku'alofa being by far the biggest port in Tonga. Nuku'alofa, managed by Ports Authority Tonga, handled about 387.000 tonnes in 2017 from international ships and about 31.000 tonnes from domestic ships; the vast majority of the cargo being import into Tonga. Total cargo throughput volume in Nuku'alofa is thus around 400.000 ton, which is being transported by about 1.250 ships. Large part of the 1.250 ships are domestic, combined passenger and cargo vessels such as the MV Otuanga'ofa, which sail only between the different island groups of Tonga; next to that, there are about 200 international calls in Nuku'alofa. The number of passengers transported by ferry services, including the combined passenger/cargo vessels, is about 98.500 in 2017. Main type of cargo based on the transported volume in Nuku'alofa is dry business – and dry private cargo, petroleum products and vehicles. Maritime transportation in Vava'u and Ha'apai is relatively small compared to Nuku'alofa; about 500 ship calls in 2017, with the vast majority being yachts (about 90%). There are a couple of international and domestic cargo vessels that call in Vava'u and Ha'apai, but the number is relatively low, as well as the total transported volumes (Source of all port statistics: MPD and PAT).

Two important elements of the maritime transportation in Tonga are the tourism sector and the fishery sector. Whale watching is an important attraction for tourism and there are a lot of vessels used for this activity. In total 84 whale watching vessels are registered; about half of them in Vava'u (source: MPD). Combined with the 27 fishery vessels which are registered in Tonga, these types of vessels account for about 83% of the vessels registered in Tonga (source: MPD)¹. A lot of the about 130 total registered vessels in Tonga are relatively small vessels, often using an outboard motor. Vessels below 8 meters are not registered, unless active in whale watching industry; therefore there is no reliable estimation of the total number of these vessels; however they use small outboard motors as well, which is unfavourable from an environmental perspective.

An important general remark is that the maritime transportation in Tonga is really cost driven. In general the scope for differentiation in maritime transportation is limited, so in order to obtain a competitive advantage, shipping operators have to compete on price. This is especially the case for cargo vessels. In order to compete on price, it is crucial to lower costs as much as possible, which could have a negative impact on the environmental – economical trade-off.

¹ Registration is only compulsory for vessels of 8 meters or longer

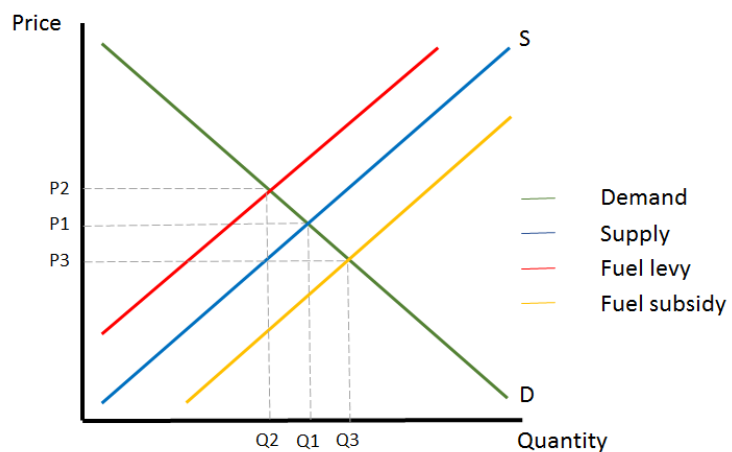
Priority measures

Taking the characteristics of the maritime transportation in Tonga into account, a number of priority measures is determined that are most relevant to the Tongan situation. These measures have been selected from an original longlist which includes, but is not limited to, the measures presented by the International Maritime Organisation in the report on the reduction of greenhouse gas emissions from ships following MEPC 72/WP.5 and initiatives such as the GLOMEEP project, which aims to “contribute to significant reduction of GHG emissions from international shipping via supporting 10 Lead Pilot Countries (LPCs) in taking a fast-track approach to pursuing relevant legal, policy and institutional reforms, driving national government action and industry innovation to support the effective implementation of the International Maritime Organisation’s energy efficiency requirements” (GLOMEEP, 2018).² Out of these sources a longlist of eight measures was selected which are relevant for Tonga, of which a further sub-selection of four priority measures is made, which could be implemented to reduce emissions from ships. These priority measures are either relatively simple to implement, generate short term benefits in terms of emission reductions, are relatively cheap measures or a combination of the aforementioned aspects. The measures will be discussed; the elaboration of the priority measures is more extensive, including dos and don’ts and international best practise examples. These measures are discussed from an MPD perspective; it does not necessarily mean that only MPD is responsible for implementation.

Priority measure 1: Fuel levy and/or subsidy

One of the most effective measures to reduce emissions from maritime transportation is enabling investments in more environmental techniques and practices, for example a switch to a more environmental friendly fuel type (such as biofuel) via a fuel levy. It is important to note that the introduction of a fuel levy is not directly resulting in a fuel switch; the fuel switch would be one of the ultimate outcomes. In the short term, the consequence of the introduction of a fuel levy might be a speed reduction, but on the longer term it provides an incentive to invest in energy efficient measures, such as a fuel switch (Kosmas and Accario, 2017).³ This latter one can be done via two ways, a fuel levy on traditional fuel or a subsidy on a more environmental alternative, such as biofuel. In any market supply and demand determine the price. A higher demand or less supply lead to a higher price, while lower demand or oversupply leads to a lower price.

Figure 1: Economic theory behind fuel levy and fuel subsidy



² <https://glomeep.imo.org/>

³ <https://www.sciencedirect.com/science/article/pii/S1361920917305114>

Figure 1 shows the economic theory behind a fuel subsidy or fuel levy. In a normal market, supply and demand are balanced and lead to a certain price (P1) and quantity (Q1). Increasing the price by means of a levy (P2, red line), leads to a lower demand (Q2), whilst lowering the price via a subsidy (P3, orange line) leads to a higher quantity (Q3).

Applying the theory to the Tongan maritime situation, one can see that the majority of the domestic ships sail on diesel or petrol. Vessels above 8 meters sail on diesel, whilst small outboard motor vessels usually sail on petrol. This is further supported by the fact that Total only supplies petrol and diesel and there is no bunkering facility for heavy fuel oil or equivalent in Tonga. International vessels are assumed to sail on heavy fuel oil or equivalents and thus bunker elsewhere. Taking into account that the Tongan maritime industry is really cost driven, currently only traditional diesel and petrol are used.

Since there is willingness to become more environmental friendly and to reduce the emissions from maritime transportation, enforcing a fuel switch could be one of the priority measures. However, more environmental friendly alternatives are at this moment still more expensive than the traditional ones and are therefore not used. Therefore a desired fuel switch should be realised via a 'distortion of the market'. Enforcing this fuel switch could be done by increasing the price of traditional fuel via a fuel levy and/or via a lowering of the price of alternative fuels via subsidies. The measure should be complimentary to each other, i.e. the revenues of the fuel levy are used to subsidise the alternative fuels. It is important that the revenues of a fuel levy are re-invested in the maritime transportation and more specifically into something that results in financial benefits for the ship operators, since the overall benefit of the measure, a reduction of emissions, is beneficial for society. Therefore a fuel levy could easily be seen as an additional tax, without any clear objective. Aim should therefore be to keep the financial position of the ship operators the same, by subsidising the alternative fuel type, offering a more environmental friendly alternative at (about) the same price.

It is important to take the business case of private operators such as Total or Pacific Energy into account. If there is no business case for biofuel, i.e. the costs of supplying are higher than the benefits, they will not be able to supply biofuel to the maritime industry in Tonga. What is also important to take into account is that the maritime industry is only a small percentage of the total volumes that are supplied by Total and Pacific Energy. For Total, the estimation is that only 4-5% of the volumes were supplied to maritime stakeholders (Total, 2018). It is therefore crucial that whilst considering biofuels, this is done on a national base and for other modes of transport as well, in order to generate sufficient volumes to build a viable business case. It is therefore important to cooperate with the ministry of meteorology, energy, information, disaster management, environment, climate change and communications (MEIDECC) and incorporate maritime transportation in the implementation initiatives following the recently delivered Tonga Energy Efficiency Masterplan. The business case for an investment in biofuel for the volumes of both road- and maritime transportation might be better already; combining it with other initiatives and components could further enhance the situation.

An example of a fuel levy for road transportation is in South Africa, the RAF Levy on petrol.⁴ The researchers have not been able to find information on the vehicle kilometres travelled, in order to

⁴ <https://www.businessinsider.co.za/south-africans-pay-nearly-r2-raf-tax-on-a-litre-petrol-which-increased-to-r16-for-first-time-2018-7>

compare the situation with and without the levy, but it would be interesting to analyse the effect of the fuel levy. Another example which provides information about a possible levy is a feasibility study which is carried out in New Zealand on an aviation fuel levy, by the Ministry of Transport.⁵ As far as the researchers are aware, this has not been applied in a Pacific maritime context, which is explainable, since the agreement to reduce the emissions from maritime transportation within the International Maritime Organisation has only been made in April 2017.

Priority measure 2: Speed reduction – maximum speed zones

Second priority measure is slow steaming; a lowering of the sailing speed of vessels operating in Tongan waters. There is an exponential relation between sailing speed and fuel consumption; a reduction in sailing speed leads to a large decline in fuel consumption and thus emissions (in amongst: Streng, 2012; Cariou, 2011⁶; Maloni et al; 2013⁷, Wärtsilä, 2010⁸). Since it is the expectation of the researchers that there is not a lot of time sensitive cargo in Tonga, a sailing speed reduction would be not lead to problematic time costs for shippers. There are two options with regards to a speed reduction: 1) a voluntary speed reduction by ship operators and 2) a maximum speed zone. In the first scenario, the role of PAT and MPD is more an information provider role, in which the benefits of a lower sailing speed are presented to ship operators, which are not informed about these benefits yet. For ship operators these are fuel savings, whilst the benefits for society are the corresponding reduction in emissions. The aforementioned sources can be used, as well as for example GLOMEEP⁹ or The geography of transport systems.¹⁰ Whether or not implementing a maximum speed zone, it is strongly recommended to actively inform ship operators of the benefits of slow steaming and stimulate them to (further) implement slow steaming.

Second option is from an enforcing perspective, by implementing a maximum speed zone, in which speed limits are implemented. An example of speed limits is the port of Xiamen, China.¹¹ For different parts of the port, Xiamen MSA has set speed limits for vessels, limiting the maximum sailing speed. In Xiamen, the aim of the measure was more from a maritime safety perspective, but such a maximum speed zone could be applied from an environmental perspective as well. An important element what should be taken into account when considering a maximum speed zone is the legal feasibility and possible market distortions due to the zone. The legal feasibility of regulating ship speed depends on where and how the speed control is imposed. Compulsory slow steaming can be imposed by a state on the ships sailing with its flag. For such ships the flag state has prescriptive and enforcement jurisdiction (CE Delft, 2012)¹². However, taking into account the relative ease of changing flag, this might not be the most effective way of enforcing. Under a global agreement, port states would also have the right to impose speed controls on ships flying the flag of non-party states. However, a global agreement on maximum sailing speeds might be a difficult situation to achieve. What is possible, is that a coastal state can impose slow steaming on all ships as

⁵ https://www.caa.govt.nz/assets/legacy/funding/Analysis_fuel_levy.pdf

⁶ <https://www.sciencedirect.com/science/article/pii/S1361920910001690>

⁷ <https://link.springer.com/article/10.1057/mel.2013.2>

⁸ <https://www.wartsila.com/docs/default-source/Service-catalogue-files/Engine-Services---2-stroke/slow-steaming-a-viable-long-term-option.pdf>

⁹ <https://glomeep.imo.org/technology/speed-management/>

¹⁰ https://transportgeography.org/?page_id=5955

¹¹ <https://safety4sea.com/speed-limit-and-heavy-weather-restrictions-for-vessels-in-xiamen/>

¹² https://www.theicct.org/sites/default/files/publications/CEdelft_slow_steaming_2012.pdf

conditions for entry into its ports. If applied by the ports in Tonga, a further analysis on whether ships would be redirected to ports outside of Tonga would have to be carried out, though the cargo would still need to be transported to Tonga. The options for a maximum speed in Tongan waters should be actively researched and analysed.

Priority measure 3: Hull cleaning and/or propeller polishing

Third measure which should lead to emission reductions from maritime transportation in Tonga is compulsory hull cleaning and/or propeller polishing. Cleaning the hull of the ship reduces water resistance, leading to a reduction in fuel consumption. Propeller polishing works similar as hull cleaning; removing dirt and biological roughness from the propeller increases efficiency of propulsion. Partially these measures are already happening in the Tongan maritime industry, however the initiative lies with the ship operators.

Different sources provide information about the reduction and efficiency of these two measures. According to Wärtsilä, propeller polishing can save up to 10% improvement in service propeller efficiency compared to a fouled propeller (Wärtsilä, 2009)¹³, with a relatively short payback time. Hull cleaning saves depending on the type of ship up to about 3% of fuel consumption, with a relatively short payback time (Wärtsilä, 2009).¹³ The GLOMEEP database states that the saving of propeller polishing is dependent on vessel size, segment, operation profile and trading areas. The likely reduction potential of propeller polishing is between 3% and 4% on main engine fuel consumption, with costs between 4.000-8.000 USD, depending on the number and complexity of the propeller(s).¹⁴ The savings from hull cleaning are ranging between 1% and 5%, depending on the degree of marine fouling, vessel size, vessel segment, operation profile and trading areas, with corresponding costs between 5.000-50.000 USD.¹⁵ An information brochure by Cleanhull, a company offering hull cleaning services states similar reductions in fuel consumption.¹⁶

In the Marine Pollution Prevention Act (2002) it is stated that hull cleaning is not allowed in Tonga whilst the ship is in the water, so the cleaning has to be done with the ship out of the water, unless the marine pollution act is adjusted. Estimations by MPD staff is that the ships go out of the water once every two and a half year, primarily for hull cleaning and painting, though this is not compulsory at the moment. It would be good to make both hull cleaning and propeller polishing compulsory on a more frequent base, depending on the amount of 'pollution and biological roughness'. Some operators, such as Tofa Ramsay Shipping already apply a higher frequency (source: Tofa Ramsay Shipping)

Priority measure 4: Emission control area in the Pacific

Fourth option of the priority measures is one with potential for substantial emission reductions, though would need to be adapted in a Pacific context. It consists of an emission control area, such as the sulphur emission control areas in Europe, Caribbean or USA (see figure 2, source: International Maritime Organisation). Within these zones, the amount of sulphur emissions is regulated and ships have to sail

¹³ <http://www.shippingtech.it/PDF/convegna%202010/2tecnologie1/Baan.pdf>

¹⁴ <https://glomeep.imo.org/technology/propeller-polishing/>

¹⁵ <https://glomeep.imo.org/technology/hull-cleaning/>

¹⁶ http://www.cleanhull.no/doc//CleanHull_brochure%20new.pdf

with either low sulphur fuel or use scrubbers to ‘clean’ the exhaust gasses. For sulphur, the International Maritime Organisation took in 2016 the decision to implement sulphur restrictions from 1 January 2020, which will cover these issues from that moment. For other types of greenhouse gasses, there aren’t such strict regulations yet within an International Maritime Organisation context, so there could be potential for emission control areas. Such a decision would have to be taken in a Pacific context, since it would not make sense to apply only in Tonga. Actively analysing the need for – and viability of – an emission control area around the Pacific Islands in the vicinity of Tonga is a recommended action for MPD.

Figure 2: Existing and proposed Emission Control Areas (ECAs) globally (Source: IMO)



An Emission Control Area can be designated for SO_x and PM or NO_x, or all three types of emissions from ships, subject to proposal from a Party to Annex VI.

Existing Emission Control Areas include:

- Baltic Sea (SO_x, adopted: 1997 / entered into force 2005)
- North Sea (SO_x, 2005/2006)
- North American ECA, including most of US and Canadian coast (NO_x and SO_x, 2016/2012)
- US Caribbean ECA, including Puerto Rico and the US Virgin Islands (NO_x and SO_x, 2011/2014)

- Existing ECA area
- Potential future ECA area

Measure 5: Active stimulation of meeting Energy Efficiency Design Index and Ship Energy Efficiency Management Plan standards

The Energy Efficiency Design Index is one of the most important technical measure and it aims at promoting the use of more energy efficient (less polluting) equipment and engines. The Energy Efficiency Design Index is a non-prescriptive, performance-based mechanism that leaves the choice of technologies to use in a specific ship design to the industry. As long as the required energy efficiency level is attained, ship designers and builders are free to use the most cost-efficient solutions for the ship to comply with the regulation (Marpol, 2018). The Ship Energy Efficiency Management Plan is an operational measure that establishes a mechanism to improve the energy efficiency of a ship in a cost-effective manner (Marpol, 2018). Both related items were made mandatory for new ships at the MEPC 62 in July 2011.

Meeting these standards for the ships in Tonga is primarily the responsibility of the ship operators in Tonga. However, the MPD could actively stimulate ship operators to comply with these international standards for all ships in Tongan waters, as far as not yet the case at this moment. The surveys and checks which are carried out by the MPD provide an appropriate moment to cooperate with the ship operators to verify and to propose suggestions about the standards. Depending on the type of ship, the MPD staff can come up with the most appropriate measure to comply with standards; these could be for example engine related measures, propulsion improving devices or energy efficient lighting systems. For more information on Energy Efficiency Design Index and Ship Energy Efficiency Management Plan standards, we refer to the following sources: IMO¹⁷, GLOMEEP¹⁸ or ABB¹⁹.

Measure 6: Trim and draft optimisation

The trim and draft of the vessel are important for the fuel consumption, since an unfavourable positioning of the ship could lead to unnecessary fuel consumption. Increased draft and displacement of cargo leads to additional fuel consumption. The loading of the vessel determines the trim of the vessel, which is defined as the difference between the forward and aft draft. A greater aft draft results in a negative trim, while a greater forward trim leads to a positive trim; the negative trim is, though to a certain extent, a favourable position. Though it is not the responsibility of the MPD, the MPD could play a role of pro-active information provider to the ship operators to make sure the operations are from an environment perspective as efficient as possible. It is crucial to show the business case perspective for private operators and illustrate the benefit, namely a reduction in fuel consumption, to them; as far as they are not aware of it at this moment. More optimisation information can be found here: GLOMEEP²⁰, DNV GL²¹, IMO²².

Measure 7: Hybridisation

Hybridisation within ships works similar as with cars; part of the propulsion is carried out by batteries. On a full-electric ship, all the power, for both propulsion and auxiliaries, comes from batteries; the Ampere Ferry in Norway is an example of such a ship. A plug-in hybrid ship is able to charge its batteries using shore power and has a conventional engine in addition. The ship can operate on batteries alone on for example specific parts of the route, when manoeuvring in port or during stand-by operations. A conventional hybrid ship uses batteries to increase its engine performance and does not use shore power to charge its batteries. Due to using batteries the fuel consumption of ships can be reduced; amount of reduction depends on vessel operational profile, power production and consumption profile, engine specifics and rules and regulations.

¹⁷ <http://www.imo.org/en/ourwork/environment/pollutionprevention/airpollution/pages/technical-and-operational-measures.aspx>

¹⁸ <https://glomeep.imo.org/resources/energy-efficiency-techologies-information-portal/>

¹⁹

https://library.e.abb.com/public/186749773c9e70f5c1257a8a002ee691/ABB%20Generations_06%20An%20intro%20to%20energy%20efficiency%20instruments.pdf

²⁰ <https://glomeep.imo.org/technology/trim-and-draft-optimization/>

²¹ <https://www.dnvgl.com/services/eco-assistant-effective-trim-optimisation-1422>

²²

<http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Air%20pollution/M4%20energy%20management%20onboard%20final.pdf>

The role of the authorities within this measure could be two folded. On the one hand, the tugboat in Nuku'alofa and the ships used for pilotage services could be replaced by hybrid ships. This also accounts for ships where the government is involved via the FISA company such as the passenger vessel MV Tongiaki or the passenger/cargo vessel MV Otuanga'ofa. Examples from the US Port of Los Angeles and Long Beach (Electric Vehicles Research, 2010) or by companies such as Damen Shipyards (Damen, 2018) show that the investments costs for these ships are millions of dollars, but they do result in substantial emission reductions. On the other hand the authorities could stimulate private ship operators to invest in hybrid or electric vessels by providing infrastructure and information on these vessels. The role of MPD is for this last variant more a provider of knowledge and information to the industry, rather than an enforcer.

Measure 8: Shore power

Measure eight includes the provision of shore power to ships whilst in port. Rather than having to use the ship's engines, it can use electricity from the shore to operate systems such as ventilation, heating, cooling, pumps, control systems and cargo handling systems. Shore power may potentially eliminate the local noise and air pollution related to ship activity in a port. Depending on the way of producing the local energy, it may also contribute positively to the climate effects of ship operation; this is especially the case if the electricity comes from renewable sources. However, due to the relatively high investment costs, both on the maritime side as well as on the land side, this measure is not considered a priority measure for Tonga. Depending on the size and type of the ship, costs vary from \$50.000 up to \$750.000 (GLOMEEP, 2018)²⁵. The costs for the infrastructure investments on the land side however are millions of dollars, as this example in Auckland, where total costs are estimated at about 18 million dollar shows (Ship technology, 2017)²³. Also other examples show high investments costs for shore power systems and therefore, despite the fact that the reductions in emissions could be relatively high, shore power is not considered a priority measure; see appendix for an overview of projects. In the port of Shenzhen, a feasibility study has been carried out to identify the costs and benefits of shore power²⁴. For more information about shore power and relevant examples, we refer to the following sources: GLOMEEP²⁵, City & Port Development, CMP + the City of Copenhagen²⁶, Canadian Sailings²⁷ or T&D Europe²⁸.

²³ <https://www.ship-technology.com/news/ports-auckland-plans-implement-shore-power-cruise/>

²⁴

https://www.wilsoncenter.org/sites/default/files/costs_and_benefits_of_shore_power_at_the_port_of_shenzhen.pdf

²⁵ <https://glomeep.imo.org/technology/shore-power/>

²⁶ http://www.cmport.com/~media/docs/corporate%20reports/shoreside%20report_enggb_final.ashx

²⁷ <https://canadiansailings.ca/implementation-of-shore-power-for-cruise-ships-wintering-vessels-reduces-greenhouse-gas-emissions/>

²⁸ https://ec.europa.eu/info/law/better-regulation/feedback/2141/attachment/090166e5b3d1e000_en/

Implementation support and framing of study

The objective of the partnership between the Kingdom of The Netherlands and - Tonga is to reduce emissions from maritime transportation. Taking into account the maritime transportation in Tonga, a number of measures have been selected that are most applicable to the Tongan situation. These priority measures are either relatively simple to implement, generate short term benefits in terms of emission reductions, are relatively cheap measures or a combination of the aforementioned aspects. However, there are a couple of issues to take into account whilst considering the implementation of these measures. It is important to consider the measures as part of an integral approach within Tonga, focusing on becoming more environmental friendly and reducing the emissions of greenhouse gasses. The recently delivered Tonga Energy Efficiency Masterplan did not focus on maritime transportation, however this study provides a useful complementary analysis. It should be the aim to combine this study with climate change initiatives within MEIDECC or initiative such as the Green ports initiative that is currently being implemented by SPC (Pacific Community) and Ports Authority Tonga. This will also facilitate the search for funding to implement some of the measures.

Especially when focusing on priority measure one, the fuel levy and fuel subsidy, it is important to combine with road transportation initiatives, since maritime transportation alone doesn't demand sufficient volumes to provide a viable business case for the oil companies Total and Pacific Energy. In case only maritime transportation is only considered, it is very unlikely that there will be supply of alternative, more environmental friendlier fuels. Next to working with other ministries and public institutions such as PAT, it is also advised to work together closely with private companies or representative organisations for a number of private operators. Several of the measures, both priority as well as supportive measures, have to be implemented by private operators. MPD as a regulator, should provide the information about the viable business case, assuming there is, to the private operators, as far as they are not currently aware of it. Private operators will only implement something if there is a viable business case, especially in such a cost driven market. Clear communication about objectives, costs and benefits does help gathering support for measures with a social objective, such as the reduction of emissions.

An important element to take into account are the small vessels below 8 meters. Currently these vessels are not registered or licensed and thus are not monitored or covered by laws such as Quality Manual of Marine & Ports Division (2013) and the Shipping Act (2016). For two primary reasons it should be considered to register these vessels as well and cover them by law. First reason is the environmental perspective; if these ships are registered and certain elements of the law apply also to these vessels, the measures as discussed within this research can be applied to these vessels as well and the available knowledge and information can be shared with these operators as well. They are also eligible for checks and surveys if registered and covered by maritime laws. Second main reason is the safety perspective. Records show that of the number of vessels that go missing each year, a relatively large part are small vessels that do not have the law applied to them, thus resulting in unknown data of vital information needed for saving them. These ships being registered, the operators can experience several benefits such as community training sessions for these owners, showing them simple:

- Radio and Communications Procedures
- Mechanical Procedures
- First Aid Procedures

- Last-Resort Procedures

An initial step within the implementation process of these measure would be an impact assessment of the proposed measures. This impact assessment should provide more information about the costs and benefits of the proposed measures. These measures have been applied or have been proposed in an international context and it is necessary to determine the local impact in Tonga. What are issues that should be taken into account, are the international costs and benefits representative for Tonga and at which stakeholder do these costs and benefits end up? These are examples of questions that would have to be answered within an impact assessment.

After the impact assessment, the actual implementation of the measures is the recommended next step. Having estimated of the costs and benefits and knowing to which stakeholder they will apply, the necessary implementation steps should be prepared and taken.

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Appendix

Figure 3: Ports using shore power (Source: Wang et al; 2015)

Table 1. Ports using shore power

Year of introduction	Port name	Country	Capacity (MW)	Frequency (Hz)	Voltage (kV)	Ship types using onshore power supply (OPS) ^a
2000-2010	Gothenburg	Sweden	1.25-2.5	50 & 60	6.6 & 11	RoRo, RoPax
2000	Zeebrugge	Belgium	1.25	50	6.6	RoRo
2001	Juneau	U.S.A.	7-9	60	6.6 & 11	Cruise
2004	Los Angeles	U.S.A.	7.5-60	60	6.6	Container, cruise
2005-2006	Seattle	U.S.A.	12.8	60	6.6 & 11	Cruise
2006	Kemi	Finland	N/A	50	6.6	RoPax
2006	Kotka	Finland	N/A	50	6.6	RoPax
2006	Oulu	Finland	N/A	50	6.6	RoPax
2008	Antwerp	Belgium	0.8	50 & 60	6.6	Container
2008	Lübeck	Germany	2.2	50	6	RoPax
2009	Vancouver	Canada	16	60	6.6 & 11	Cruise
2010	San Diego	U.S.A.	16	60	6.6 & 11	Cruise
2010	San Francisco	U.S.A.	16	60	6.6 & 11	Cruise
2010	Karlskrona	Sweden	2.5	50	11	Cruise
2011	Long Beach	U.S.A.	16	60	6.6 & 11	Cruise
2011	Oakland ^b	U.S.A.	7.5	60	6.6	Container
2011	Oslo	Norway	4.5	50	11	Cruise
2011	Prince Rupert	Canada	7.5	60	6.6	N/A
2012	Rotterdam	Netherlands	2.8	60	11	RoPax
2012	Ystad	Sweden	6.25	50 & 60	11	Cruise
2013	Trelleborg	Sweden	3.5-4.6	50	11	N/A

[a] RoRo or "roll-on/roll-off" ships carry wheeled vehicles or cargo. RoPax or "roll-on/roll-off passenger" ships are essentially RoRo vessels with passenger accommodation. [b] Information provided by Port of Oakland.