Green Inland Ports

Good Practices

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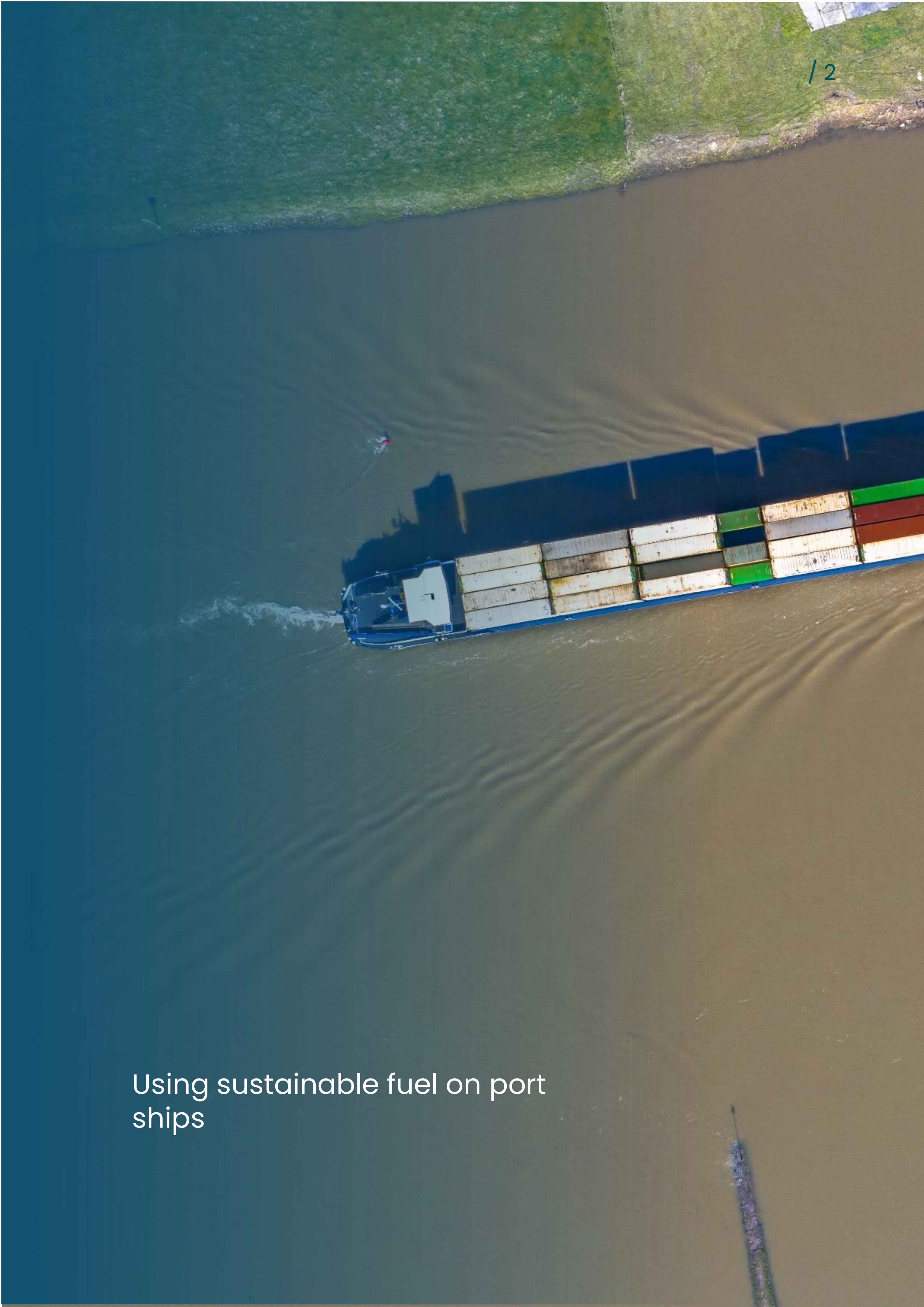

Using sustainable fuel on port ships

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1.1 Description

Port vessels, such as tugboats, are increasingly transitioning to alternative marine fuels instead of using traditional diesel (LionRock Maritime, 2022). The key question in this transition remains: *What will be the fuel of the future?* Will it be hydrogen, methanol, ethanol, hydrotreated vegetable oil (HVO) (biodiesel), ammonia or any other alternative maritime fuel? By using one of the alternative fuels mentioned instead of fossil diesel, significant emission reductions can be achieved, which is explained later in this good practice in more detail. The use of more sustainable fuels by ships calling the port is difficult to influence but is partially addressed in this good practice. 'Discount on waterways and port fees for cleaner ships. In this factsheet we focus on the port's own ships.

Hydrogen

Hydrogen is present in almost all molecules in living things, but as a gas (needed to be used as a fuel), it is scarce. Hydrogen can be produced in several ways. The production of hydrogen using natural gas without carbon capture storage (CCS) is currently the most common method for hydrogen production but generates significant emissions. This type of hydrogen is called grey hydrogen. However, hydrogen is expected to be more widely produced using renewable energy in the future. Green hydrogen is hydrogen produced by water electrolysis, using renewable energy. Well-to-tank[1] GHG emissions of green hydrogen will be close to zero. Blue hydrogen is hydrogen produced by natural gas with carbon capture. Blue hydrogen can be used as a transitional solution, as it still generates greenhouse gas emissions (ABS et al., 2023).

Ammonia

Ammonia consists of hydrogen and nitrogen and can (depending on the production process) be produced as used as carbon free fuel, but can also serve as a convenient way to transport and store clean hydrogen. It is produced in large quantities as a feedstock for products in the fertilizer and chemical industries. Currently, almost all ammonia production is 'grey ammonia', using the Haber-Bosch process, which emits more greenhouse gas emissions on a well-to-wake basis[2] than conventional marine fossil fuels. It can also be produced as 'blue ammonia', where the byproduct CO_2 is captured and stored. Green ammonia is produced when hydrogen comes from water electrolysis powered by alternative energy. No greenhouse gases are emitted in the production of green ammonia (C&EN, 2021). Using green ammonia as fuel in an internal combustion engine reduces emissions of sulphur dioxide, carbon monoxide, heavy metals, hydrocarbons, and polycyclic aromatic hydrocarbons to almost zero. Harmful particulate emissions will also be significantly lower than conventional fuels (ABS et al., 2022).

Hydrotreated vegetable oil (HVO)

HVO is a biofuel that functions as a drop-in alternative to regular diesel. Almost any engine, machine or vehicle that can run on diesel can run on HVO with little or no engine modifications. HVO100 means that the HVO is made from 100% renewable and sustainable materials, ensuring it is not mixed with regular diesel. Running engines on HVO reduces CO_2 emissions, NO_x emissions, CO emissions, and PM emissions (Crown Oil, n.d.; Nationwide Fuels, n.d.). In addition, filters and injectors will stay clean longer (Neste, n.d.).

Methanol and ethanol

Methanol and ethanol are both alcohols with about half of the energy density of conventional fossil fuels. Methanol can be produced from many different feedstocks, both fossil and renewable. Ethanol is produced primarily from biomass. Both fuels can be corrosive to some materials, thus requiring careful selection of tank coatings, piping, and seals. . Methanol is classified as toxic to humans, but ethanol is not. Both fuels have many environmental advantages over conventional fuels because they burn cleanly, contain no sulphur and can be produced from renewable resources. Particulate emissions are very low and nitrogen emissions are also lower than conventional fuels. The environmental impacts of producing and using methanol vary depending on the feedstock. Methanol produced from natural gas as feedstock has similar well-to-wake greenhouse gas emissions as other fossil fuels such as liquefied natural gas (LNG) and marine diesel oil (MDO). Bio-ethanol produced from second-generation biomass has a much lower global warming potential than fossil fuels. Both methanol and ethanol dissolve easily in water and are biodegradable (Ellis & Tanneberger, 2015).

Examples

The Port of Antwerp-Bruges has announced its intention to use and test the world's first hydrogen-powered tub by 2024 as part of an integrated greening program for the Port of Antwerp-Bruges fleet. The tug is manufactured by CMB.TECH and is part of the international leadership in the transition to environmentally friendly fuel powered vessels (Port of Antwerp Bruges, n.d.).

The port of Antwerp-Bruges also announced in 2021 the conversion of a tug to methanol propulsion, which was a world first. The so-called 'methatug' was part of the European Union-funded Fast water project, which aimed to demonstrate the feasibility of methanol as a sustainable marine fuel (Port of Antwerp Bruges, 2021). The implementation was scheduled for 2022, but was postponed to May 2024 (European Commission, 2024).

Amogy, an American fuel cell developer, plans to test an ammonia-powered clean tug to an inland waterway in New York state in 2024. The developer will retrofit a diesel generator and electric motor tugboat from 1957 with its clean power generation technology. The vessel is designed for a 1MW ammonia-to-power system, but further testing will determine the exact power output (Argus Media, 2024).

Svitzer, the company responsible for towing practices in many ports and terminals, has begun fuelling its five escort and port tugs operating at the South Hook LNG Terminal in Milford Haven, Wales (UK) with low-carbon hydrogenated vegetable oil (HVO) to reduce the greenhouse gas emissions under a new long-term agreement (Riviera Maritime Media, 2023).

1.2 The aim of alternative fuels

The main purpose of using alternative fuels to replace diesel is to reduce greenhouse gas and air pollutant emissions. Most truck manufacturers have approved the use of pure HVO100 in their engines, which means that the initial investment costs will be relatively low. (Lantmännen, 2023). All other alternative fuels require engines to be converted or specially made to run on that fuel, which significantly increases costs. Overall, alternative and cleaner fuels are still significantly more expensive than their fossil-fuel counterparts. However, this is expected to decrease over time and become more comparable (ABS et al., 2022, 2023; Ellis & Tanneberger, 2015).

1.3 Ports and other parties that use/have used sustainable fuels instead of diesel

- Port of Antwerp-Bruges
- Port of Aalborg
- Port of New York
- Van Berkel Logistics
- Svitzer

1.4 Stakeholders

- The port authority is responsible for the operational and capital expenses of its own ships. The port authority therefore decides what fuel to use and may decide to modify vessels to use alternative clean fuels. If a towing company is operating within the port area, a port authority can set requirements for fuel types and maximum greenhouse gas emission.
- Alternative fuel suppliers: When ships running on alternative fuels are used in the port area, the supply of this alternative fuel must be arranged.
- Towing companies (if applicable): In some ports, towing may be done by a separate company and not by the port authority. In this case, arrangements can be made between the towing company and the port authority concerning the type of fuel and maximum greenhouse gas emissions. If the port authority wants more sustainable towing services, operations will become more expensive and towing prices are likely to increase.

1.5 Voluntary or mandatory

Currently, there are no direct requirements for port vessels for the use of sustainable fuels. However, it is likely that this will play a greater role in the future, as greenhouse gas emission requirements become more prevalent, and the entire shipping industry needs to become more sustainable.

1.6 Realised/potential impact

To compare the environmental impact of the sustainable alternative fuels and conventional fossil fuels, Table 1 provides an overview of the WTW GHG emissions (expresses in gram $CO_{2eq.}$/MJ) of all these fuels.

Table 1 - CO_2-eq. g/MJ WTW emissions from different types of fuels for inland traffic (ABS et al., 2022, 2023; CE Delft, 2021b; Ellis & Tanneberger, 2015)

Fuel	WTW

MGO (Marine Gasoil)	91
MDO (Marine Diesel Oil)	± 90
VLSFO (Very Low Sulphur Fuel Oil)	92
Liquefied Natural Gas (LNG)	87.9
HVO (Hydrotreated Vegetable Oil)	10.1
Green hydrogen (wind energy electrolysis)	4 - 10
Green hydrogen (solar energy electrolysis)	9.3 - 30
Blue hydrogen (natural gas, CCS)	18 - 63
Grey hydrogen (natural gas)	71 - 120
Methanol (farmed wood)	± 7
Methanol (waste wood)	± 1
Ethanol (Brazil sugar cane)	± 22
Ethanol (US corn)	± 70
Green ammonia (low-temperature electrolysis)	0 - 12
Green ammonia (high-temperature electrolysis)	0 - 13
Grey ammonia (SMR)	100 - 137

From Table 1, it becomes clear that a grey variant is used for an alternative fuel, the greenhouse gas emission reductions are limited or may even exceed the greenhouse gas emissions of conventional fossil fuels. Greenhouse gas emissions from alternative fuels depend largely on the production technique and on the feedstock used. For example, green hydrogen leads to significantly lower greenhouse gas emissions than blue hydrogen. Abd ethanol made from sugarcane in Brazil leads to significantly lower greenhouse gas emissions than ethanol made from corn from the United States. Table 2 shows the well-to-tank (WTT) air pollutant emissions on a qualitative scale for conventional fossil and alternative fuels.

Table 2 - Air pollutant WTT emissions from different types of fuels (ABS et al., 2022, 2023; CE Delft, 2021a, 2021b; Ellis & Tanneberger, 2015)

Fuel	**SO_x & metals**	**NO_x**	**PM**
MGO (Marine Gasoil)	Present	Present	Present
MDO (Marine Diesel Oil)	Present	Present	Present
VLSFO (Very Low Sulphur Fuel Oil)	Reduced	Present	Reduced

Liquefied Natural Gas (LNG)	Not present	In general, meet Emission Control Area standards	Reduced
HVO (Hydrotreated Vegetable Oil)	Reduced	Reduced	Reduced
Green hydrogen (combusted in engines)	Not present	Not present	Not present
Green hydrogen (used in fuel cells)	Not present	No significant NO_x emissions	Not present
Methanol	Reduced	Reduced	Reduced
Ethanol	Reduced	Slightly reduced	Reduced
Ammonia (combusted in engines)	Not present	Needs a selective catalytic reduction (SCR) for Emission Control Area standards	Reduced

1.7 Possible obstacles

- The results of the Green Inland Ports survey (2024) show that there are not yet enough ports and parties that have implemented this good practice to make a statement about the difficulty of implementation.
- The amount of greenhouse gas emissions depends largely on the method and type of feedstock used to produce the fuel. This means that it is not enough just to prescribe which fuels are required, but that strict rules and regulations around emissions are needed to avoid the use of 'grey' alternative fuels.
- Existing ships and marine engines often need to be retrofitted to run on alternative fuels. This involves high investment costs. In addition, the costs of alternative fuels are currently still higher than the costs of conventional fuels. These additional costs may be an obstacle to the implementation of this good practice.

1.8 Key learnings

The port authority can set an example for other ships by running port-owned ships on alternative fuels.

1.9 Sources

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