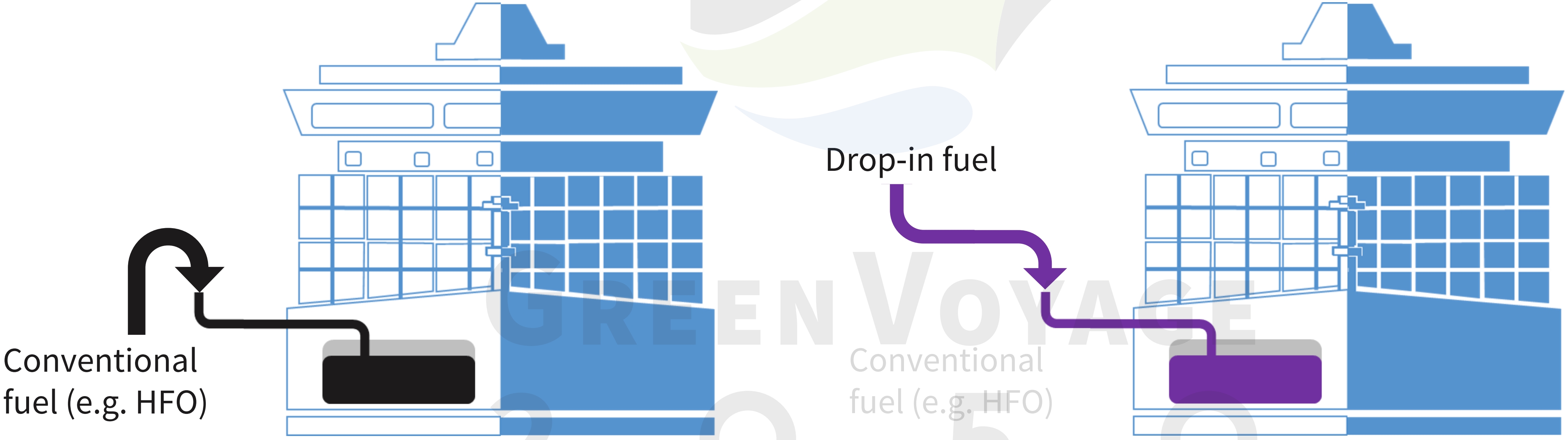
Key concepts

2. Fuel use

Key concept: ‘drop-in’ fuels

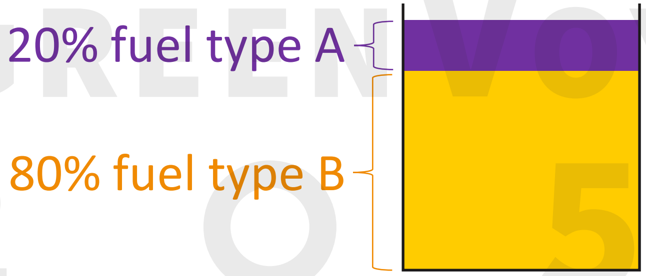
- ‘Drop-in’ refers to a fuel that can be directly used in place of an existing fuel with minimal alterations to the equipment using the fuel.
- In some cases, an alternative fuel may not be useable in its 100% pure form and may require ‘blending’ to produce a drop-in solution.



Key concept: blending of drop-in fuels

- ‘Blending’ refers to mixing an amount of one type of fuel with another type, expressed as a percentage (%) of the total mixture*.
- Usually describes the amount of an **alternative fuel** added to a **traditional fuel.**
- Maximum limits on how much alternative fuel can be added are often dictated by quality standards, technical requirements and the properties of the alternative fuel.
- This maximum limit is sometimes referred to as the **blend wall**.
- Fuel blending is undertaken prior to delivery of the fuel and is **not usually carried out by end-users**.

Example: 20% blend



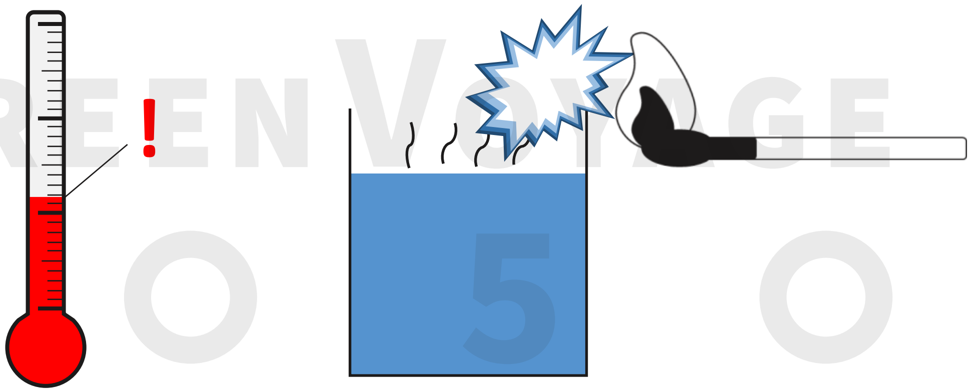
Q: How does this affect emissions?

A: For GHGs, weighted average of emissions per energy of fuel

*in this course, we will consider this percentage (and blending rate) by volume, although it can also be considered by mass.

Key concept: flashpoint

- When exposed to the open atmosphere, liquid fuels can release vapour. How readily this happens depends on the **volatility** of the fuel and the atmospheric conditions.
- When exposed to a source of ignition, such as an open flame, the vapour can ignite.
- The **lowest temperature** at which this happens is known as the fuel's '**flashpoint**'.
- Fuels with a low flashpoint can present an increased handling risk, which we will explore further as part of the detailed fuel sessions.
- Flashpoint requirements are outlined in the SOLAS regulations and The International Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF Code).



Key concept: energy density

- There are two key measures of energy density that we will examine as part of this course:
  - Volumetric energy density
  - Gravimetric energy density

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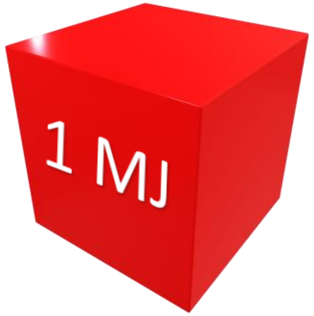
  - **Volumetric energy density**
  - Gravimetric energy density

$$\text{Volumetric energy density} = \frac{\text{Energy content (e.g. MJ)}}{\text{Volume (e.g. l)}}$$

Fuel A
(16 MJ/l)



Fuel A…

has a… **lower** volumetric energy density
which means it contains… **less** energy for the same volume of fuel
so it takes up… **more** space for the same amount of energy

Fuel B
(35 MJ/l)

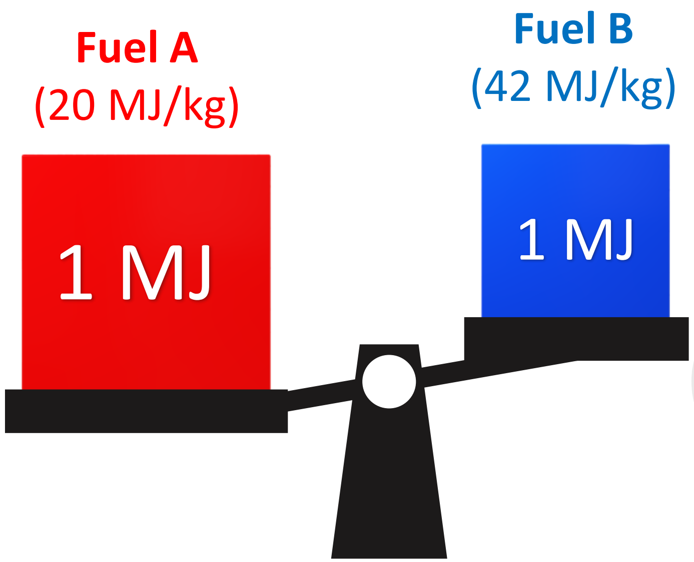
Fuel B…

has a… **higher** volumetric energy density
which means it contains… **more** energy for the same volume of fuel
so it takes up… **less** space for the same amount of energy

Key concept: energy density

- There are two key measures of energy density that we will examine as part of this course:
  - Volumetric energy density
  - **Gravimetric energy density**

$$\text{Gravimetric energy density} = \frac{\text{Energy content (e.g. MJ)}}{\text{Mass (e.g. kg)}}$$



Fuel A…

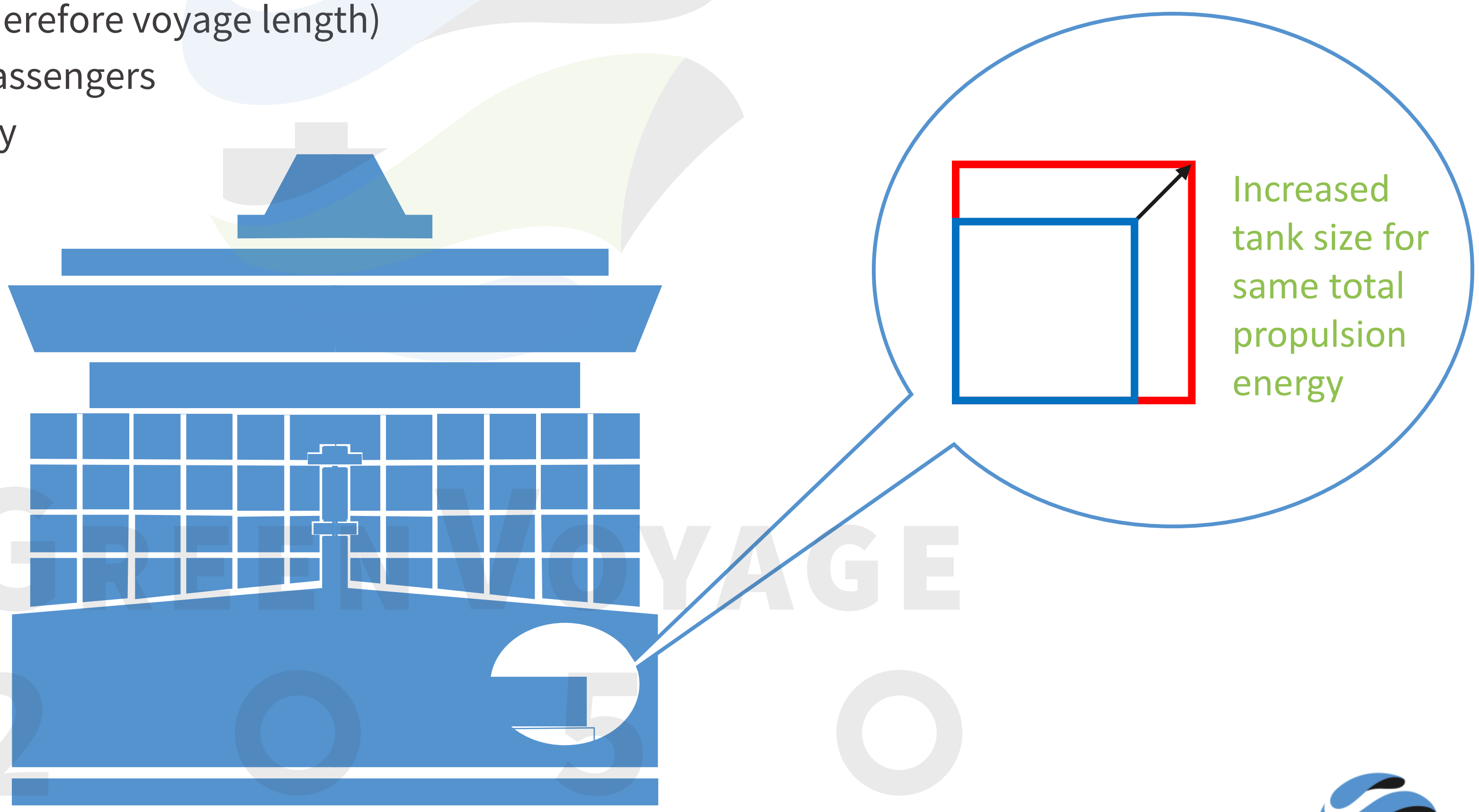
has a… **lower** gravimetric energy density
which means it contains… **less** energy for the same mass of fuel
so it weighs… **more** for the same amount of energy

Fuel B…

has a… **higher** gravimetric energy density
which means it contains… **more** energy for the same mass of fuel
so it weighs… **less** for the same amount of energy

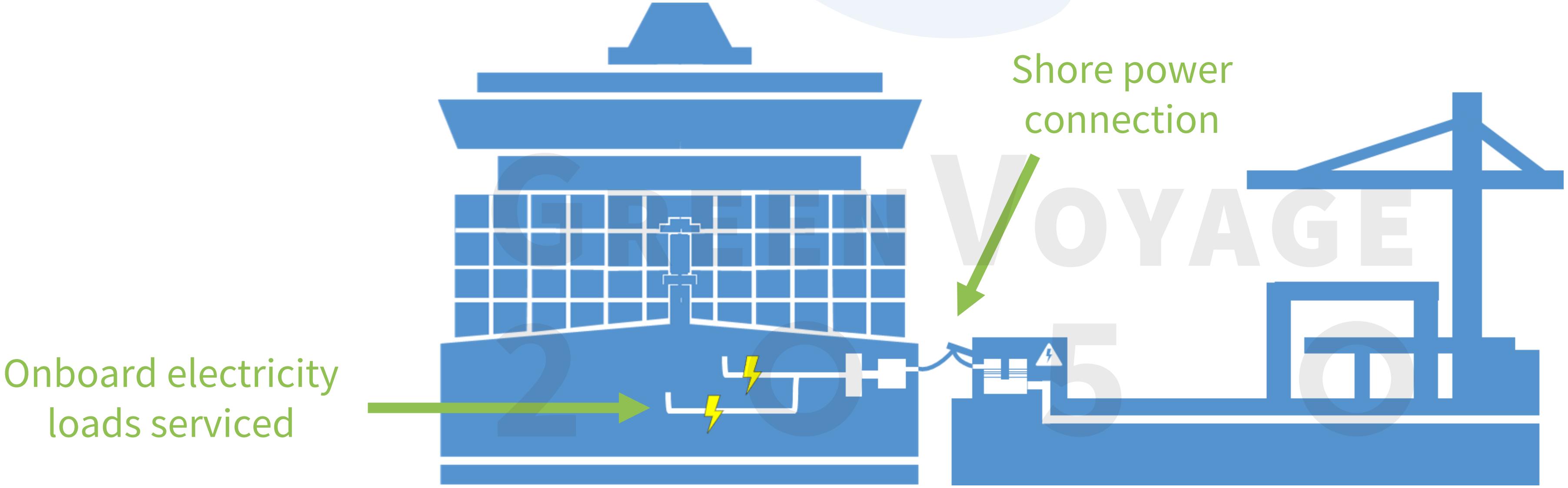
Key concept: energy density

- The energy density affects amount of energy that can be stored on board for a given volume or mass, which therefore can affect:
  - Available engine hours (and therefore voyage length)
  - Space available for cargo or passengers
  - The deadweight cargo capacity



Key concept: cold ironing

- This key concept refers to the use of electricity by vessels when they are in port.
- Electricity is provided to service onboard power demand (e.g. from lighting, refrigeration etc) via a shore-to-ship connection (known as a **shore power** system).
- The term was first used to refer to coal-fired ships when they were moored in harbour – the iron furnaces didn’t need to be fed and would literally cool down.
- Cold ironing is used to reduce emissions when in port, which are produced by burning fuel for onboard power generation.



Key concept: methane and ammonia slip

- '**Slip**' in this context is used to refer to the leakage of **unreacted fuel into the atmosphere** from the onboard system.
- **Methane slip** can occur from LNG-powered vessels, which, due to the potency of methane as a greenhouse gas, can offset any carbon emissions savings even when emitted in relatively low quantities*.
- **Ammonia slip** could similarly occur from ammonia-powered vessels, or from vessels using some types of NOx emissions abatement technology, resulting in a negative impact on local air quality.
- We will discuss these concepts in more detail as part of the relevant fuel sessions.

*Methane has a global warming potential of 28[1], meaning that 1 tonne of methane causes the same global warming effect as 28 tonnes of CO_2.

[1] GWP100 value. IPCC 5th Assessment Report. https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf

Key concept: Technology lock-in

- Technology lock-in describes a situation where a particular technology becomes a **dominant incumbent solution**, presenting **barriers to adoption of alternatives.**
- This issue is particularly relevant to the maritime sector, given the long lifetimes of vessels.
- Technology lock-in can be driven by several factors, for example:
  - Changing from an incumbent technology to a new technology may involved financial barriers, such as new upfront investment or sunk costs that cannot be recovered.
  - Regulatory environments, supporting infrastructure and industry practices may have developed in accordance with the specifics of a particular technology, requiring time and investment to change or adapt to suit new solutions.
  - Driven by uncertainty associated with new options (e.g. regarding safety or reliability), strong stakeholder preferences for a well-known incumbent solution may develop, hindering adoption of alternatives.
- If a technology that does not deliver required reductions in GHG emissions becomes ‘locked in’, this could present a risk to meeting GHG reduction targets.