IMPACTS OF A BAN ON HEAVY FUEL OIL USE AND CARRIAGE AS FUEL BY SHIPS IN THE NORWEGIAN ARCTIC WATERS

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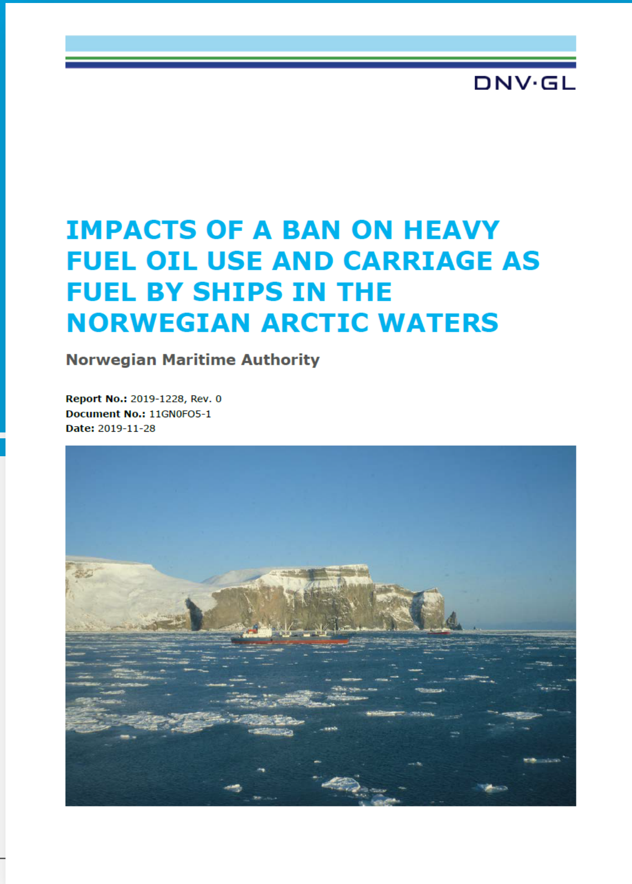
04 February 2020



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Norwegian Maritime Authority

Report No.: 2019-1228, Rev. 0
Document No.: 11GN0FO5-1
Date: 2019-11-28

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Economic implications for the Norwegian Arctic of an HFO ban

Fuel alternatives with the new regulatory regime

What are the environmental properties of these fuels when spilled to the Arctic sea?

How will the environmental risk be affected by an HFO ban in the Arctic?

Purpose of study and main findings

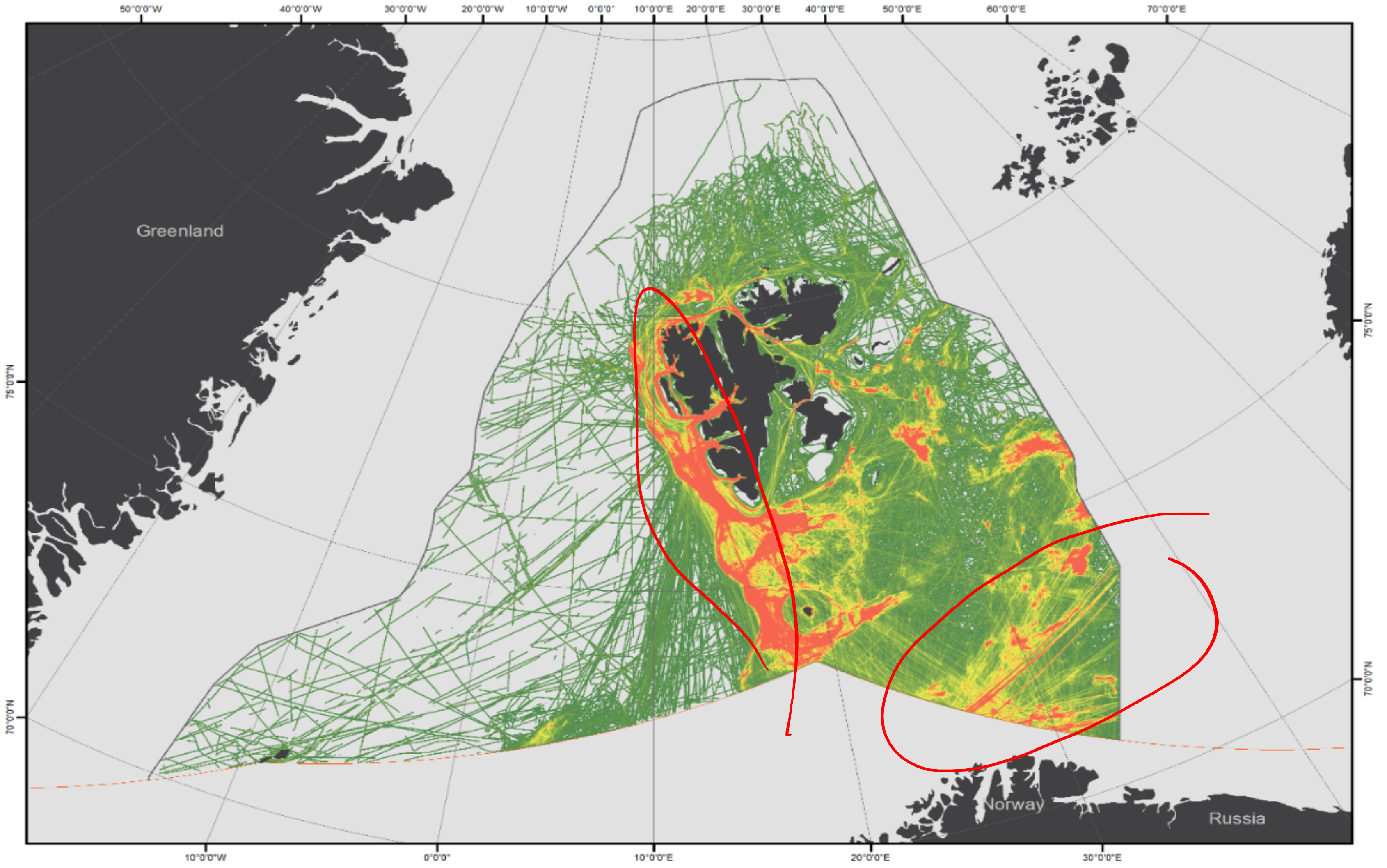
- Assess the economic impact of an arctic HFO ban on local activities and industries in the Norwegian Arctic communities

Our conclusion: Marginal

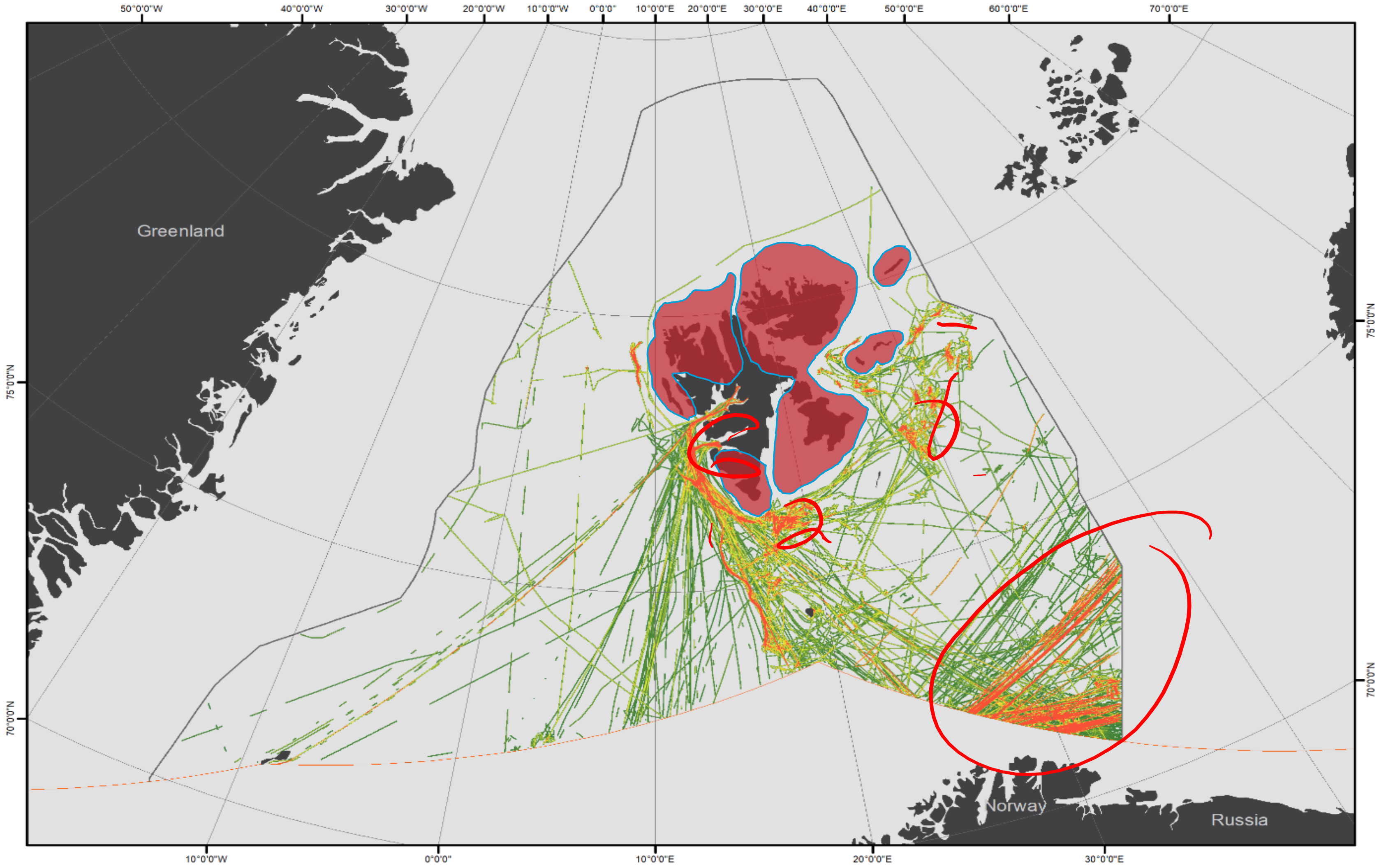
- Assess whether the proposed HFO-ban fulfils its policy objective of reducing the environmental risks related to HFO spill from shipping in the Norwegian Arctic waters.

Our conclusion: Uncertain, but probably not

The Norwegian Arctic – ship traffic density



The Norwegian Arctic – HFO ship traffic density



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Effects on the local Norwegian economy from an HFO ban

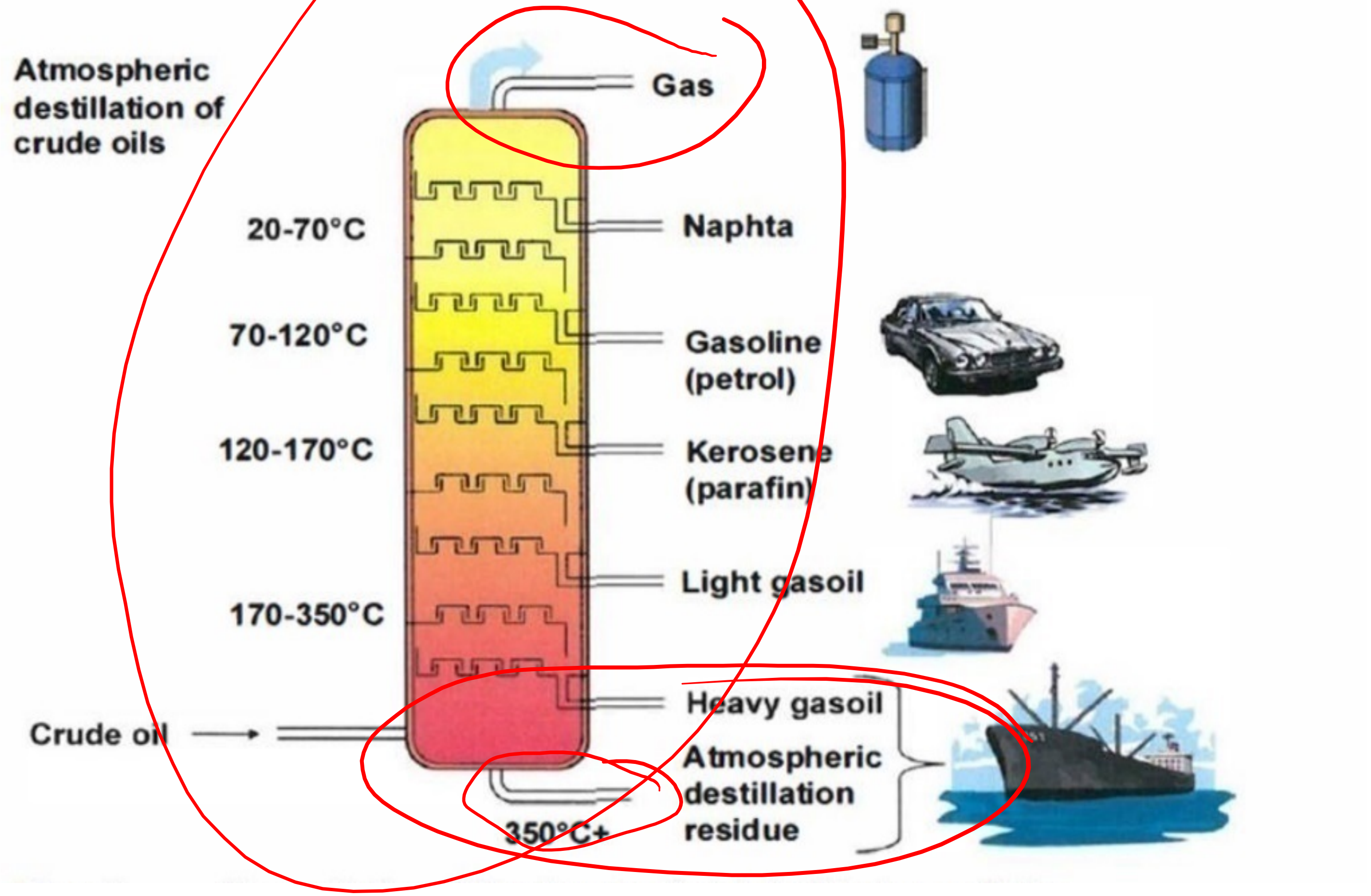
- In practice the transition to distillate fuels is already done for nearly all supply lines and activities to/from Norwegian ports.
- The limited coal export will be having to pay more for transport of coal.
- The large – high volume – cruise vessels will be affected – but the major incomes come from smaller expedition cruise vessels already using distillate fuel.
- New oil qualities (hybrid fuels) will require research and development of new oil contingency equipment – irrespective of a HFO ban.

Crude oil distillation and fuel alternatives

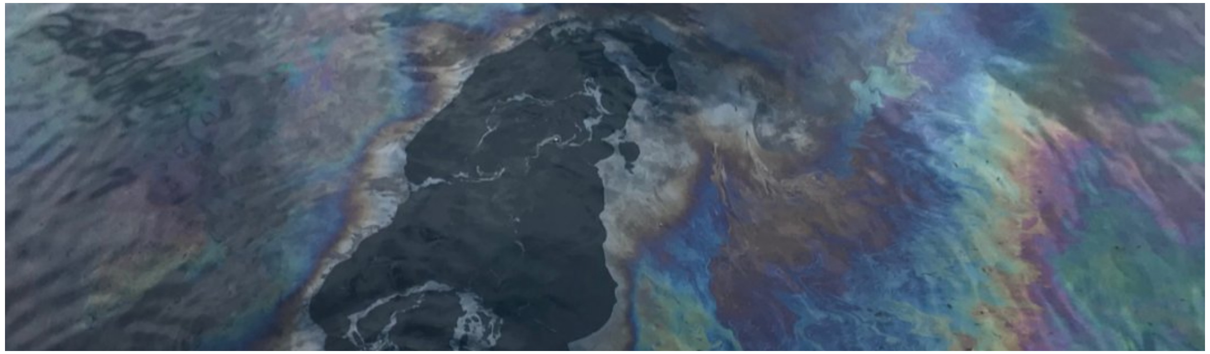
- Marine fuel oil is distilled from crude oil, and may be sorted in two main categories:
  - **Distillate fuel** – smaller and lighter hydrocarbons – lower boiling point
  - **Residual fuel** – containing large and heavy hydrocarbons – high boiling point – non-distillable

  HFO contains residue according to the desired qualities required for the blend.

  Depending on the crude – sulphur content will wary.



Distillate oils versus residual oils when spilled to sea



- Distillate oils do not persist on the surface of the sea for long, as a result of the fast evaporation of the volatile components and the easy dispersion. Neither do they emulsify and solidify, but they may be highly toxic.
- Cold climate will affect the process, but with limited consequences.

- Heavy fuel oils are persistent in the environment, because they contain a high ratio of non-volatile components and they have a high viscosity, emulsify (leading to volumetric growth) and solidify.
- In cold climate, these properties are particularly problematic and available abatement technologies limit response effectiveness.

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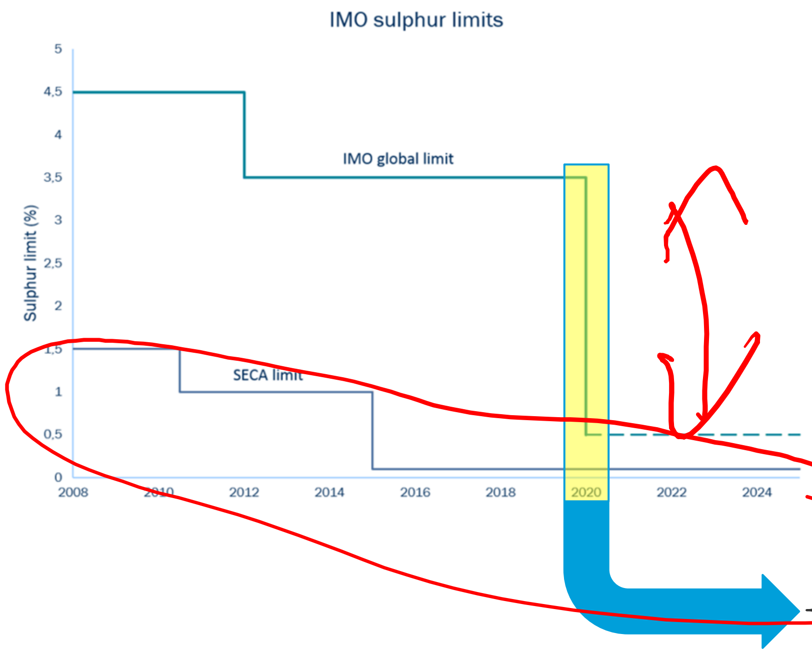
New sulphur limits lead to new fuel qualities



Fuel type	Price (USD/ton)
HFO	338
VLSFO	527
ULSFO	553
MGO	633

1. HFO with Scrubber
2. Low sulphur fuel
   1. Distillate fuel < 0.1% S
   2. Ultra Low Sulphur FO (ULSFO) < 0.1% S
   3. Very Low Sulphur FO (VLSFO) < 0.5% S
   4. LNG ++

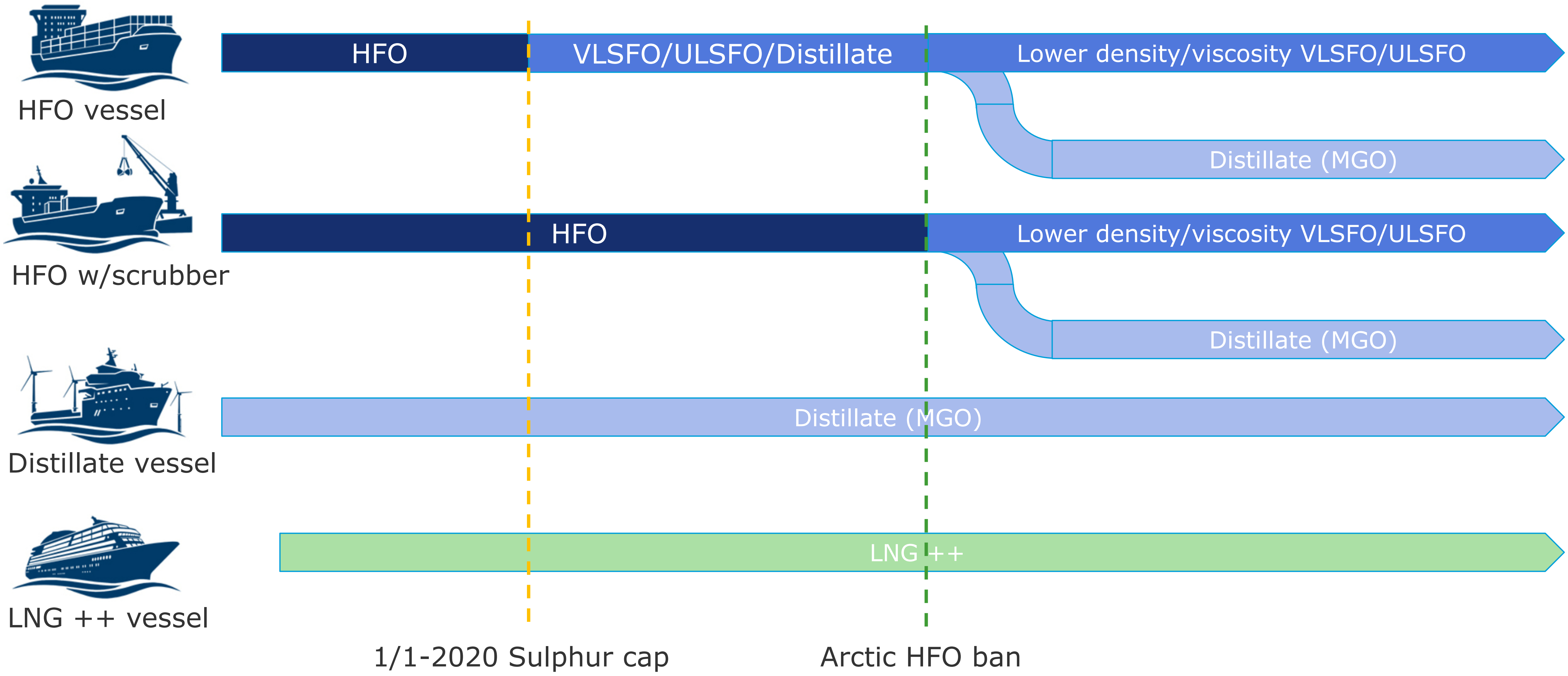
These residual hybrid fuels are designed to be used by HFO machineries without conversion

Definition of HFO, and will ULSFO and VLSFO be under limit?

- Assume same definition as in Antarctica:
  – Oils having a density at 15°C higher than 900 kg/m3, or a kinematic viscosity at 50°C higher than 180 mm2/s
- ULSFO hybrid oil is currently available at “sub-HFO” standard
- DNV GL believe such VLSFO hybrids will also be available

Hence – the new hybrid fuels will likely be adapted and used under an Arctic HFO ban

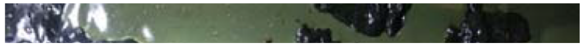
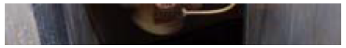
The Arctic HFO ban – Fuel alternatives



Will an HFO-ban reduce the environmental risks related to oil spill?

- Is it better to spill hybrid fuel (USLFO/VLSFO) to arctic water than HFO?
  - Still limited data available - BUT the tests that have been performed (in cold water) reveals:
  - Less soluble in water than distillates and caused little toxic effect.
  - But they may solidify on the sea-surface and form solid lumps, requires special skimmers for oil recovery, chemical dispersion may have limited effect and in-situ burning difficult.

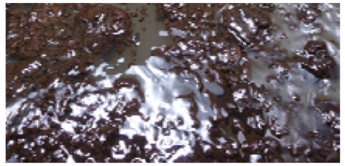
Example ULFSO at 2°C, (pour-point = +24°C)


The key question will then be how different the weathering properties and behaviour could be for the hybrid oils (ULSFO/VLSFO), as they seem to have "similar" weathering properties as HFOs', and in addition could solidify on the sea surface at low temperatures?

Just after release (0 hr)
→ immediately solidified lumps
(5000 mPas)

After 72 hours:
Stable emulsion
(75 -80 % water)
(25000 mPas)



After 72 hours weathering, and just after dispersant treatment:
- Low effectiveness: < 20 % disp.
- Surface: 25000 → 14000 m Pas

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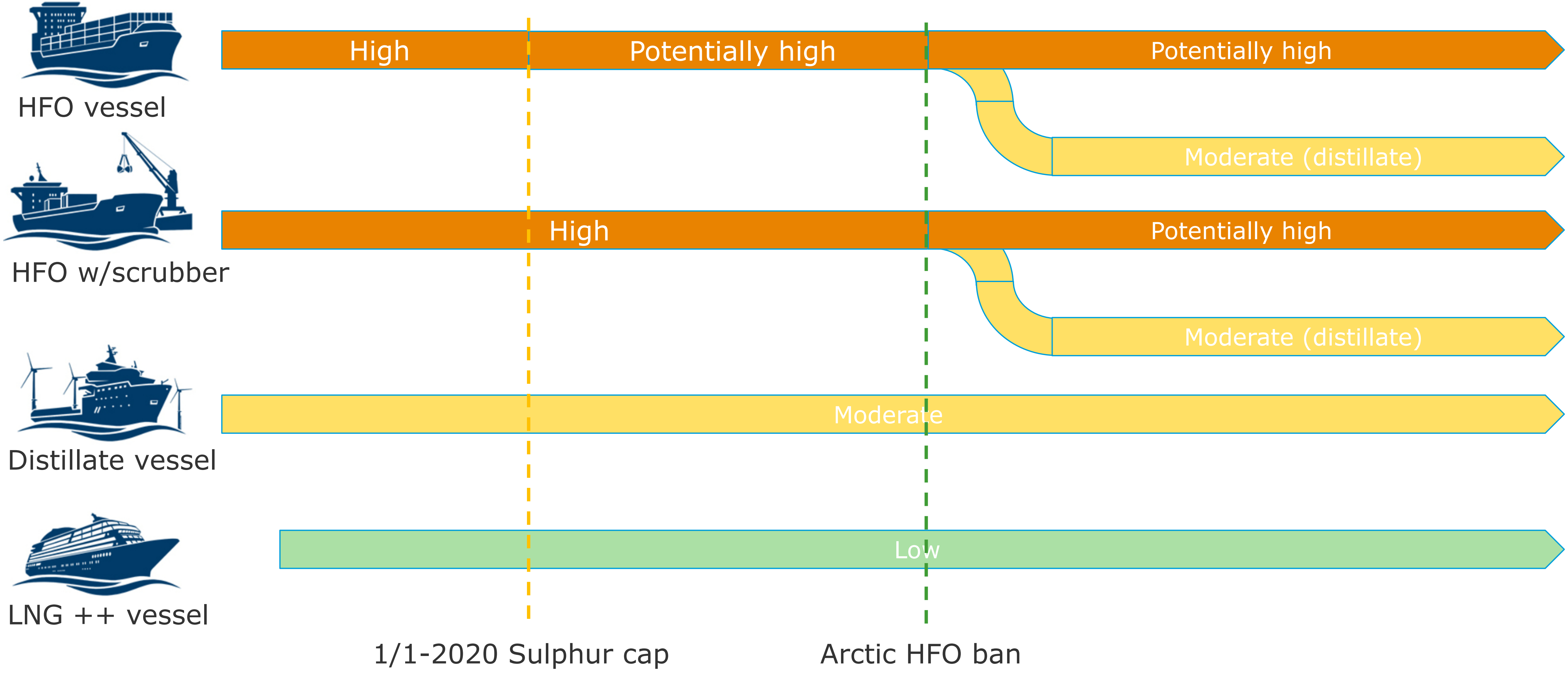
The Arctic HFO ban – Environmental risk



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