Environmental impacts of LNG as a shipping fuel

LNG in Shipping,
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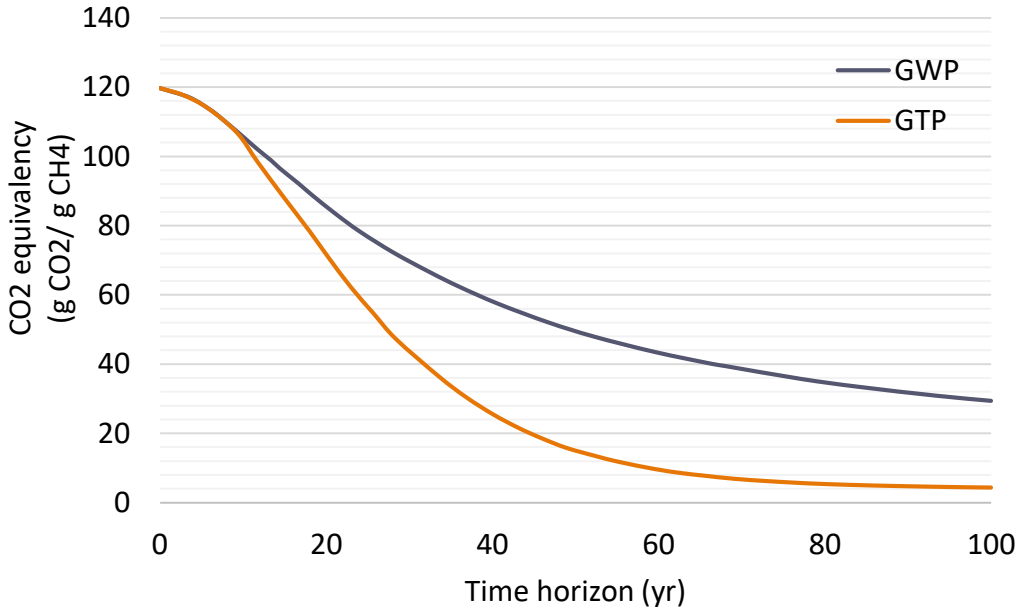
Background

- International shipping is facing tougher constraints: NO_X, SO_X, GHGs
- But shipping demand may grow 50-250% up to 2050

  - What role for LNG in meeting these targets?
  - Air quality emissions are mostly reduced
  - CO_2 emissions are reduced
  - But methane may marginalise this benefit?
    - On-board emissions: lack of data
    - Supply chain

Methane and the Climate

Metric	Methane	Carbon dioxide
Atmospheric lifespan	12 years	100s years
Instantaneous climate forcing	120	1
Global Warming Potential (GWP 20 years)	84-87	1
Global Warming Potential (GWP 100 years)	28-36	1



Small release of methane = large impact (at least in the short term)

Aims and Scope

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- Determine the life cycle environmental and economic impacts associated with LNG as a shipping fuel and compare to alternative fuels.

- Determine the methane emissions required to ensure a climate benefit over liquid fuels

- Assess further decarbonisation opportunities and potential for LNG to contribute to IMO target

Results:
The Impact of Methane

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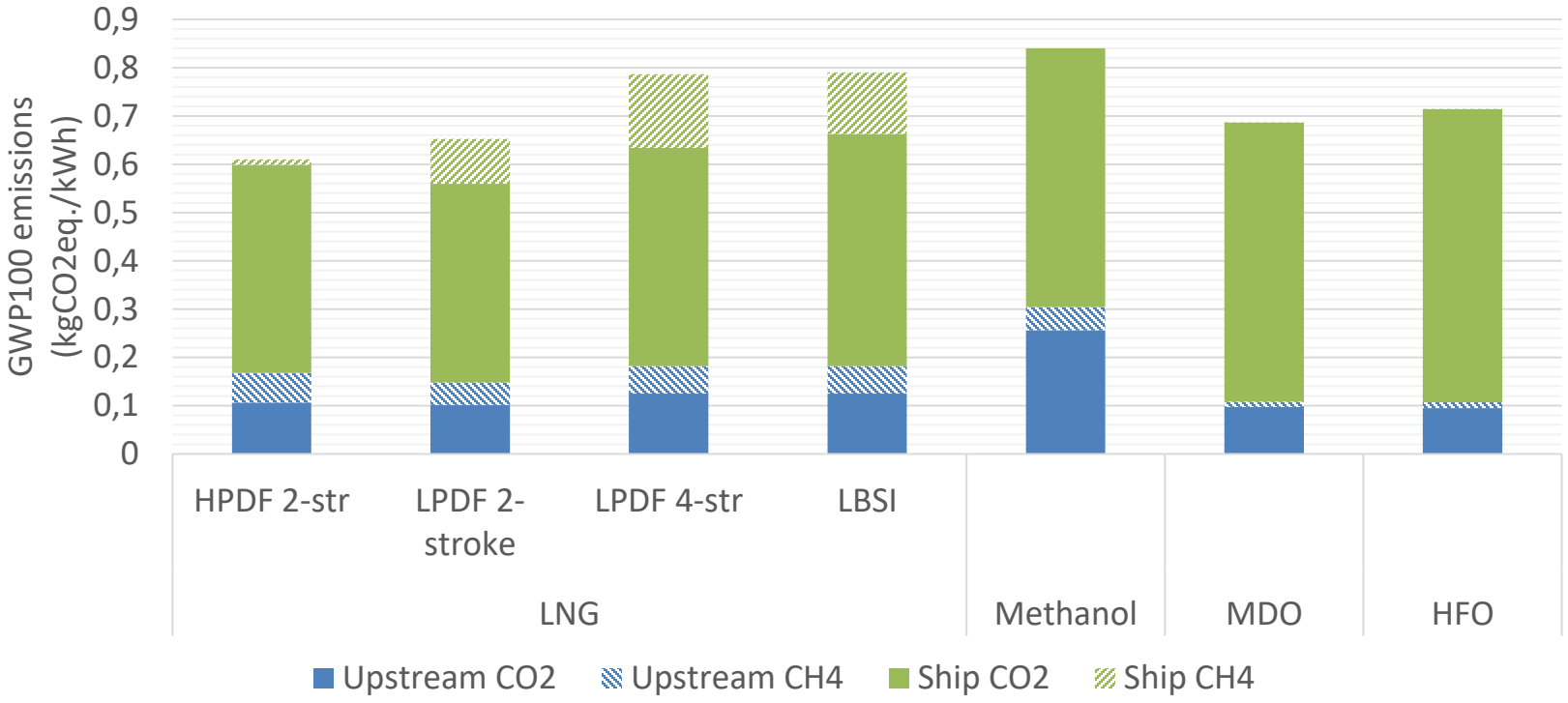
- 2 LNG engines perform well on a GWP100 basis: HPDF and LPDF 2-stroke
- High engine efficiencies and lower methane emissions
- Methane emissions for other engines are unacceptably high from the best available data



The GHG reduction potential of LNG

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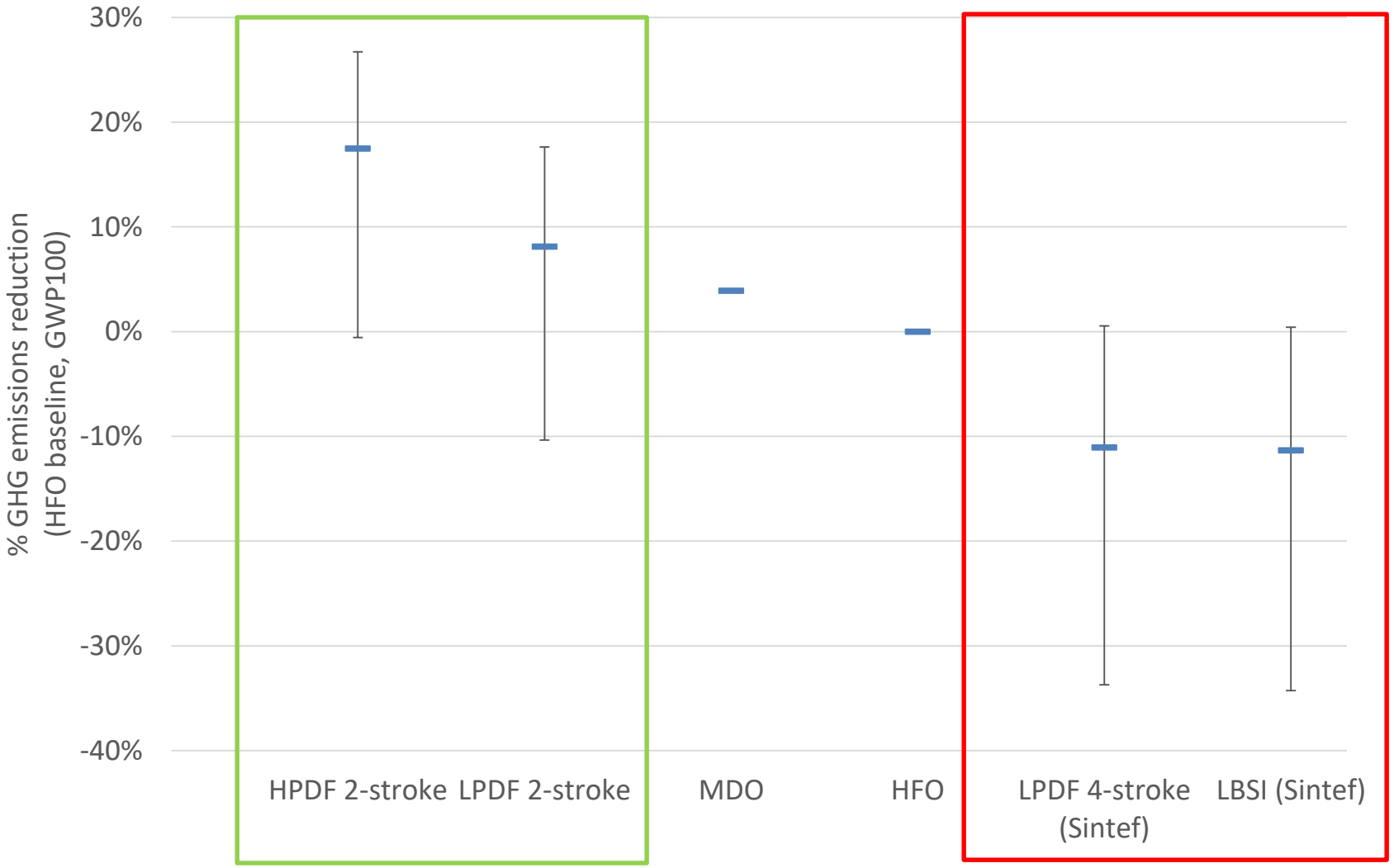

The Pros and Cons of LNG

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	LNG:				Methanol	MDO	HFO
	LPDF 4-stroke	LBSI	HPDF 2-stroke	LPDF 2-stroke			
GWP100	×	×	✓	-	×	×	×
Climate long term (GTP100)	-	-	✓	✓	×	×	×
Climate short term (GWP20)	××	××	✓	×	×	×	×
Ozone creation	✓	✓	×	✓	×	-	×
NOX	✓	✓✓	××	✓✓	✓	××	××
SOX	✓✓	✓✓	✓✓	✓✓	✓✓	-	××
Particulates	✓✓	✓✓	✓✓	✓✓	✓✓	✓	××
Cost	✓✓	✓✓	✓✓	✓✓	××	××	×

- LNG performs well on most indicators, but is penalised by methane emissions.
- HPDF engines perform the best regarding climate and cost, but not NO_x.
- Measured methane emissions data is lacking

Further conclusions

- If methane emissions are constrained, a combination of LNG and other efficiency measures, together with bio-LNG will enable IMO decarbonisation targets to 2050.

- Great care must be taken to avoid supply chain routes with high embodied emissions and the impact of ‘super-emitters’.

- There is an urgent need for more independent, transparent and robust measurements of emissions to prove environmental credentials:
  - LNG-fuelled ships in operation
  - LNG shipping
  - LNG bunkering
  - Across the supply chain in general for regions other than the US