

NSTA Emission Reduction

Armada Kraken FPSO
Alternative Liquid Fuel &
Fuel Gas Usage Efficiency



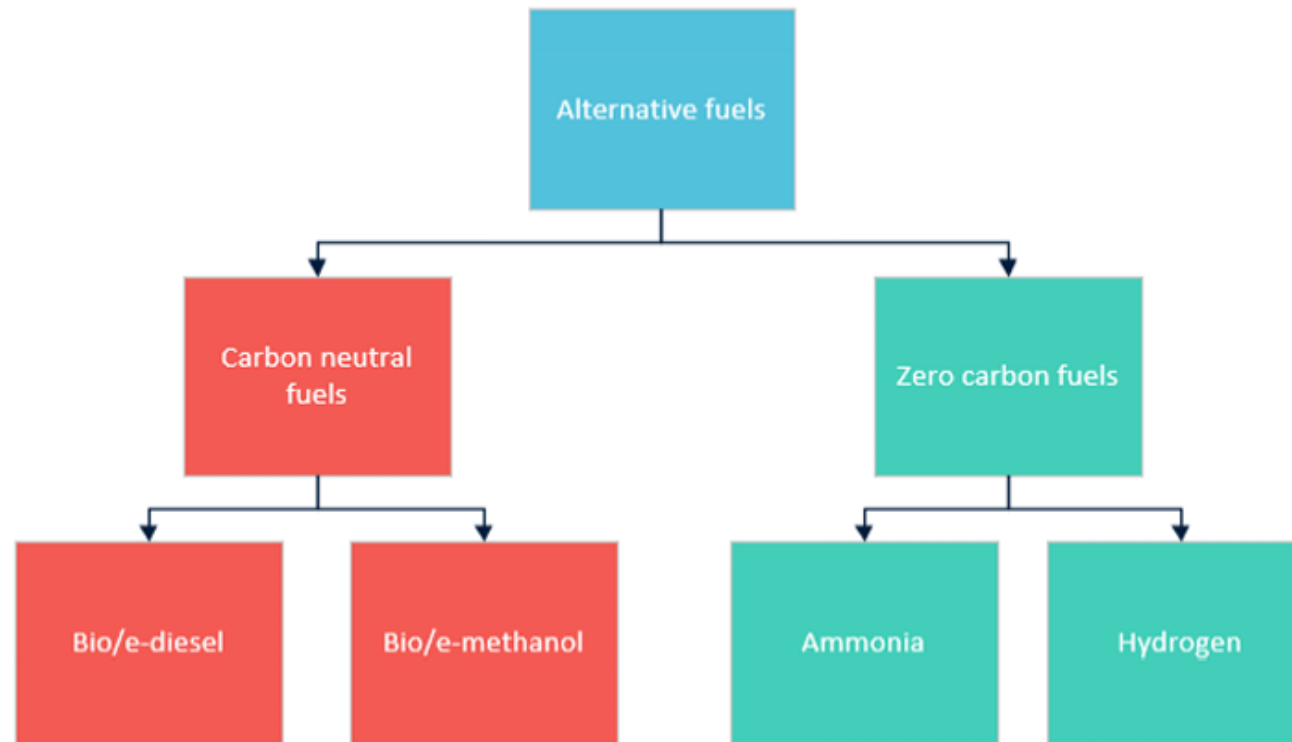
Alternative Fuel

Armada Kraken

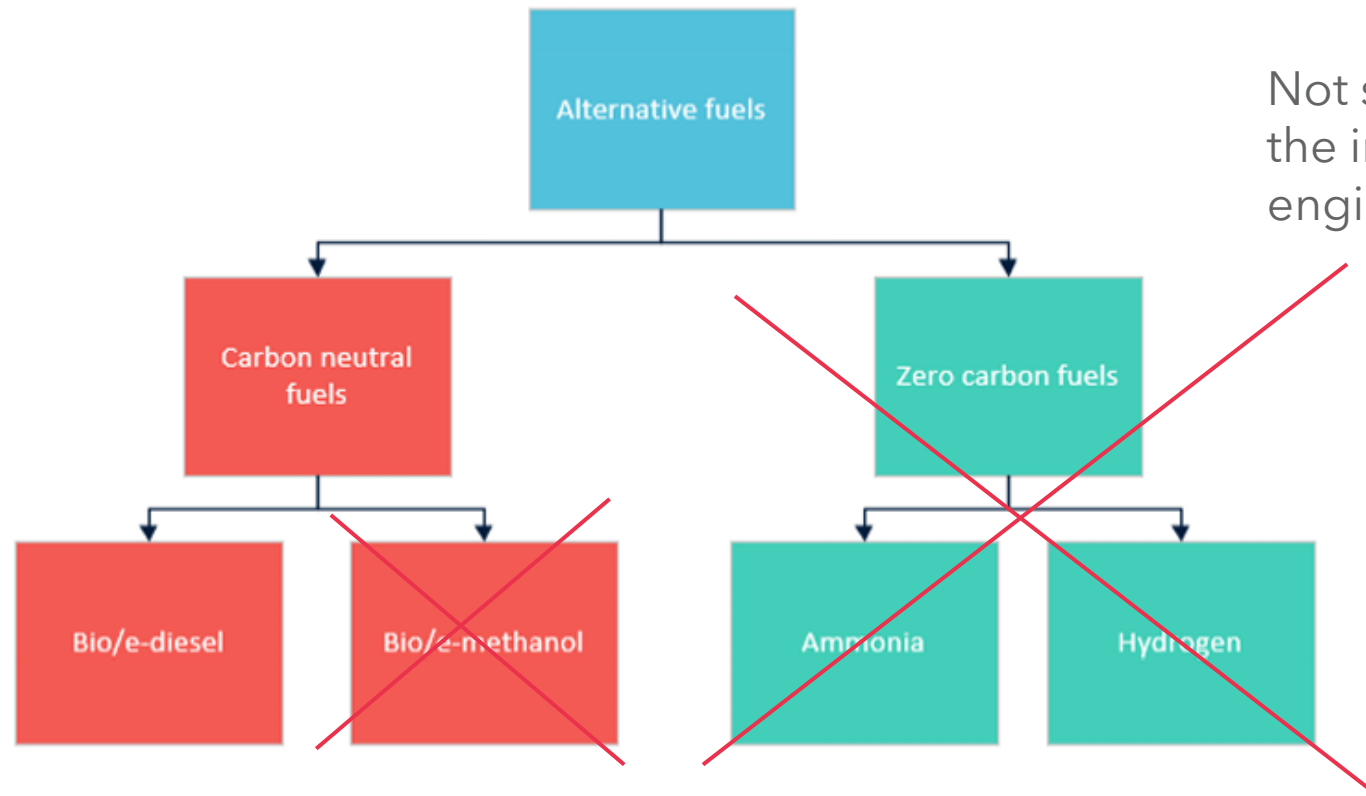
- Heavy Oil FPSO – First Oil June 2017
- Operated by Bumi Armada on behalf of EnQuest
- Energy Demand
 - 28 MW Electricity
 - 4 x Wärtsilä 16V50 Engines
 - 45 MW Heat
 - 3 x Hamworthy MAL80BF Steam Boilers
- Fuel: Produced gas or Diesel (crude oil no longer permitted)
- Available Liq. Fuel Storage: 3200m³
- Current diesel usage ~ 50k tonnes/annum



Feasibility Study

The Apollo logo, featuring the word 'apollo' in a lowercase, sans-serif font, with a small red and blue icon to the right.The BUMIARMADA logo, featuring a stylized green and blue icon to the left of the word 'BUMIARMADA' in uppercase, sans-serif font.The EnQuest logo, featuring a stylized 'EQ' in blue and purple, with the word 'EnQuest' in blue text below it.The Net Zero Technology Centre logo, featuring a stylized green and blue icon to the left of the text 'Net Zero Technology Centre' and 'Technology Driving Transition' below it.

Feasibility Study



Not suitable for use in
the installed Wärtsilä
engines

Bio Diesel or E-Diesel

Developing Technology

FAME

Fatty Acid Methyl Ester

- Strong Solvent
- 0°C Cold Filter Plugging Point
- Hydroscopic
- Microbial Growth
- Short Shelf Life <6 months
- Widely blended in filling station Diesel

HVO

Hydrogenated Veg Oil

- -30°C Cold Filter Plugging Point
- 10+ year Shelf Life
- Drop in Diesel Alternative
- 1.8x cost of Diesel
- Supply chain risk?

E Diesel

- CO₂ capture, green hydrogen
- eReact™ & Fischer Tropsch Synthesis
- Surplus Renewable electricity source required
- Not currently widely available
- 3x cost of Diesel

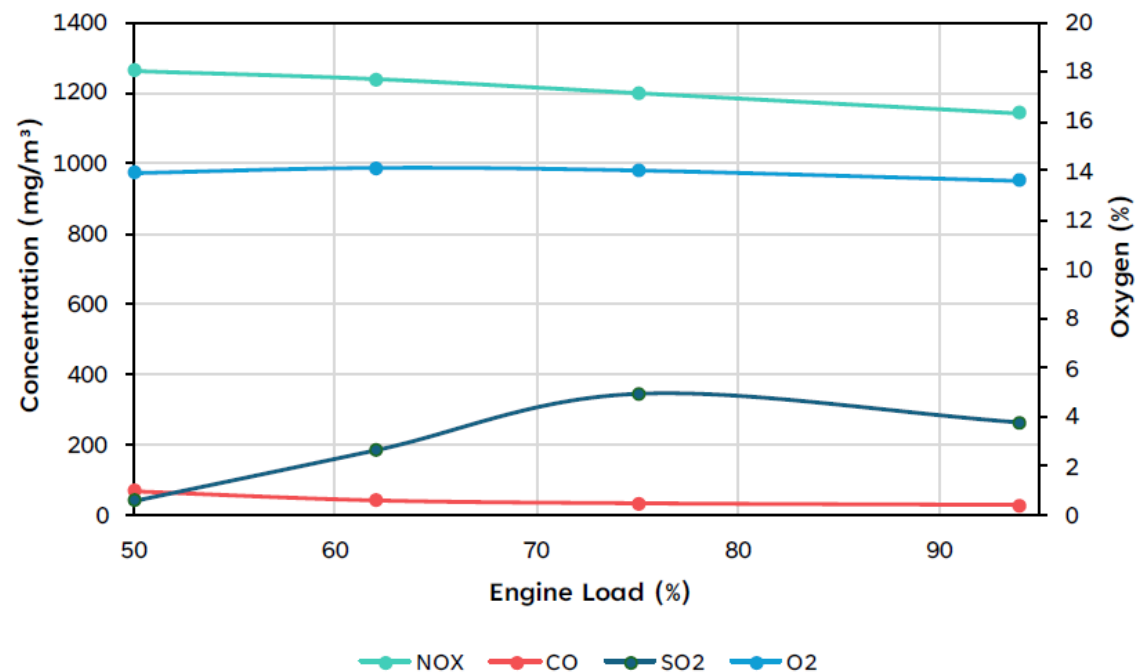
Advanced BioDiesel

- Similar to HVO
- Advanced Feedstock not used for food
- Higher yield per unit of land
- Still under development

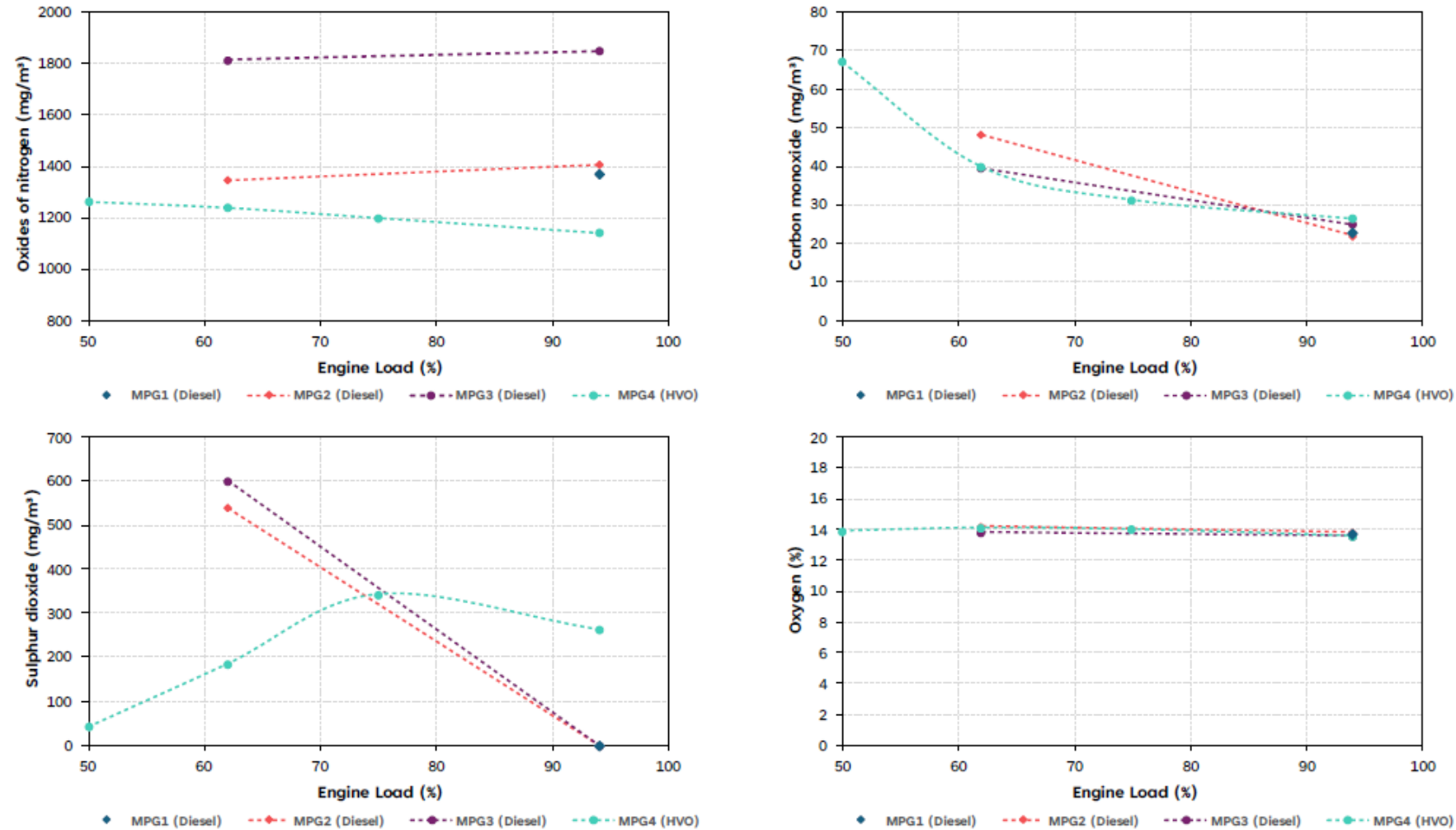
Alternative Fuel

Field Trial

- Wärtsilä MPG4 selected for the trial - no modifications were made.
- Day tank drained of Diesel and filled with HVO
- Operated on 100% HVO at 25%, 50%, 75% and 94% of max power, 2 hrs at each stage
- Then run in isochronous mode with two other generators for 24 hrs
- 59.3m³ HVO consumed



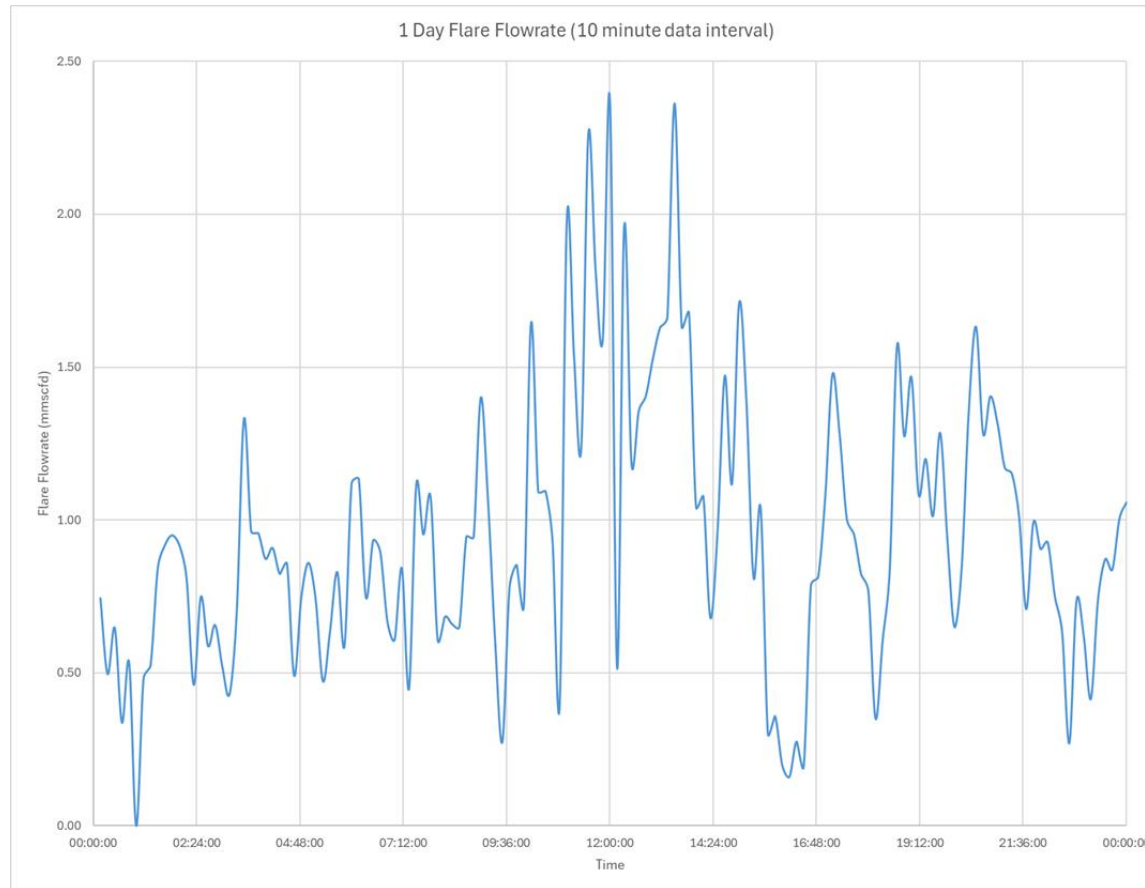
Performance Comparison



Conclusions

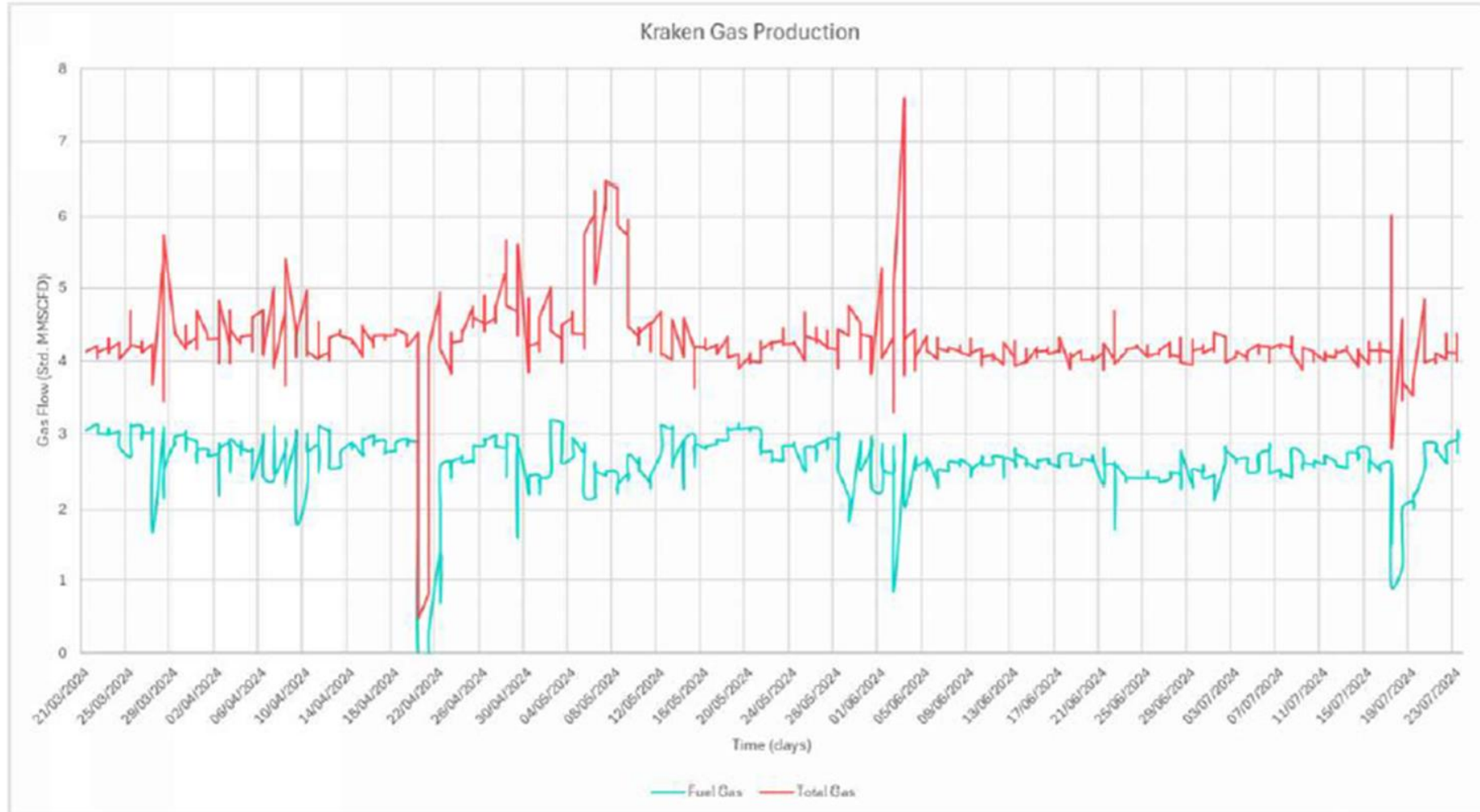
1. HVO functions as marketed i.e. a drop in Diesel substitute
2. HVO was supplied with full compliance to ISCC (International Sustainability and Carbon Certification) and EU Renewable Energy Directive II (RED II) requirements
3. Certas Energy UK Limited confirms they can satisfy 10k tonnes/ annum demand
4. UK Gov GHG Conversion Factors for Company Reporting assigns an emission factor for:
 - **HVO = 0.04562 tonnes CO₂/ tonne**
 - **Diesel = 3.164 tonnes CO₂/ tonne**

Slugging Gas Production



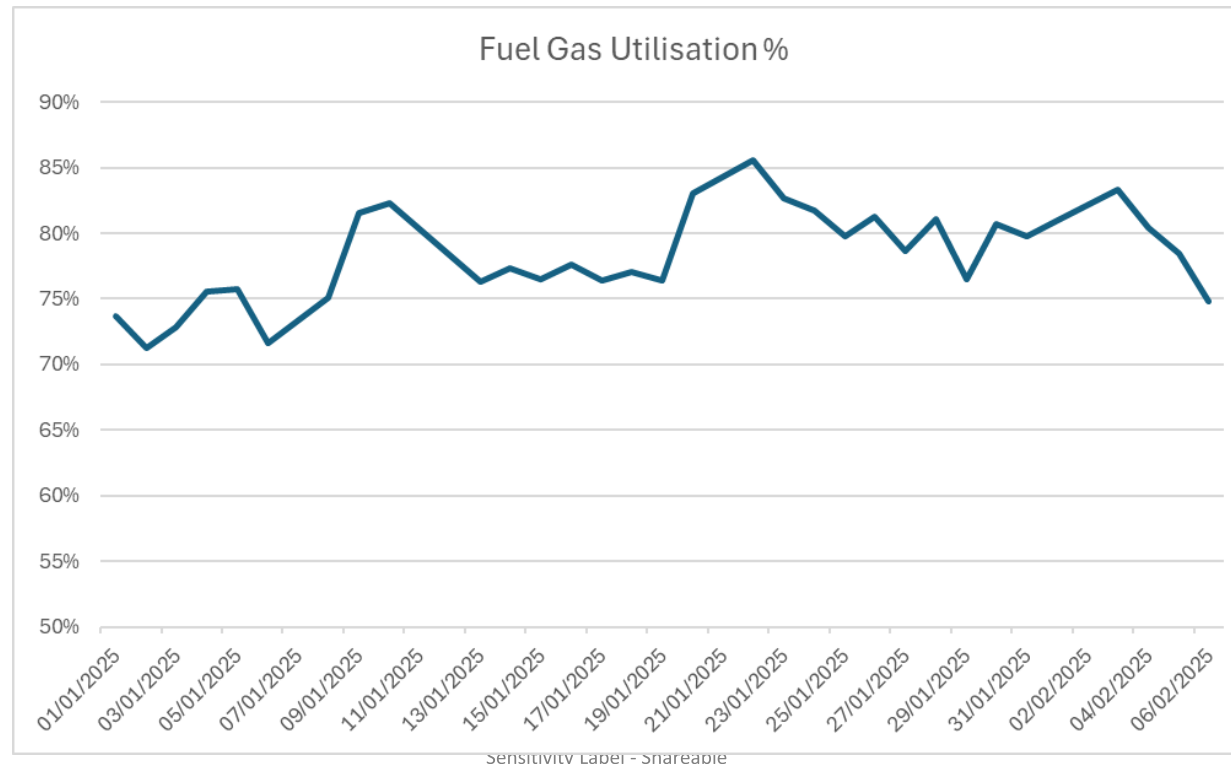
- Heavy oil production using HSP's results in slugging production
- Gas evolves and is routed to the fuel gas process in 'surges'
- There is no gas export option therefore unused gas is flared
- An operational gap is maintained to avoid starvation of the fuel users

Fuel Gas Usage vs. Total Produced Gas



Fuel Gas Usage vs. Total Produced Gas

- MPG's are selected to burn a single fuel type
- Hamworthy Steam Boilers controls have been modified to modulate and optimise gas usage whilst minimising liquid fuel consumption and reducing flare



Thank you

Any questions?

