THE FUTURE DESIGN OF, AND OPERATING ENVIRONMENT FOR, MILITARY SHIPS/PLATFORMS: FUTURE FUEL COST AT USE

PRESENTATION

Introduction

- HVO (Hydrotreated Vegetable Oil) is a renewable diesel gaining worldwide appeal.
- For fuel planning and buying, it's quite important to be able to accurately predict prices.
- This study looked at how prices changed from 2022 to 2025.
- This study used three different forecasting models: ARIMA, ETS, and CAGR (Holzer *et al.*, 2022).
- Scenario analysis was done to help make judgements on military fuel strategy.

Historical Price Trends of HVO (2022–2025)

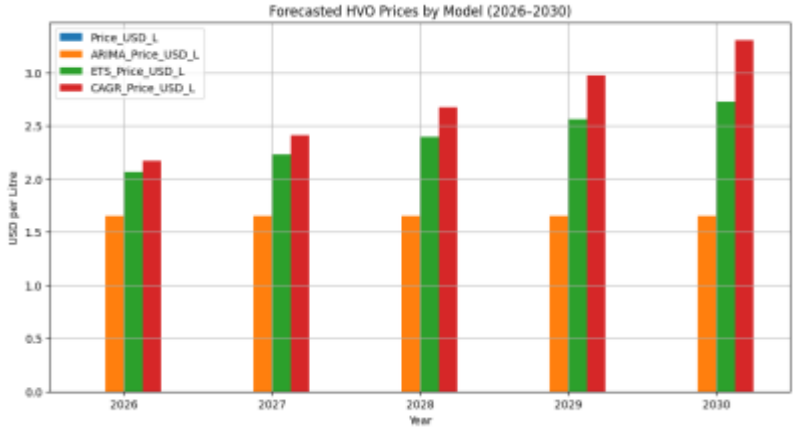
- Prices increased steadily from $1.42/L in 2022 to $1.95/L in 2025
- The rise in prices every year is due to higher demand throughout the world and limited supply.
- The biggest growth from year to year was almost 11% in 2023.
- Market volatility caused by changes in policy and feedstock prices
- Sets a starting point for predicting future HVO pricing

Forecasting Methodologies Applied

- The ARIMA Model uses previous price patterns and autocorrelations to predict future HVO prices.
- ETS Model: Uses exponential smoothing to show trend parts in time data.
- CAGR Method: Uses the historical compound rate to predict steady development.
- Scenario Analysis looks at the best, worst, and most likely future prices (Hor *et al.*, 2023).
- Comparative Evaluation: Checks to see whether each model's prediction is correct and realistic.

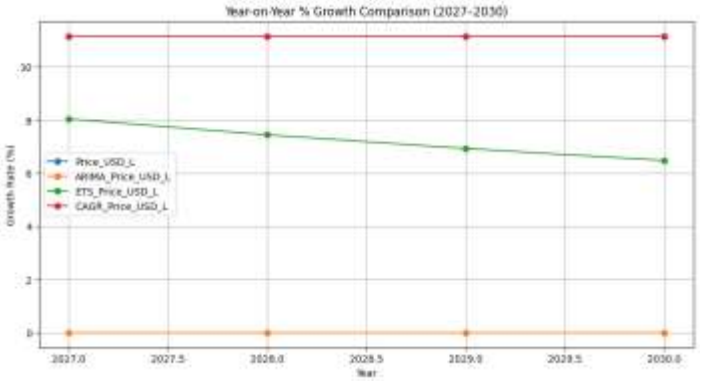
Model Outputs and Price Projections (2026–2030)

- The ARIMA Forecast suggests that prices will keep up steadily, with modest yearly increase.
- The ETS Model shows a more linear trend based on smoothing previous data.
- The CAGR Projection shows that the compound growth rate will be a little higher each year.
- The estimates predict that the price will be between $2.10 and $2.65 per litre by 2030.
- All models say that HVO prices will keep going higher.



Year-on-Year Growth Trends

- Growth rates vary across models, reflecting different assumptions.
- ARIMA indicates year-on-year gains that go up and down but stay stable.
- ETS predicts steady, small increases (Hunter *et al.*, 2021).
- CAGR shows that growth is speeding up because of the compounding impact.
- All models show that peak yearly growth will happen around 2028–2029.

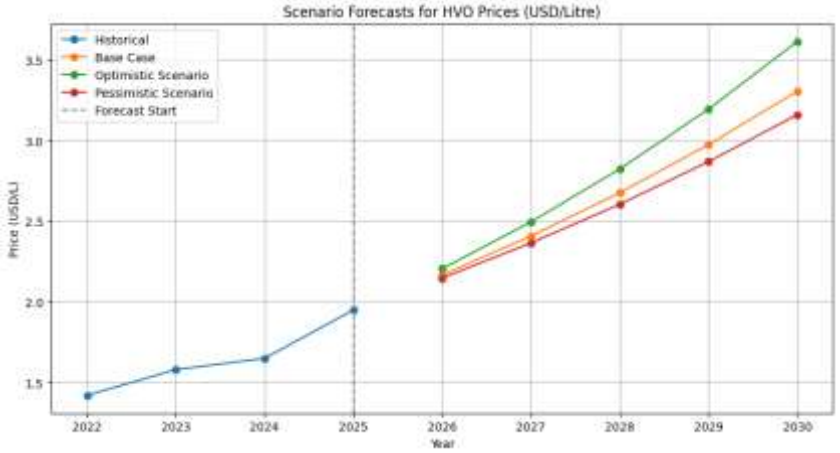


Scenario Analysis Framework

- Baseline Scenario: HVO prices and demand will continue to follow the same patterns.
- Optimistic Scenario: A rise in demand because of military sustainability initiatives and changes in fuel use throughout the world (Kossarev *et al.*, 2023).
- Pessimistic Scenario: Use goes down or is replaced by cheaper options.
- External Factors: Things include changes in policy, problems with the supply chain, and happenings in other parts of the world.
- Sensitivity Testing: Checking how sensitive the projection is to price and demand changes of ±10–15%.

Scenario Forecast Outcomes (2026–2030)

- Baseline Scenario: Prices to increase consistently based on current growth patterns and historical CAGR.
- Optimistic Scenario: More assistance from policies and a rise in demand push HVO prices above baseline projections.
- Pessimistic Scenario: Market problems or too much supply cause prices to rise less than projected.
- ARIMA Sensitivity: Small changes in the input data change the prediction range by a small amount.
- Strategic Implication: The results of scenarios may assist one improve their investment and purchasing plans.

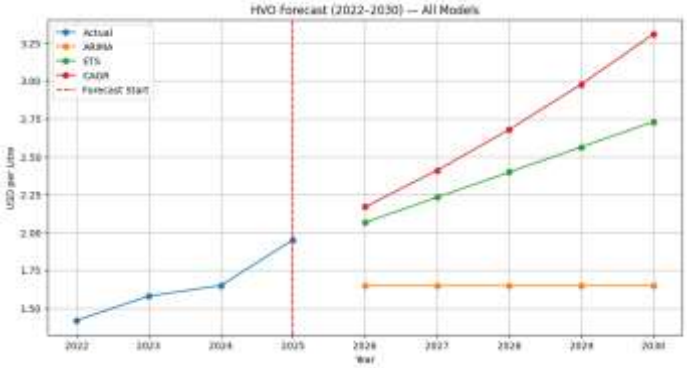


Implications for Military Fuel Planning

- Helps plan for how much money will be needed in various gasoline price situations
- Tells long-term plans for buying and storing things
- Helps with using other types of fuel, such HVO instead of regular diesel.
- Improves planning on how to lower the risk of supply disruptions
- Fits with goals for sustainability and energy security

Key Forecast Insights and Risks

- Across ARIMA, ETS, and CAGR models, HVO prices have been steadily rising.
- The CAGR model suggests that growth is faster, which means it is sensitive to past trends.
- ARIMA is better at picking up short-term changes, but it could miss out on big changes in turbulent markets.
- Scenario forecasting shows that prices might change a lot if things go wrong.
- The main dangers include political instability, problems with the supply chain, and changes in legislation that make it harder to use biofuels.



Conclusion

- It is expected that the costs of all HVO models would keep going up until 2030.
- ARIMA and ETS show realistic patterns in the near term, but CAGR shows higher development over the long run.
- Scenario analysis shows that geopolitical and supply chain issues might cause changes.
- Dynamic pricing techniques and backup plans must be part of military fuel strategy.
- Forecasting based on data lets one manage energy resources in a proactive and cost-effective way.

References

- Holzer, A., Günthner, M. and Jung, P., 2022. Performance of pure OME and various HVO–OME fuel blends as alternative fuels for a diesel engine. *Automotive and Engine Technology*, *7*(3), pp.369-383.
- Hor, C.J., Tan, Y.H., Mubarak, N.M., Tan, I.S., Ibrahim, M.L., Yek, P.N.Y., Karri, R.R. and Khalid, M., 2023. Techno-economic assessment of hydrotreated vegetable oil as a renewable fuel from waste sludge palm oil. *Environmental Research*, *220*, p.115169.
- Hunter, A.P., Coll, G., Akca, A. and Moore, S., 2021. *The Future of Military Engines*. Bloomsbury Publishing PLC.
- Kossarev, K., Scholz, A.E. and Hornung, M., 2023. Comparative environmental life cycle assessment and operating cost analysis of long-range hydrogen and biofuel fueled transport aircraft. *CEAS Aeronautical Journal*, *14*(1), pp.3-28.
- Lai, K. and Zhang, L., 2021. Sizing and siting of energy storage systems in a military-based vehicle-to-grid microgrid. *IEEE Transactions on Industry Applications*, *57*(3), pp.1909-1919.
- Macedo de Araujo Azeredo, F., Moll Hüther, C., Barbosa Werlang, J. and Panizio, R., 2025. Hydrotreated Vegetable Oil (HVO): A Review on Production, Properties, Environmental Impact, and Future Perspectives. *Insights into Energy Trends: Selected Papers from ICOWEFS 2024*, pp.99-109.