

# Sustainable and Future-ready Inland waterway vessel design

*Name:* **Richmond Anku**

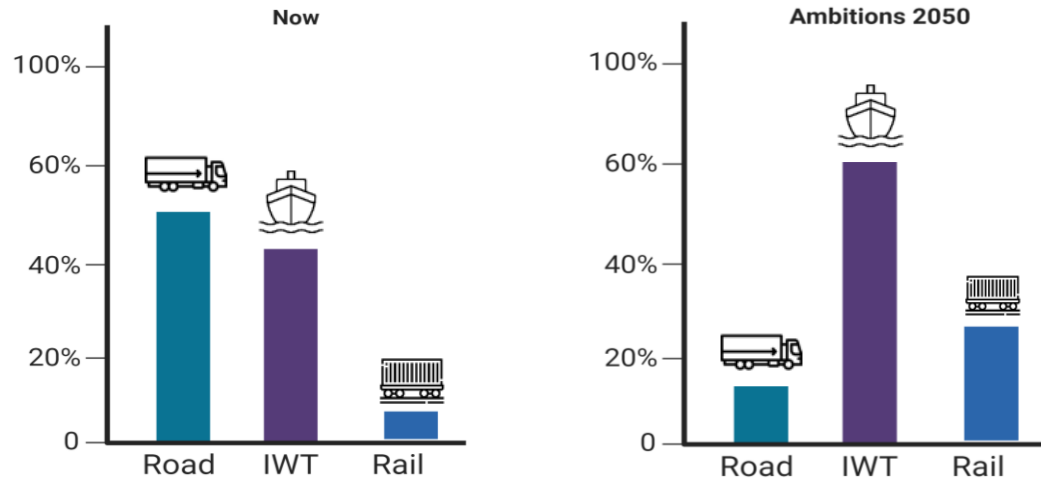
*Supervisors*

- Jeroen Pruyn
- Cornel Thill

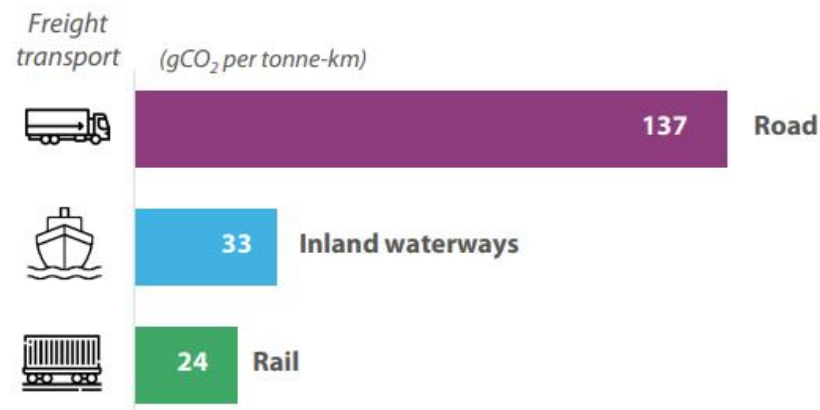
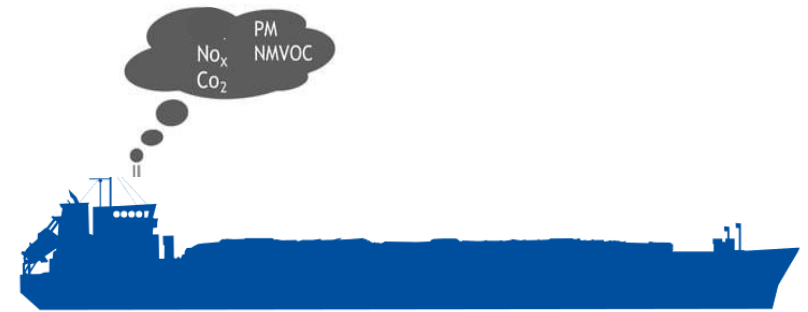


# Introduction

## Increase Modal Share of IWT

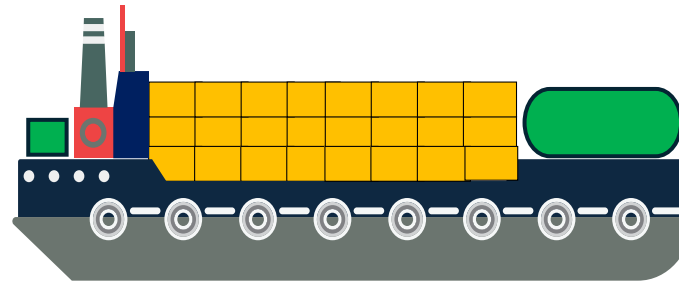


## Pathways towards Zero Emission IWT

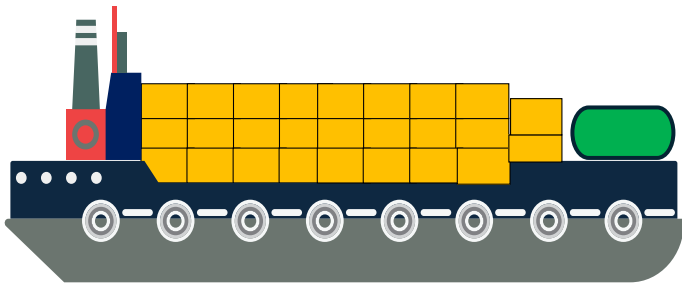


# Introduction

## Balance

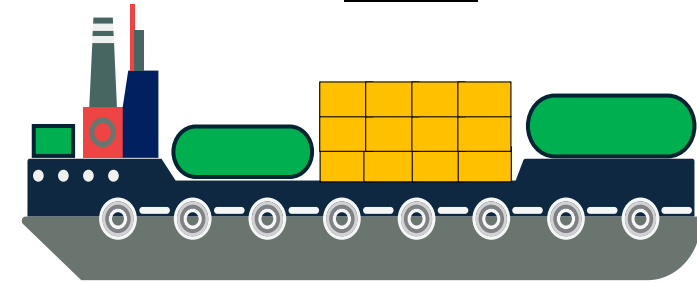


## More Cargo – Less Fuel



Shorter range

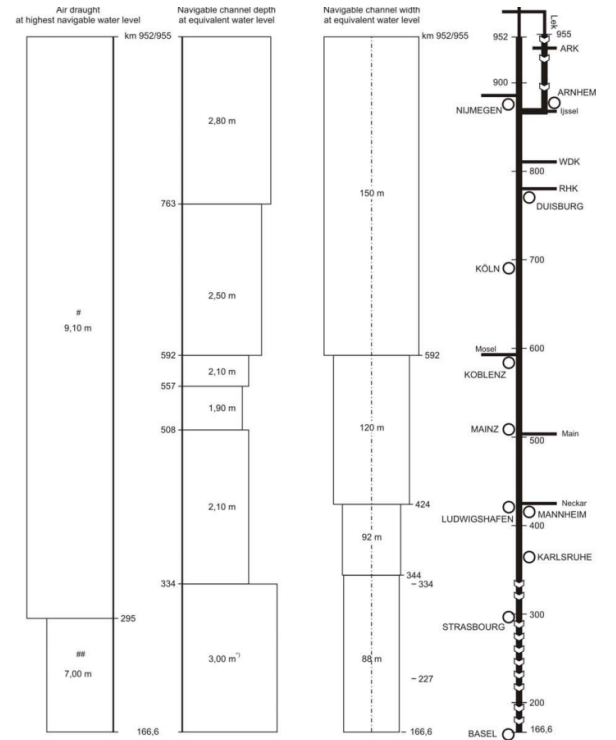
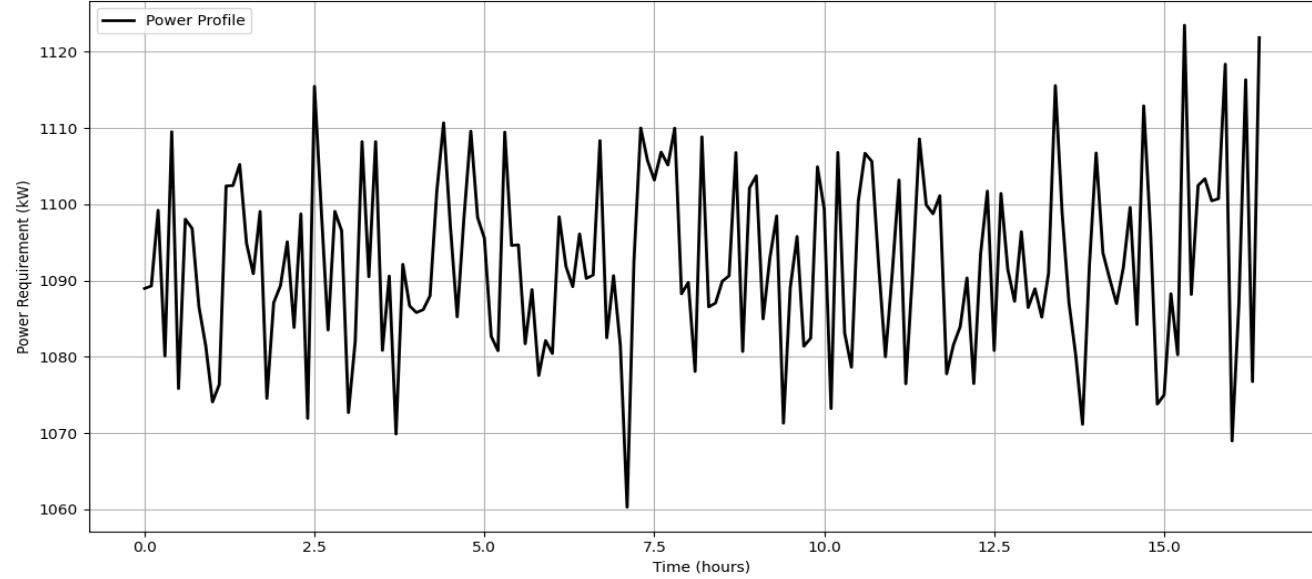
## Less Cargo – More Fuel



Longer range

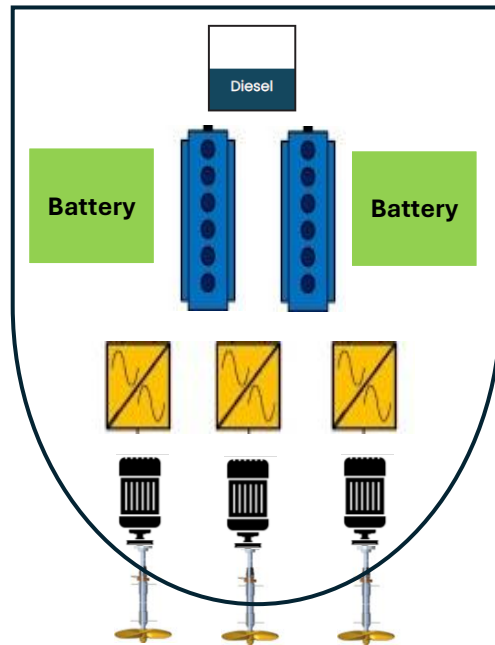
# Methodology

## Rotterdam - Duisburg

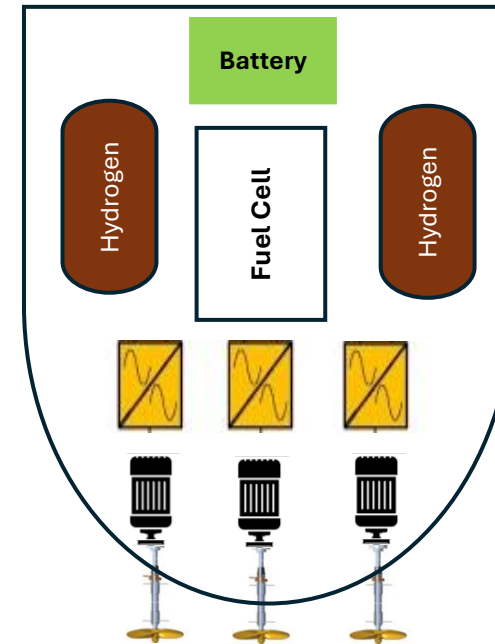


# Methodology

## ICE – Battery Configuration



## Fuel Cell – Battery Configuration



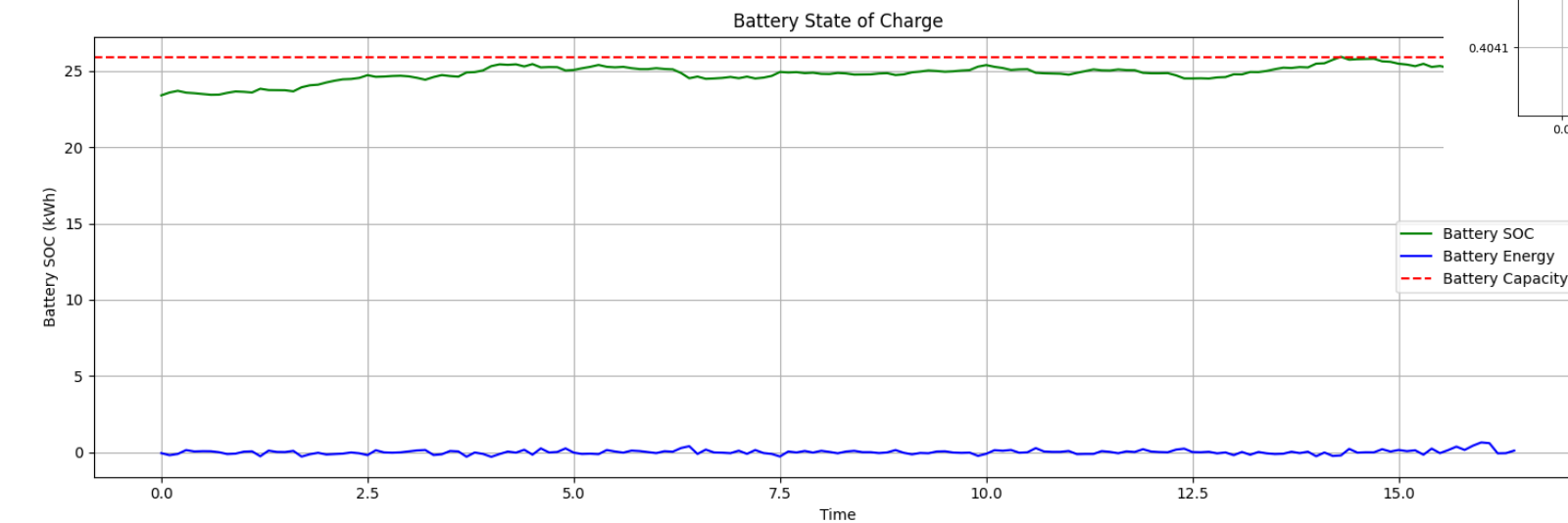
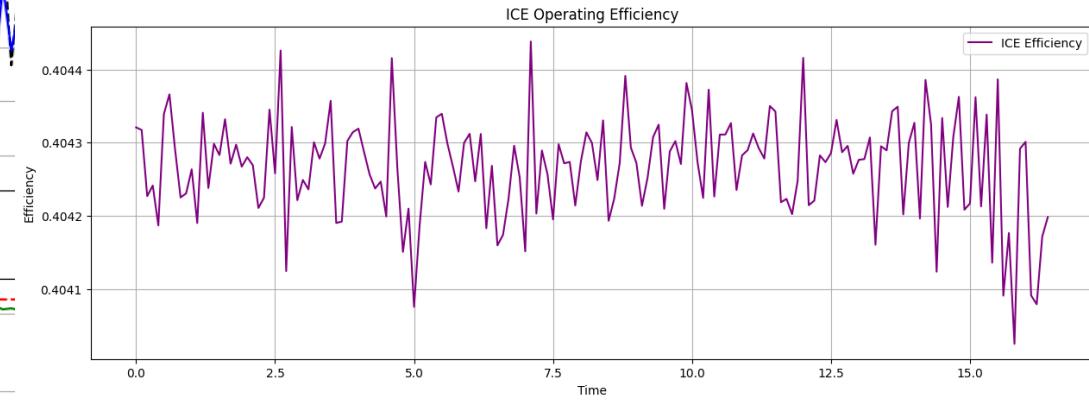
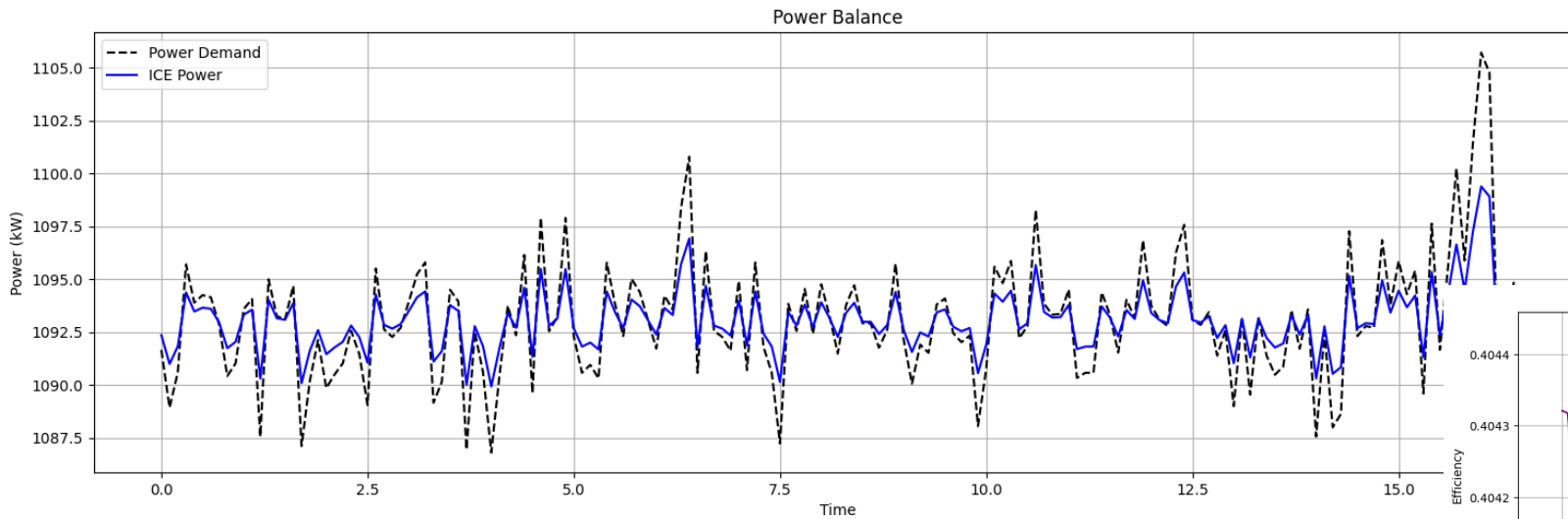
$$\text{Energy Consumption (kWh)} = \int_0^T P(t) dt$$

$$\text{Fuel Consumption (kg)} = \frac{\text{Energy Consumption (kWh)}}{\text{Fuel Energy Density (kWh/kg)}}$$

$$\text{Fuel Consumption (m}^3\text{)} = \frac{\text{Energy Consumption (kWh)}}{\text{Fuel Energy Density (kWh/m}^3\text{)}}$$

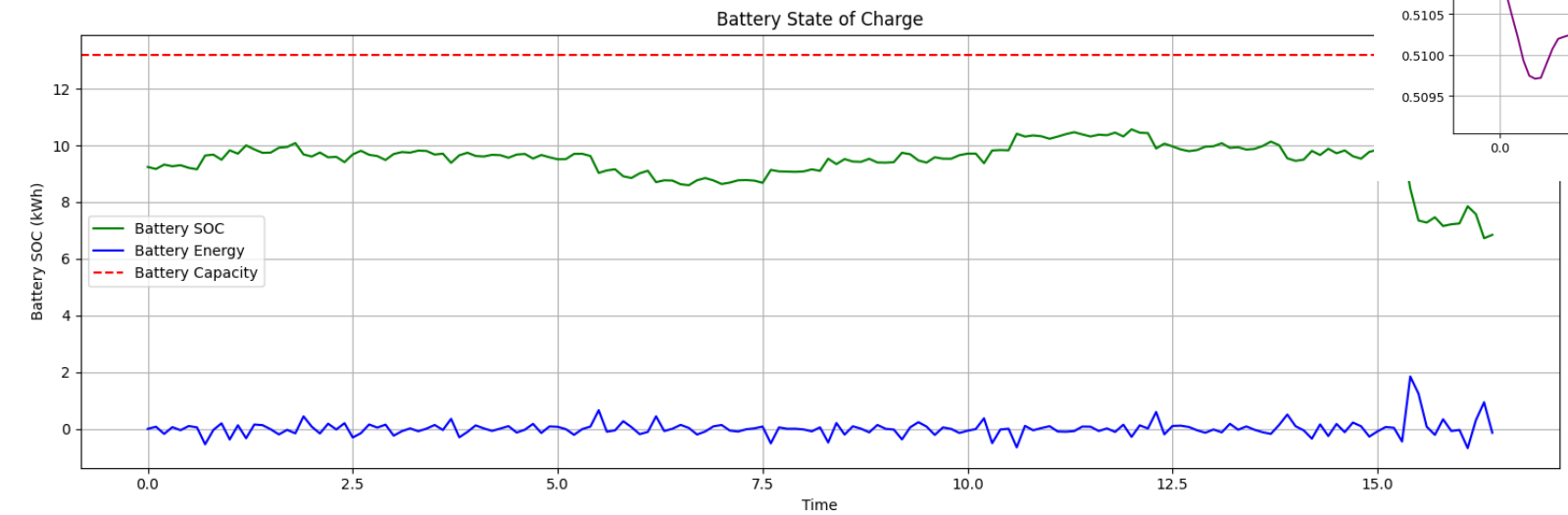
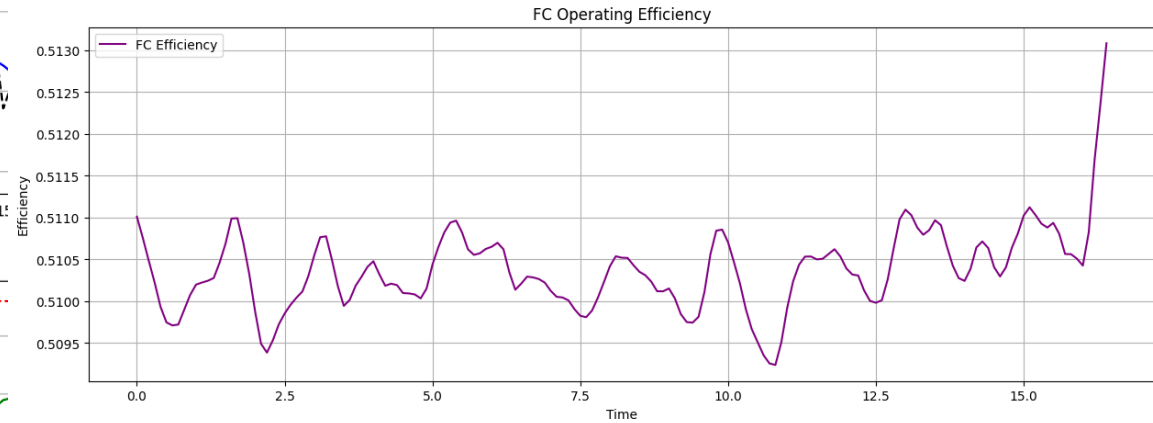
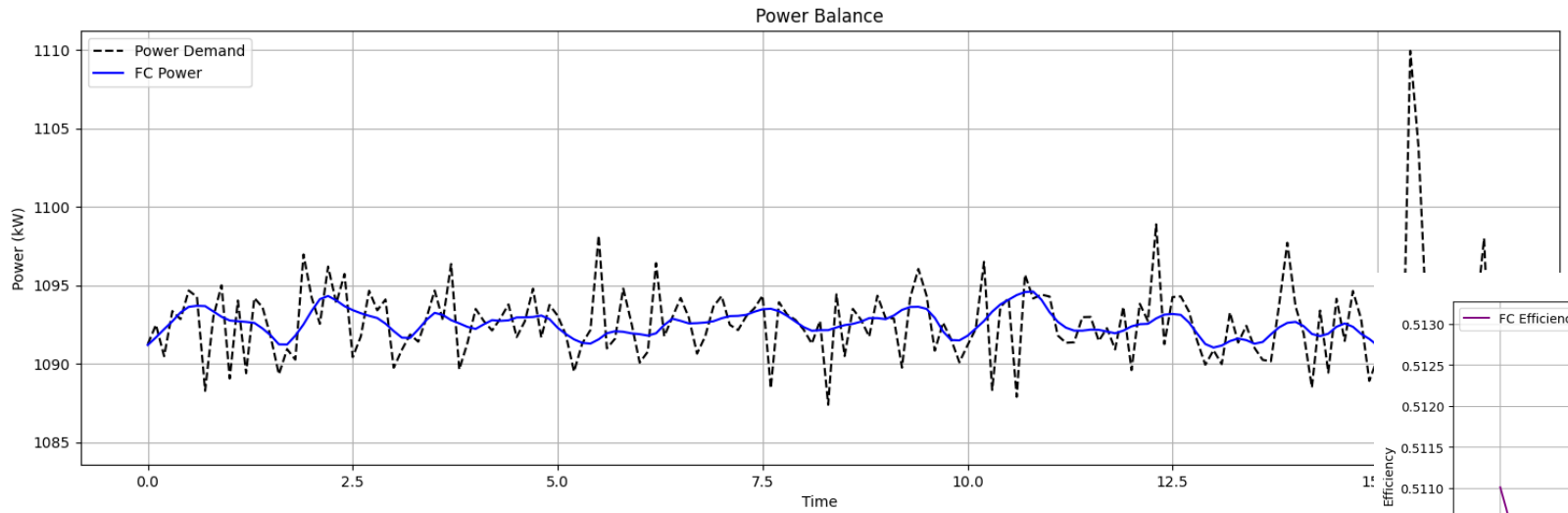
# Results

## ICE – Battery Configuration

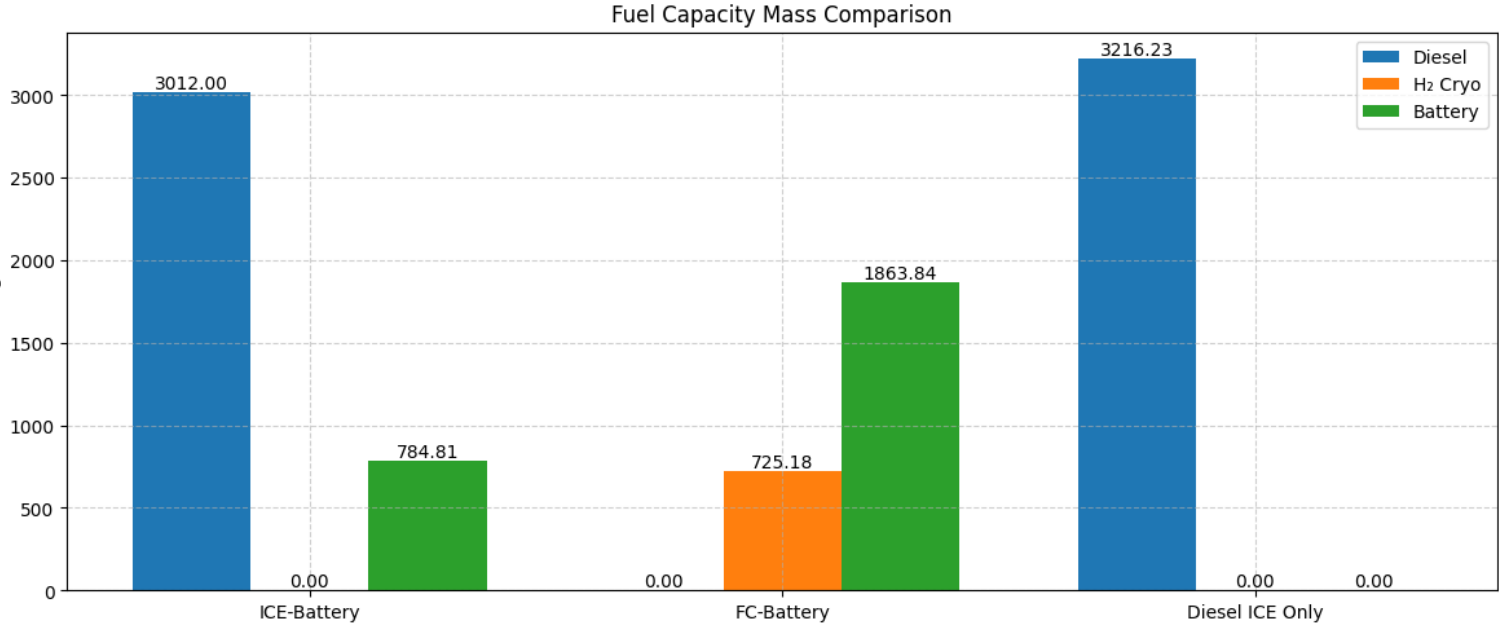
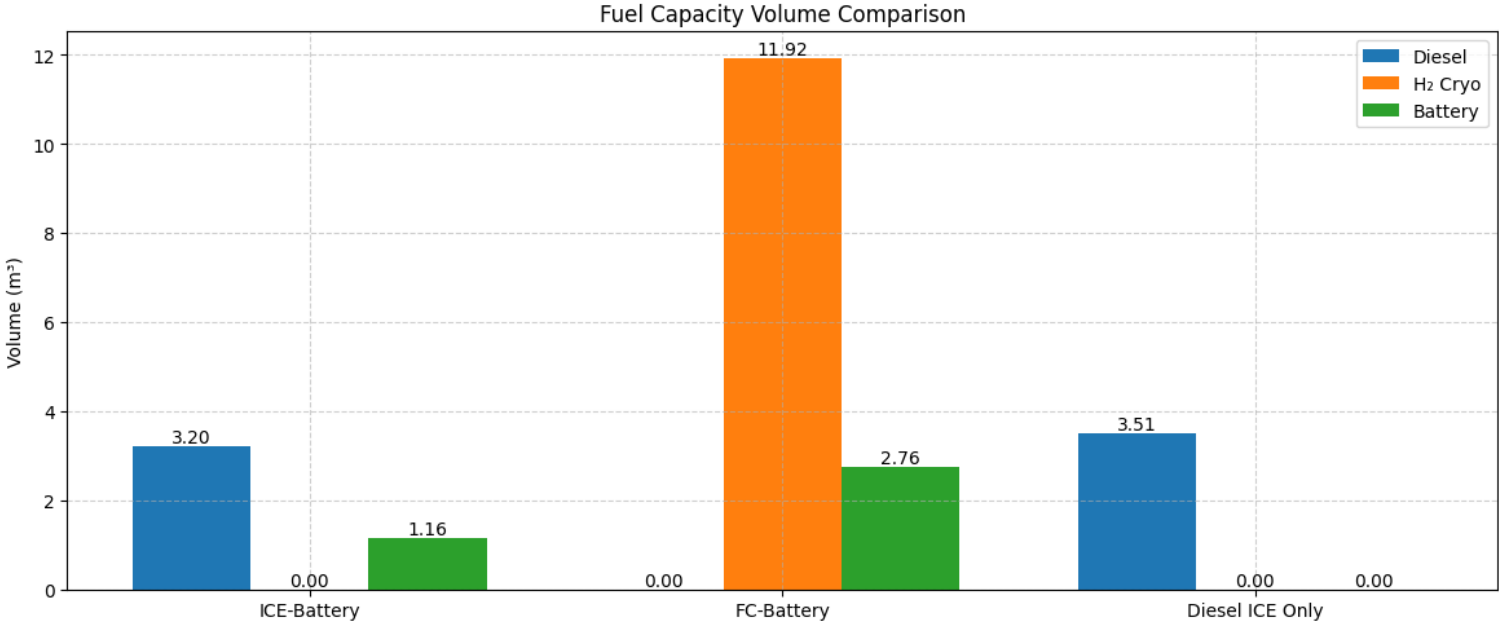


# Results

## Fuel Cell Battery Configuration

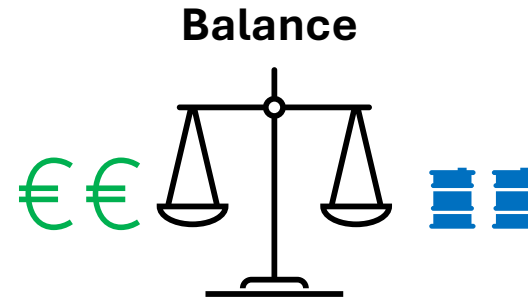


# Results

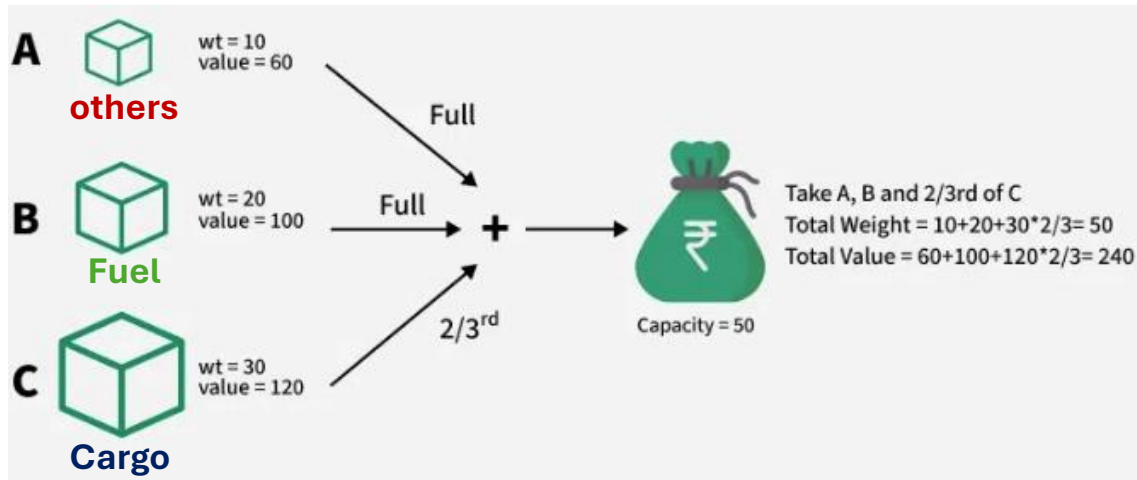




# Next steps

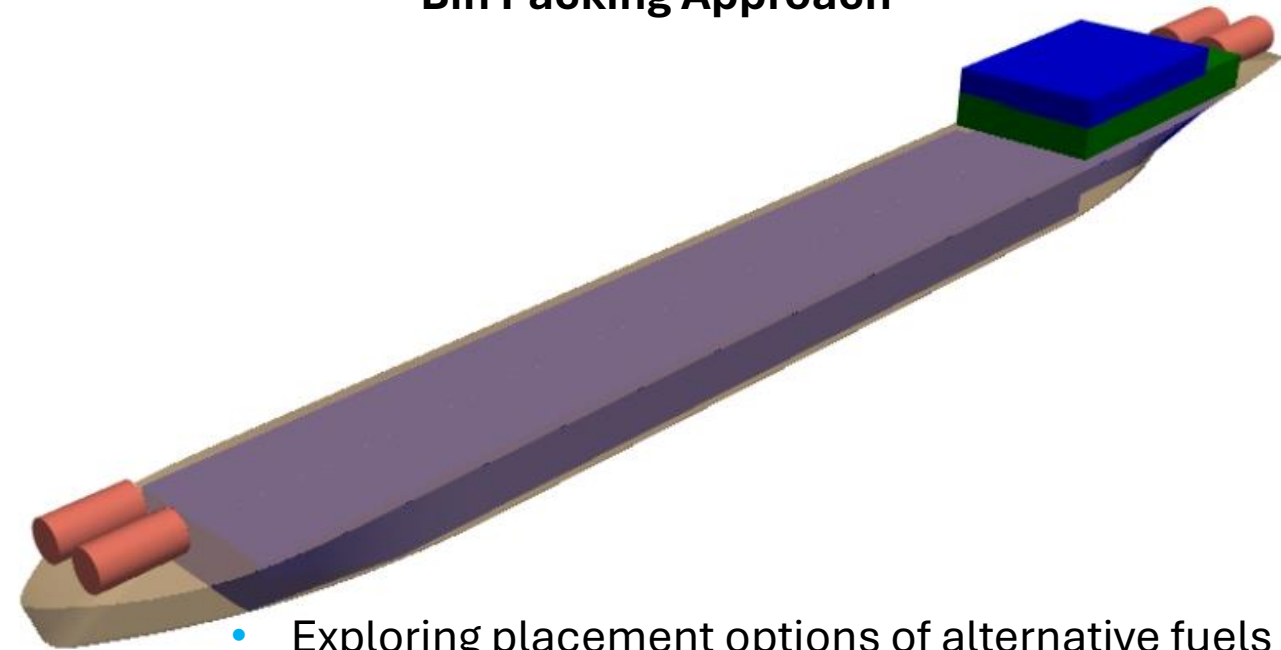


## Fractional Knapsack Problem

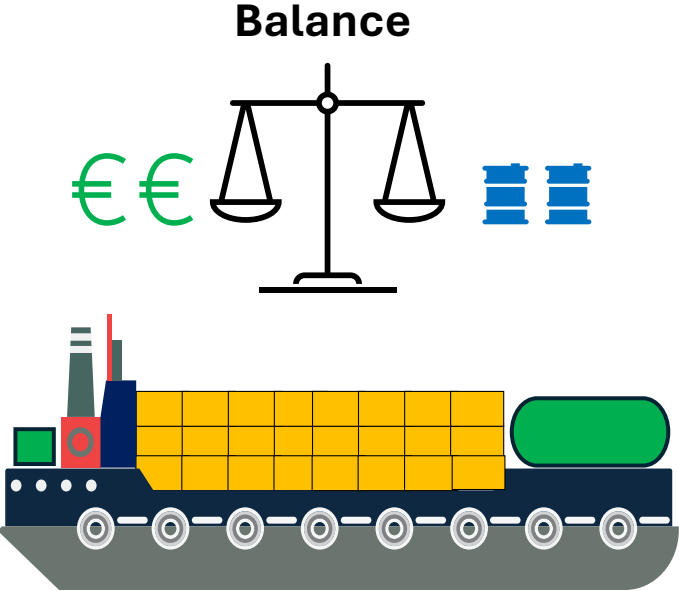


- Optimise Payload and range
- Maximise overall transport efficiency

## Bin Packing Approach



# Conclusion



Adopting greener fuel solutions is not without problems



**Balance** – sustainability (zero emission) and transport efficiency (profitability)