

# New Proven Propulsion Optimization Solution



# Main Market Challenges in the Shipping World



Today, shipowners and operators must



Reduce fuel consumption to lower operational costs / increase competitiveness



Comply with new regulations or risk being grounded



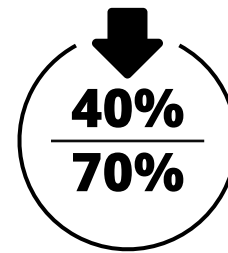
Choose between a large variety of innovative technologies – often with long implementation time/high costs and various fuel saving potentials



# Marine Industry Trends Driven by Decarbonization, Higher Fuel Efficiency and Ship Technology Improvements

## 1 Increased Focus on Decarbonization

- More national and international regulations (IMO, Marpol)
- Fuel transition needed to achieve emission target!



### Emission Reduction Targets

Shipping CO<sub>2</sub> intensity 40% reduction target in 2030 (70% in 2050)



### Huge Decarbonization CAPEX

Cumulative capital investments needed to decarbonize the shipping industry (World Economic Forum)

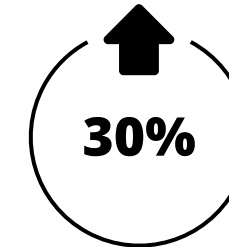
## 2 Higher Fuel/Energy Efficiency

- Increasing voyage costs due to fuel prices
- Eco-friendly fuels still more expensive



### Voyage Cost Split

Fuel cost as % of total voyage costs range from 40-70% depending on ship type

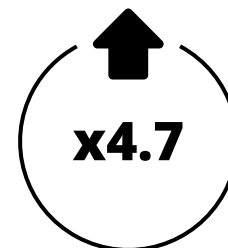


### HSFO Bunker Price Increases

YoY increase in HSFO prices (Rotterdam) from 2021 to 2022

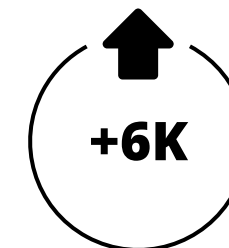
## 3 Innovative Ship Technologies

- More 'Eco' Ships and energy saving technologies (ESTs)
- Fleet Performance Monitoring (ship-to-shore communication)
- Increased data acquisition from smart devices and analysis / AI



### More Innovators

Avg. no of start-ups in digital maritime engineering increased by a 4.7-fold since 2011

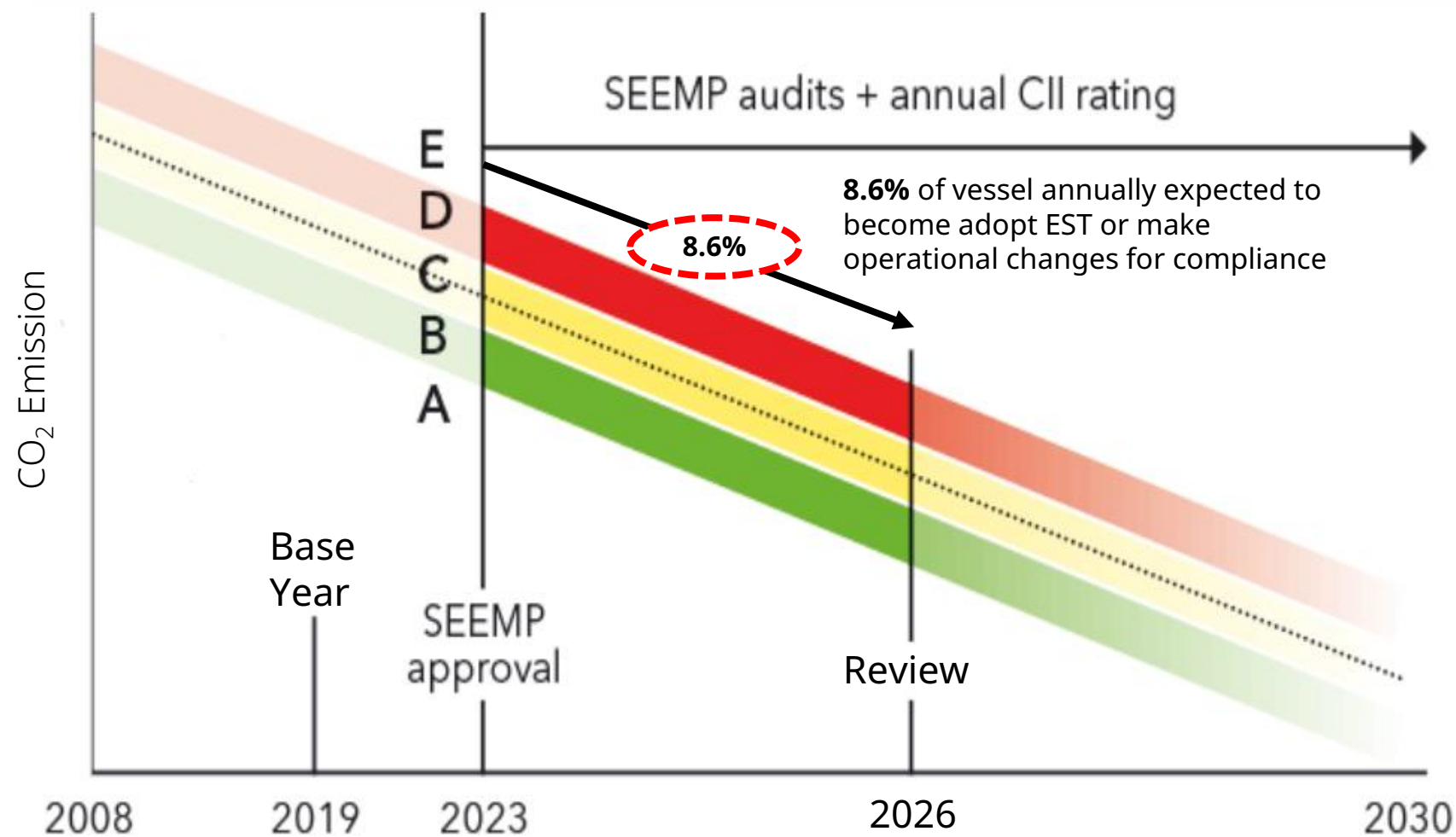


### 'EST Ships'

Fleet fitted with energy saving technologies

## Non-compliance Expected to Increase by CAGR of 8.6% (2023-2026)

**Vessel in compliance today might not comply next year due to CII limits becoming more stringent in subsequent years**



## CII and its Impact

The CII measures how efficiently a ship transports goods or passengers and is given in grams of CO<sub>2</sub> emitted per cargo-carrying capacity and nautical mile.

- Applies to all vessels 5,000+ GT from 2023-30, with each vessel given an annual rating from 'A' to 'E'
- The required CII will be reduced annually from this 2019 baseline, at a rate of 1 percentage point per year from 2020-22 (before the measures come into force), followed by 2 ppt increments each year from 2023-26. Reduction rates for 2027-30 will be reviewed at a later date, by 2026

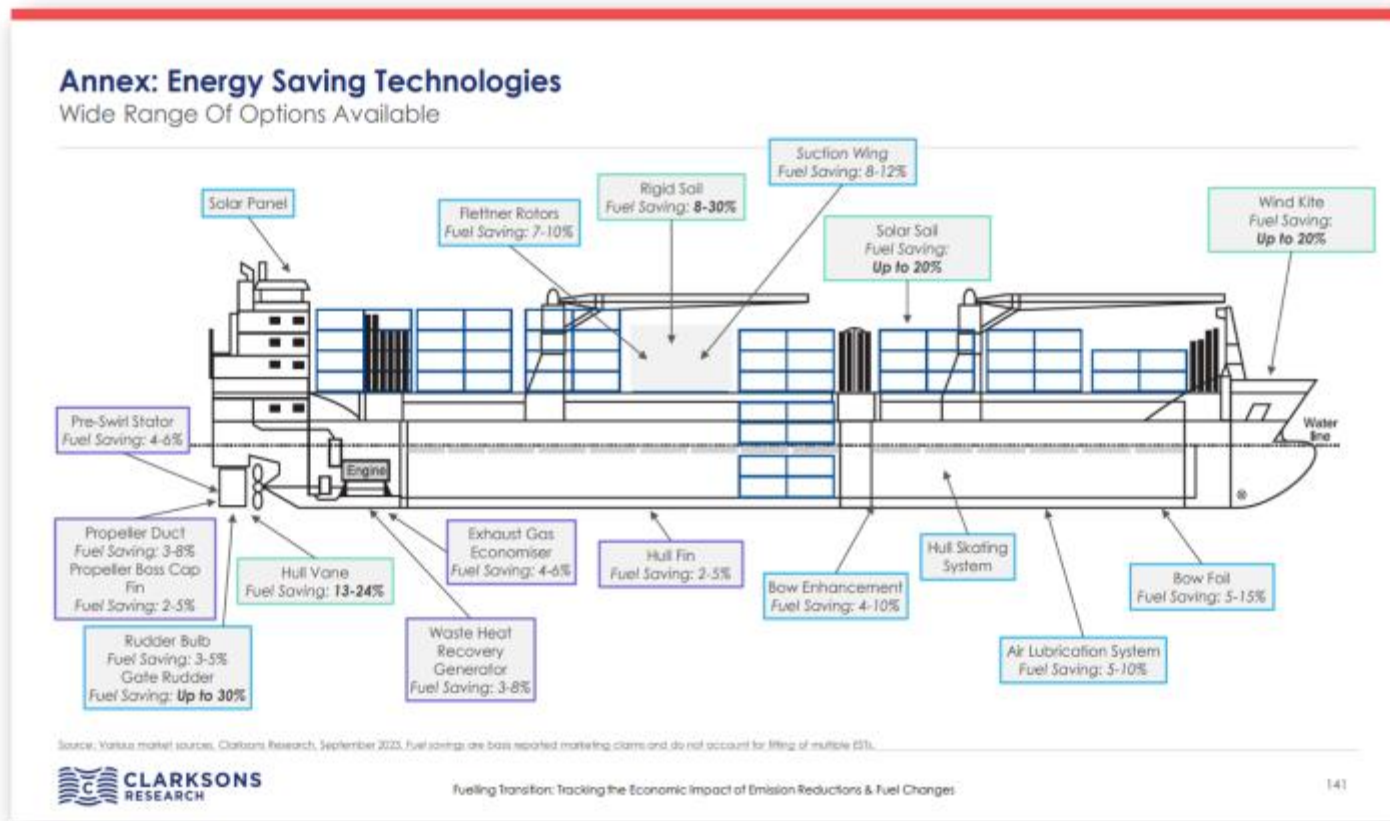
### Repercussion for non-compliance

Vessel rated 'D' for three consecutive years, or 'E' for a single year, must provide a corrective action plan to be signed-off by the vessel's flag state or class, failing which a vessel could be banned from trading.

# Many Energy Saving Technology Options Are Currently Available

## Many Energy Saving Technology Options Are Currently Available

## Slowsteaming Is An Easy Alternative ... However, It Is Not Free



Ships	Large Bulk Carrier	Large Containership	Large Tanker
Size	169,868 DWT	179,971 DWT 17,250 TEU	155,878 DWT
CII Required (C ship)	2.07	4.23	2.81
Deviation D Ships	113%	116%	118%
Required Improvement of AER (%)	12%	14%	15%
Required Speed Reduction (%)	6%	7%	8%
Original Yearly Ton Mileage (x10 <sup>6</sup> )	11,506	17,807	9,383
Yearly Loss of Ton Mileage (x10 <sup>6</sup> )*	687	1,245	744
Historically Daily Charter Costs	\$14.8K	\$70K	\$22.6K
Yearly Revenue Loss*	\$324K	\$1,787K	\$655K

Most Emission Saving Technologies (EST) Will **Require Docking and Bigger Investments** to Install

Compliance Can Be Achieved by Lowering Speed But **Impacts Top Line**

# Our Combined Solution Is Smart

SmartPropulsion Is the Combined Propulsion Control & Optimization Solution From Emerson from idea to implementation and life-time support – powered by Frugal Technologies



Delivers CO<sub>2</sub> regulatory emission compliance



Creates fuel savings in range of 10-15%



Provides owners with fleet performance data



# Creating SmartPropulsion by Combining the Best From Two Worlds



## Marine Engineering Capabilities & Global Customer Support

- Financially Strong Trusted Partner
- Strong Fuel Measurement and Ship Control Solution Synergies
- Availability, Accessibility & Global Service Support
- +50 Years of Marine Experience



## Competitive Value-Adding Fuel Saving Technology

- Competitive and Proven Technology Platform
- Start-up Agility and Innovation Focus
- Naval Architectural Background



**Combining Frugal Technologies' Energy Saving Technology Platform with Emerson's Marine Expertise, Relevance and Global Support to Deliver Consistent, Reliable and Predictable Customer Value**

# Groundbreaking AI Technology to Support Shipowners in Their Sustainability Journey

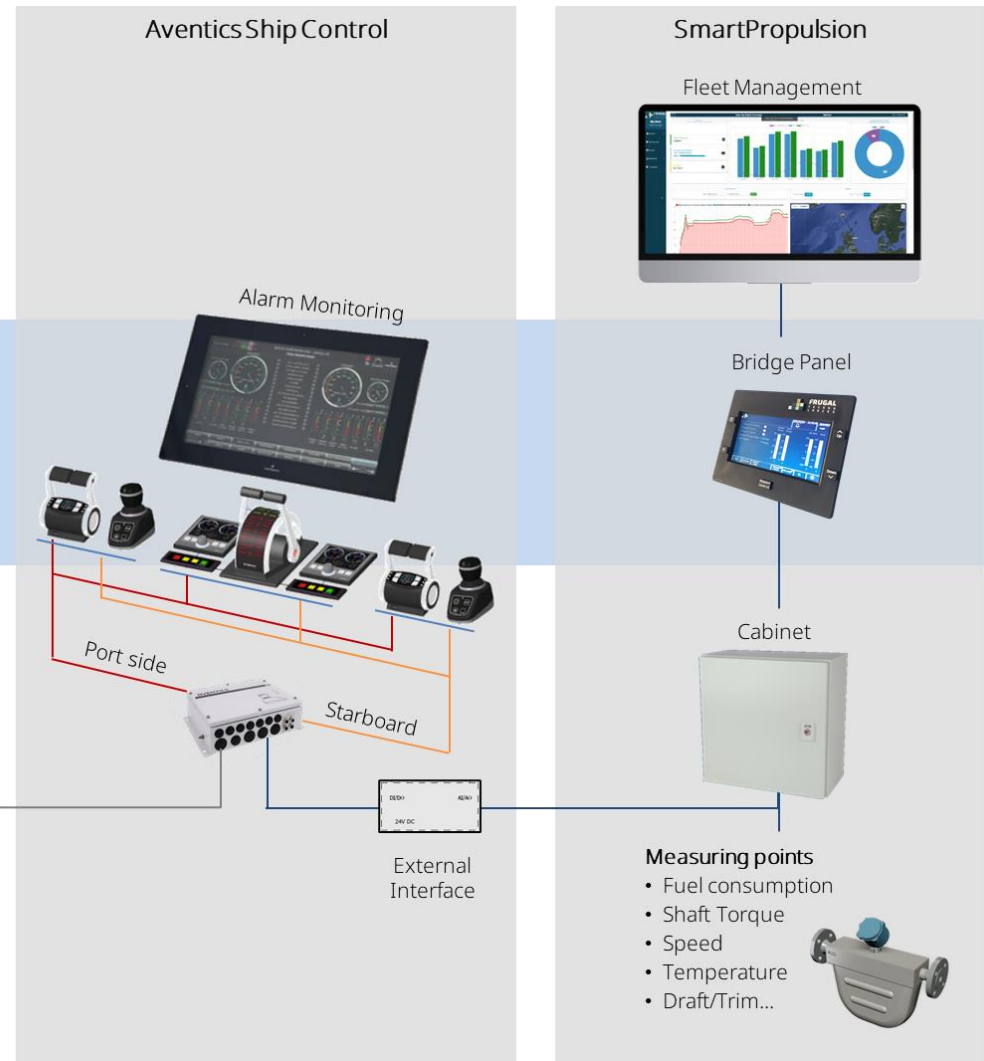
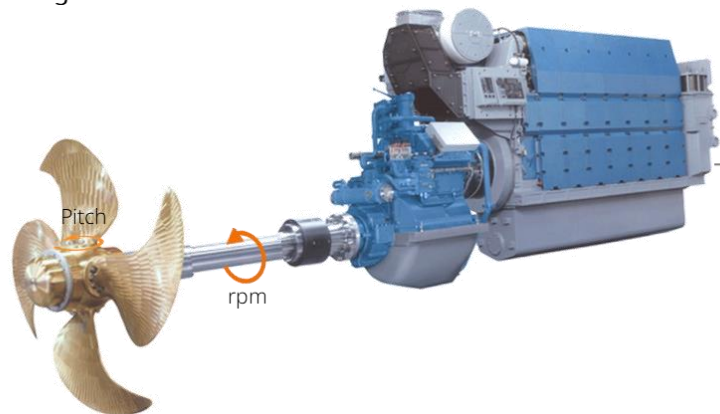
Onshore Control Room



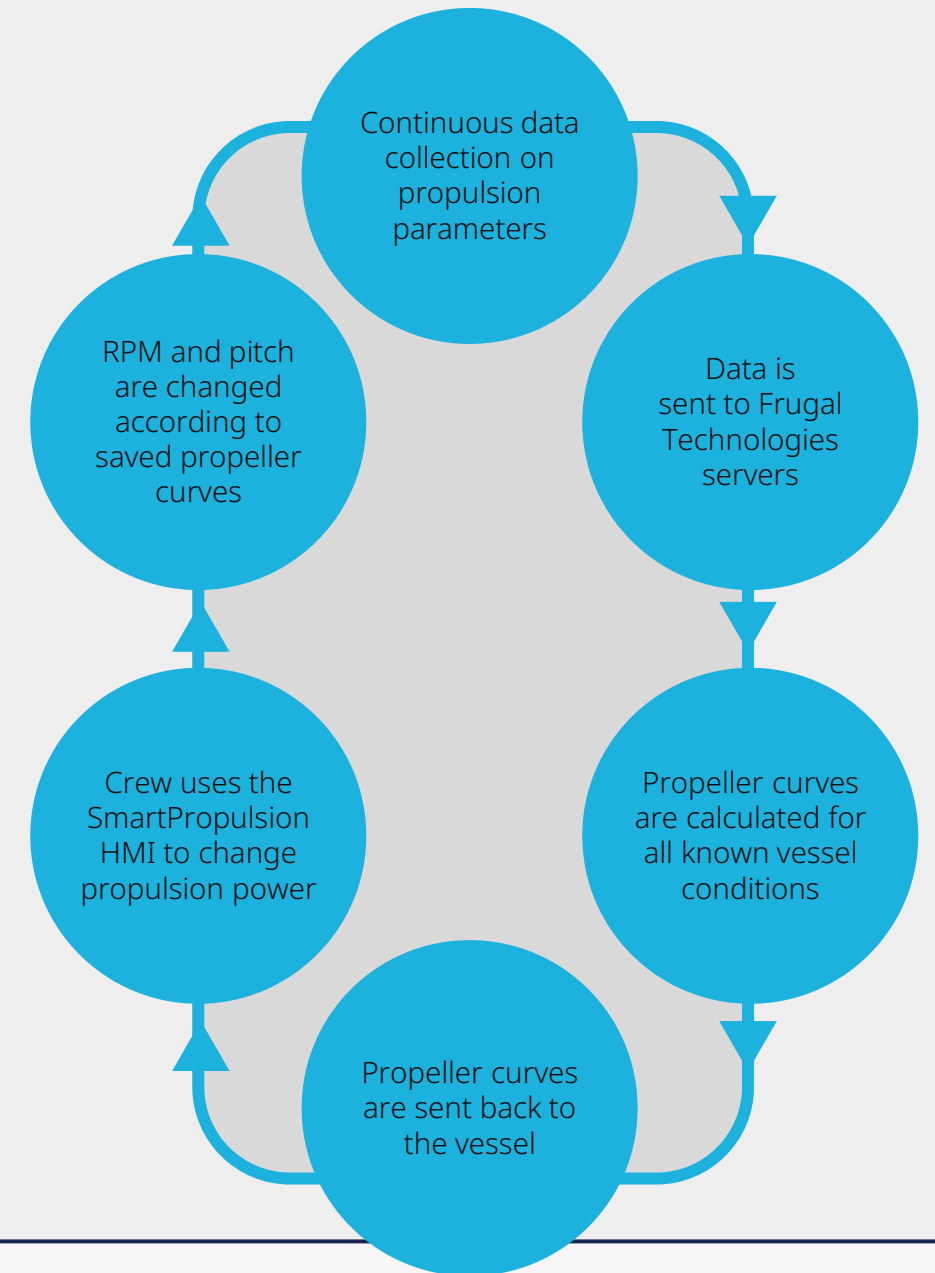
Bridge



Engine Room / Engine Control Room



## The AI Learning Loop



### PROPULSION OPTIMIZATION

- Automated AI-based technology saving fuel and CO<sub>2</sub>
- Collects data related to dynamic conditions, like weather, cargo load and propulsion operation

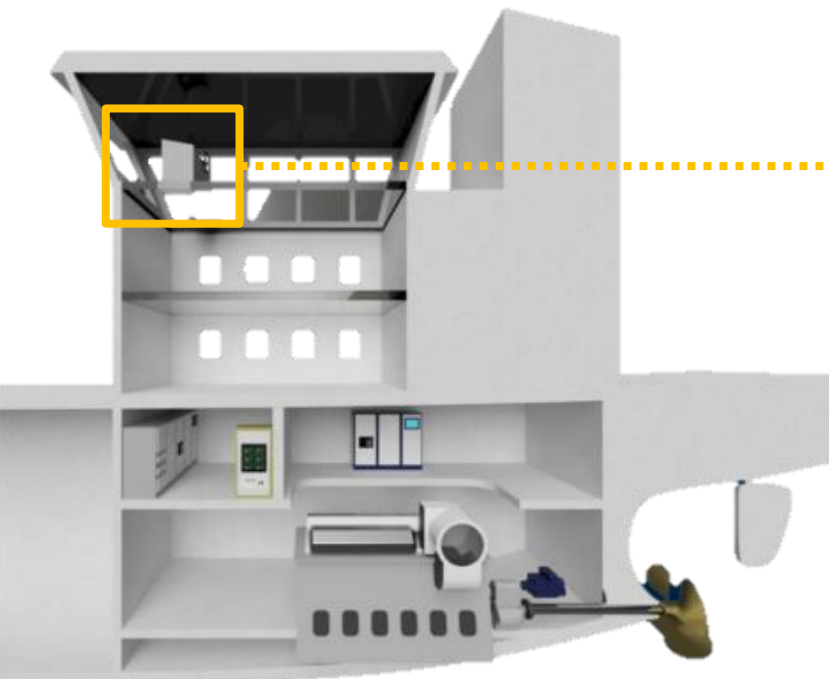
- AI learning algorithm processing data and develop new optimal engine model
- Intelligent SaaS deployment model supporting recurring business

- AI learning algorithm processing data and develop new optimal engine model

# The Bridge HMI Display

The HMI solution is basically an additional power handle that integrates with the existing PCS solution. When the panel is in control, you get:

- Propulsion according to the latest available cloud generated propeller curve
- The option to use our speed pilot
- The option to use our power pilot
- All options serve to improve propulsion efficiency



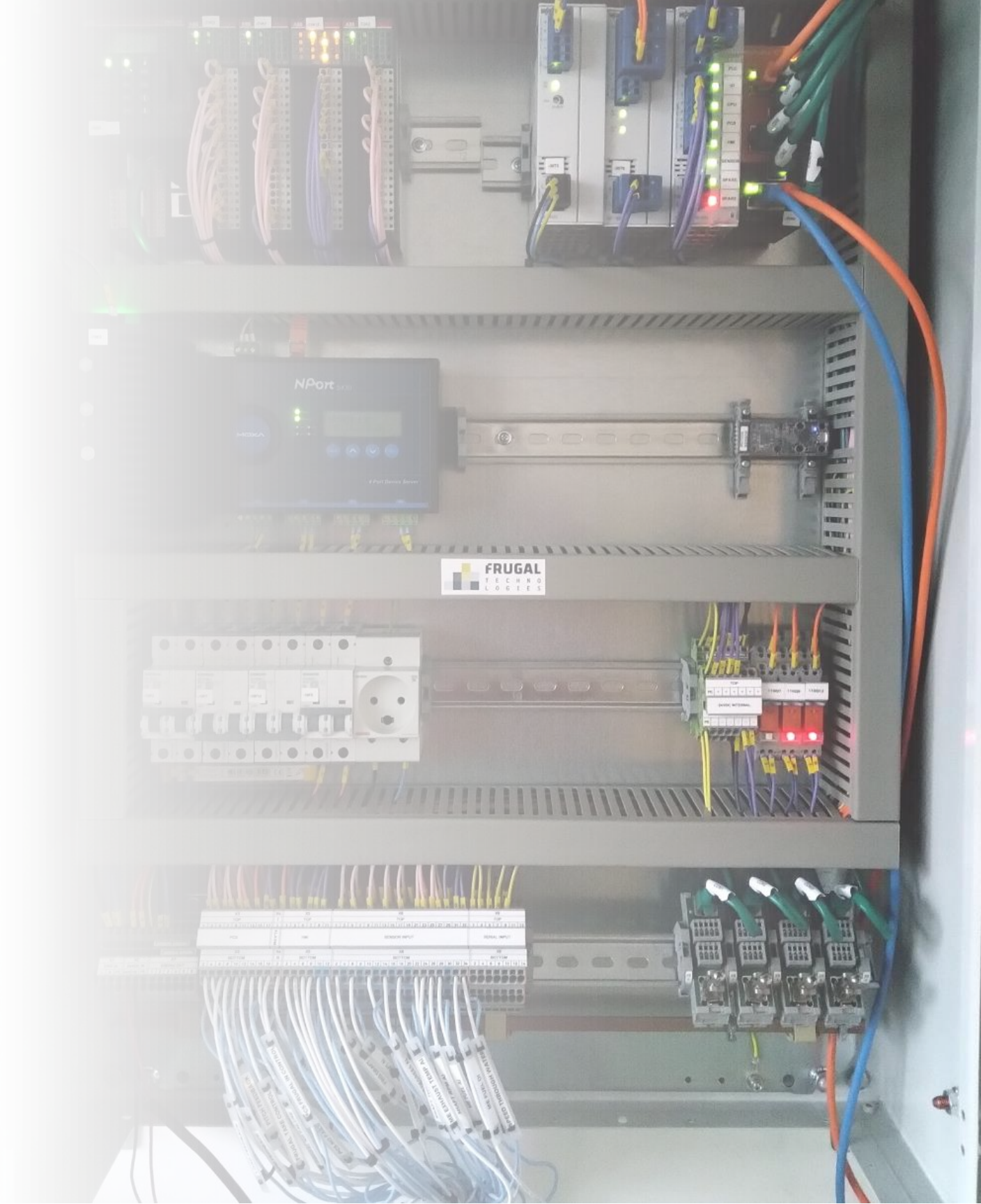
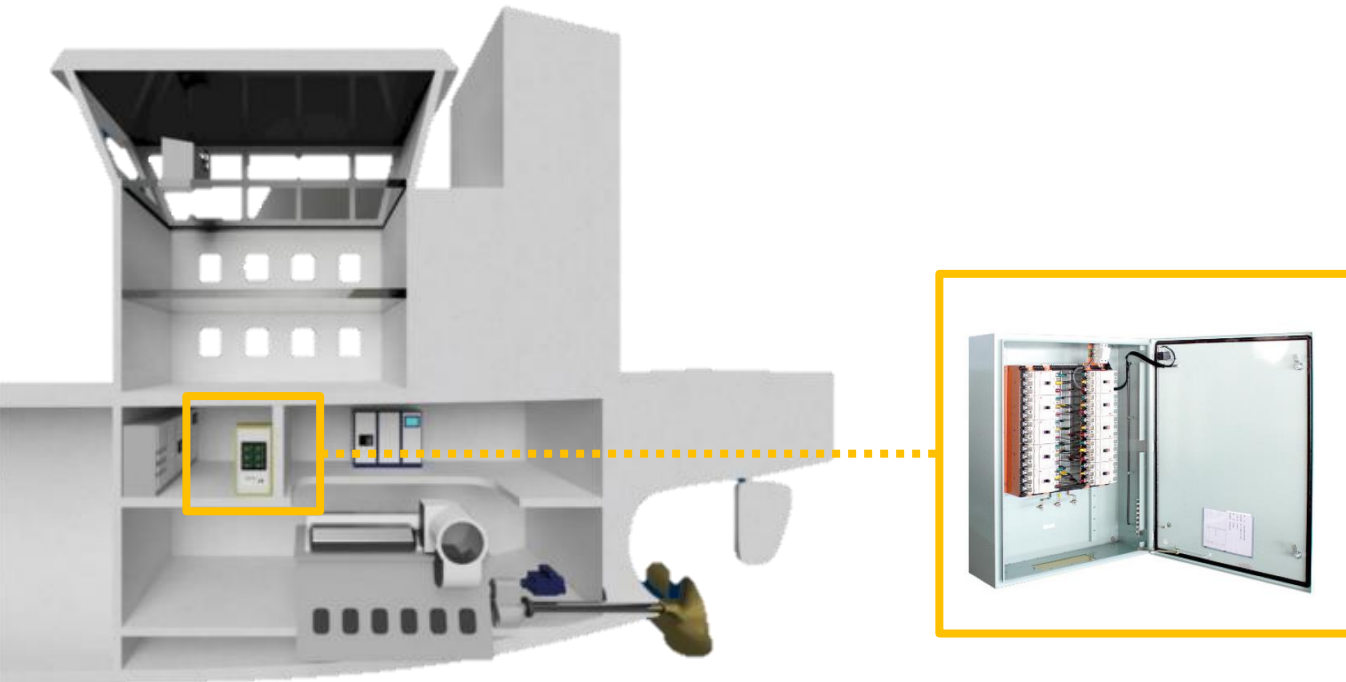
Option: Additional read-only displays that can be customized to show whatever information is required by the crew:

- Implemented in HTML5/JS
- Backend is the FPEC which serves web socket data

# The Electronics Cabinet

The electronics cabinet serves several purposes:

- Integration point with the existing PCS solution
- Integration point with the cloud solution
- Integration point for sensor input
- Backend for the bridge HMI panel
- Backend for other on-board displays



# Things Impacting the Propulsion Efficiency

Propulsion efficiency is a product of many factors:

- Engine best performance points
- Hull performance at varying speeds
- Hull performance at varying conditions
- Vessel trim
- Weather, waves and swells

And of course, the combination of engine RPM and propeller pitch



# Controllable and Non-Controllable Parameters

## Controllable

The parameters we can adjust using Frugal Propulsion are quite simply:

- The engine RPM
- The propeller pitch

SmartPropulsion continuously identifies the most efficient combinations of RPM and pitch.

These in turn make up the propeller curve we embed into our bridge panel, making optimization transparent and seamless.

## Non-Controllable

Some variables are really not up to us control wise:

- Weather, waves and swells add to the complete picture, but we can mainly make a note of the impact
- The same is true for vessel draft. This is a critically important parameter – but not an adjustable one
- Trim also has a significant impact on performance and is to some extent adjustable.

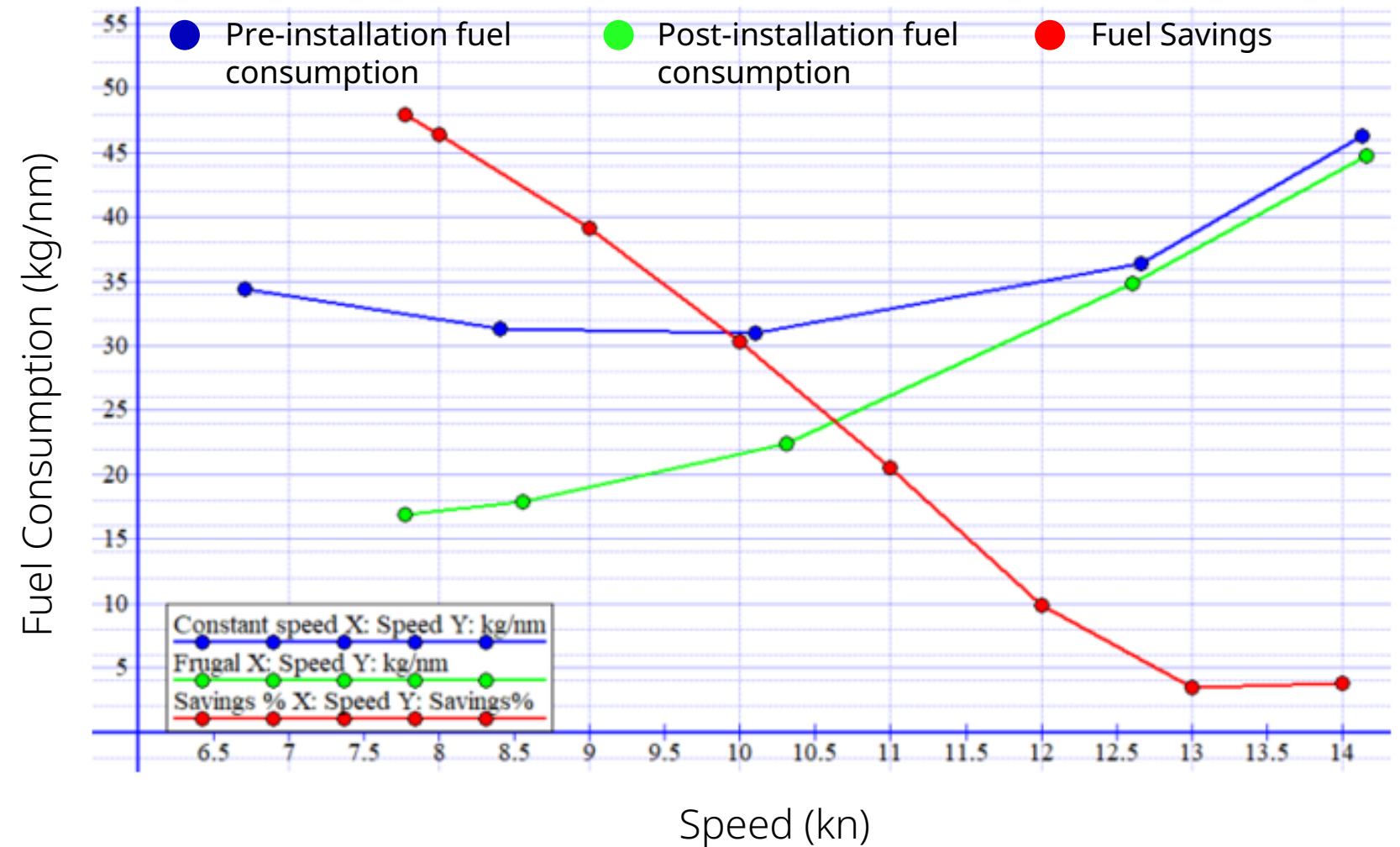
# SmartPropulsion Advantages

- Documented benefit before purchase/new performance test against acceptance test record
- Approved by class
- Patented technology
- Skilled technicians and installation in 3 days, 1 day along pier (Phase 1)
- Proven results

## VALUE PROPOSITION

- Easy installation during operation
- Lower investment with quick ROI
- Solution to stay compliant with CII
- Maintain speed and revenues

## Case Example: Higher speed leads to higher consumption and lower savings



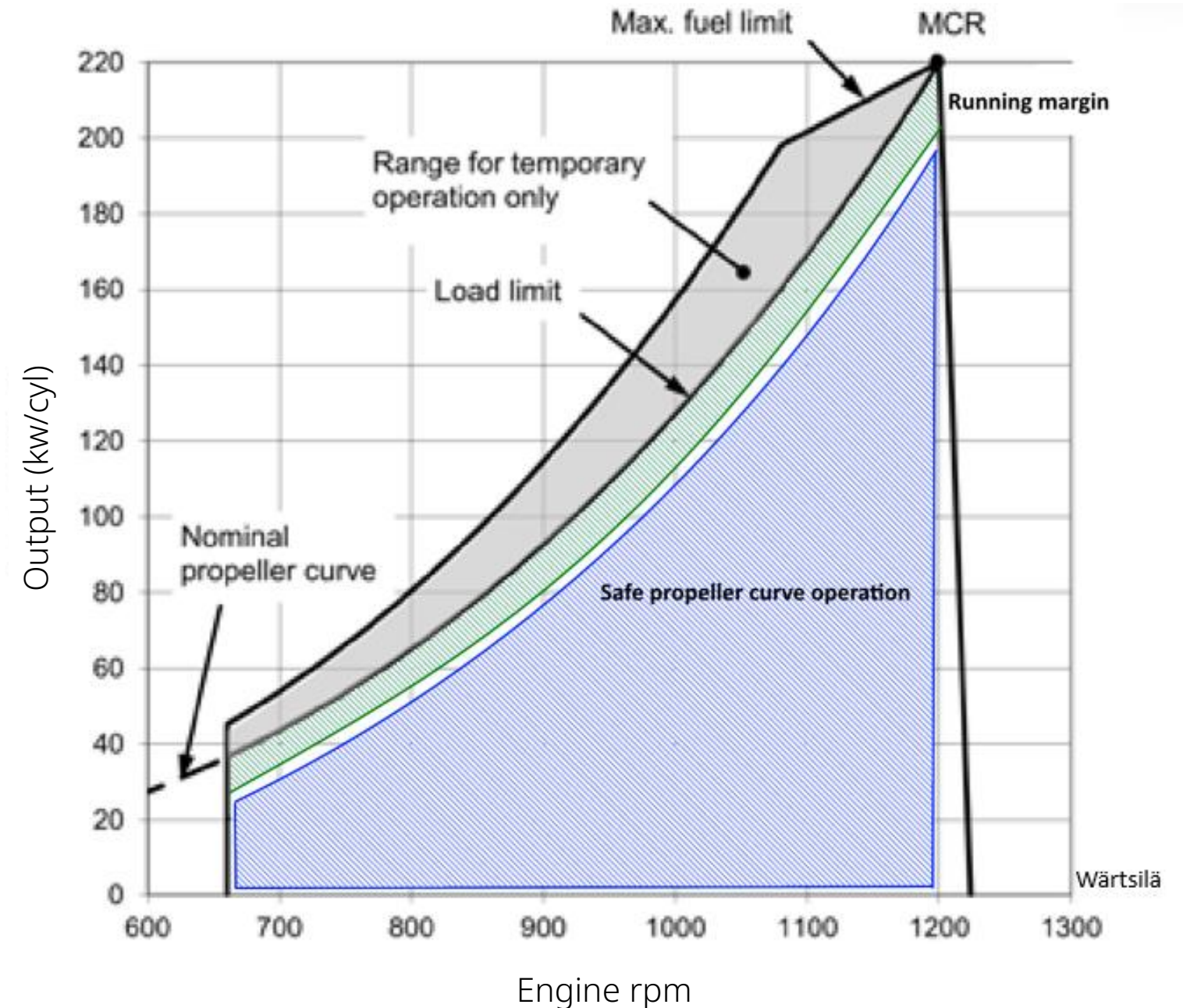
# On Top Solution to Assure Safety Even During Fuel Optimization

- On top system – all existing systems are maintained
- All existing safety systems are maintained
- The solution is designed always to fulfill the engine load limits

## SAFE ENGINE OPERATION

Between overhauls, engine and turbocharger efficiency may vary quite a bit.

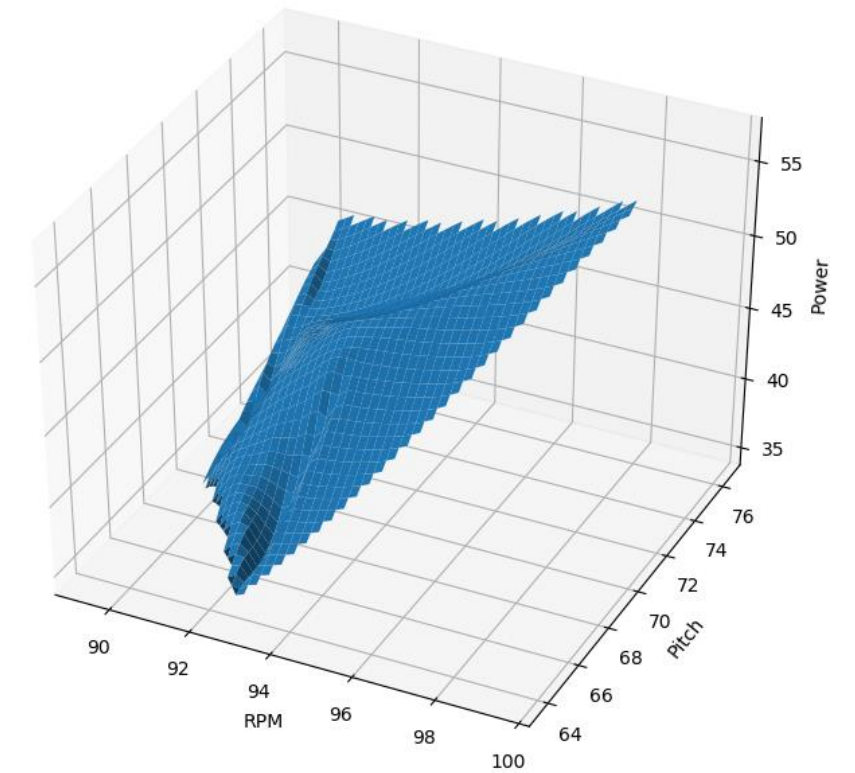
All engine operation must take this into consideration, keeping distance to the max. allowable load.



# Hull Dynamics vs Efficiency: Optimizing Propeller Curves by Vessel Conditions

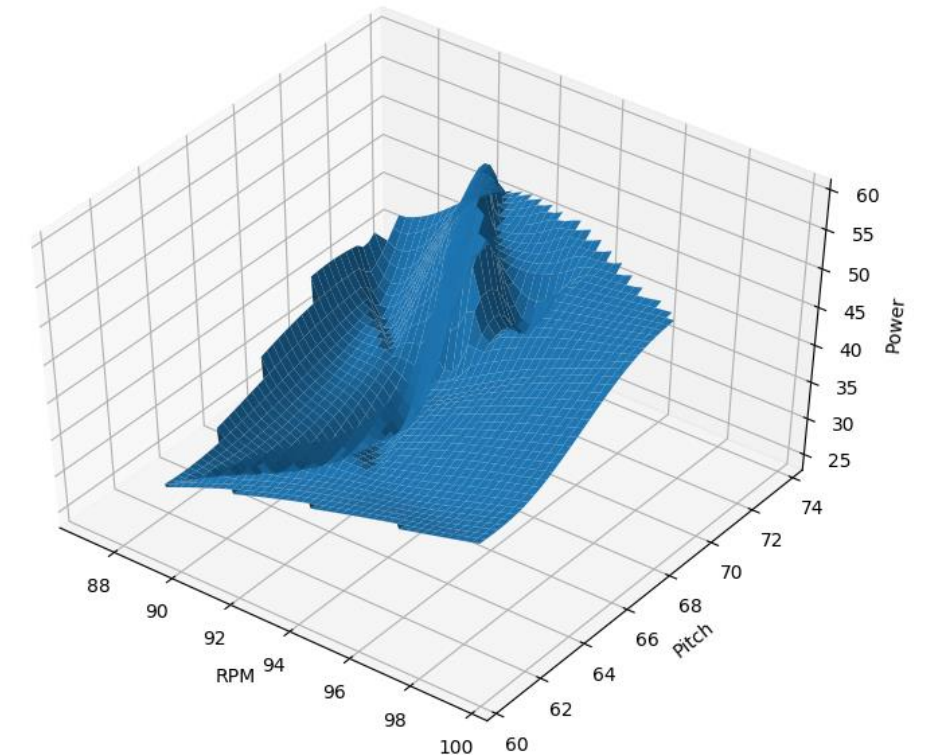
## High Draft Power Response

- Combining classifiers with the data we continuously collect on engine power, fuel consumption, speed and so on, we can generate propeller curves that match the vessel's current condition
- The upper right plot shows the power response at high draft on one of our vessels



## Low Draft Power Response

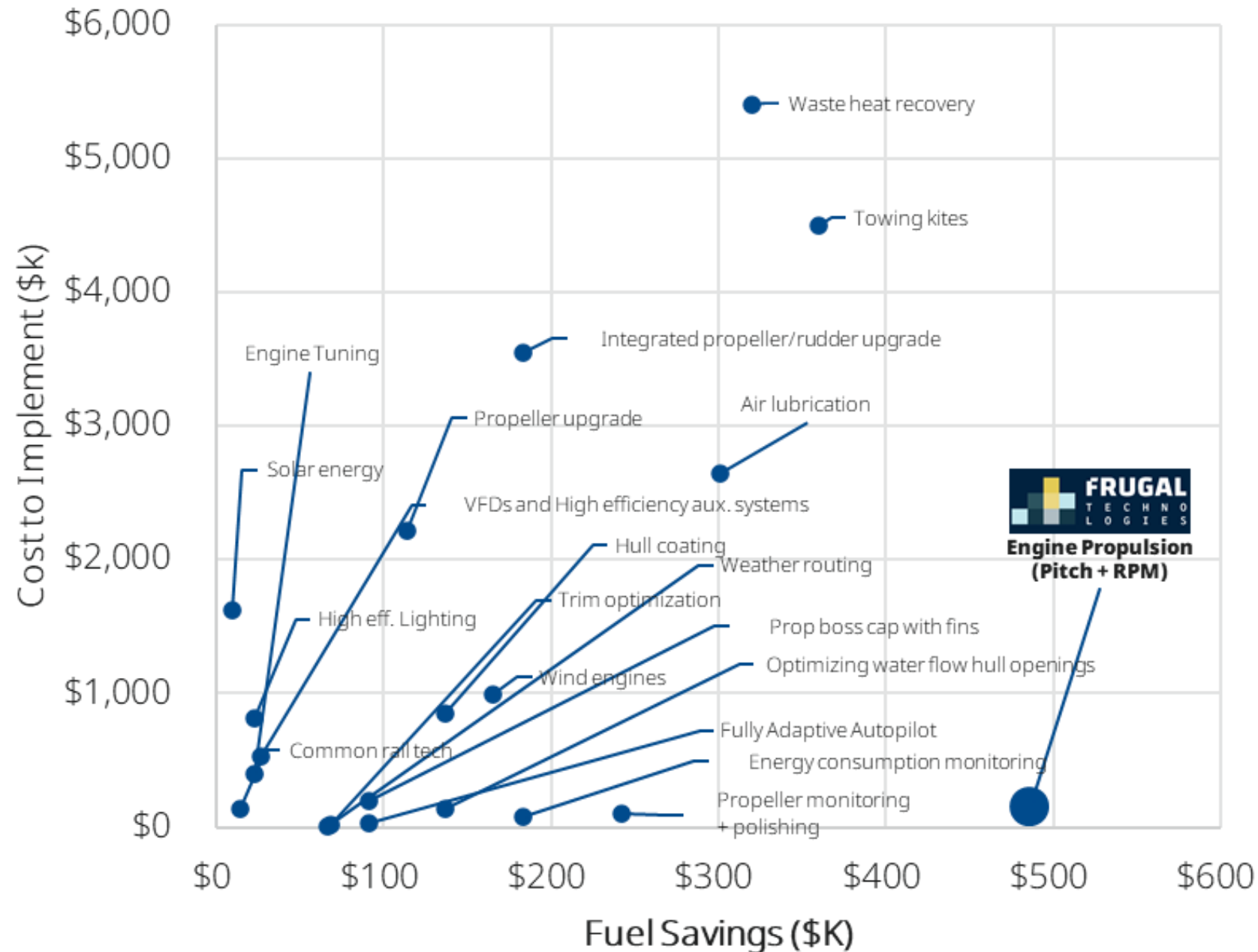
- The lower right plot shows the power response at low draft on the same vessel.
- Clearly, certain combinations of RPM and pitch are good for low draft, while others are better suited at higher draft
- Since power is directly proportional with fuel consumption, it makes sense to take this into consideration!



## MACHINE LEARNING

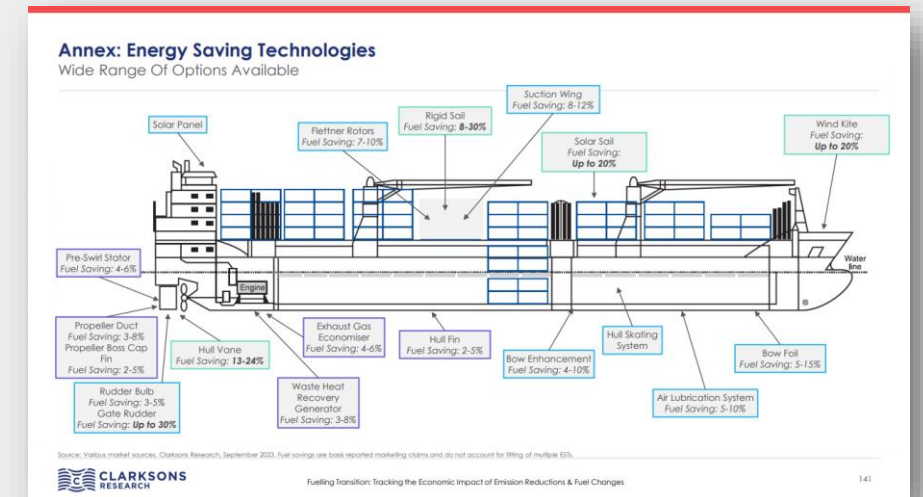
Leveraging machine learning to persist optimization patterns

# SmartPropulsion a Very Competitive EST: High Savings Compared to Implementation Costs



## Emission Saving Technology (EST) Comparison

- Much higher ROI as compared to other Emission Saving Technology
- Easy to implement without the need for dry dock
- Start saving today



Source: Fuelling Transition: Tracking the Economic Impact of Emissions Reductions & Fuel Changes (Clarkson Research, September 2023)



**EMERSON**<sup>™</sup>

# Engage With an Emerson Marine Solutions Expert



**SmartPropulsion**

Powered by Frugal Technologies



RPM



PITCH

15%

