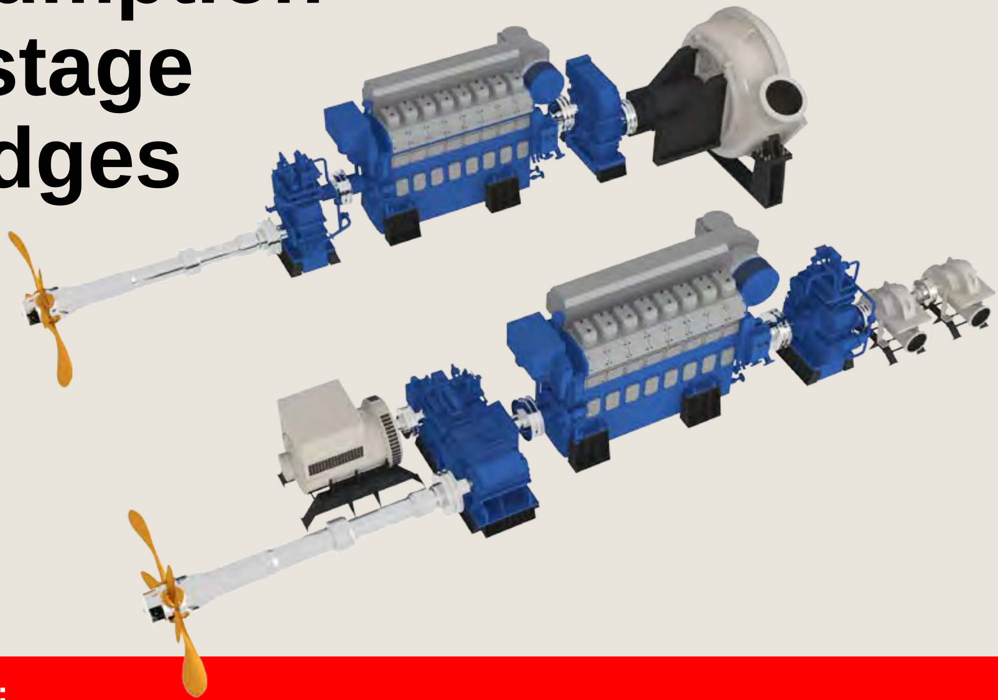
DEME

Dredging, Environmental & Marine Engineering

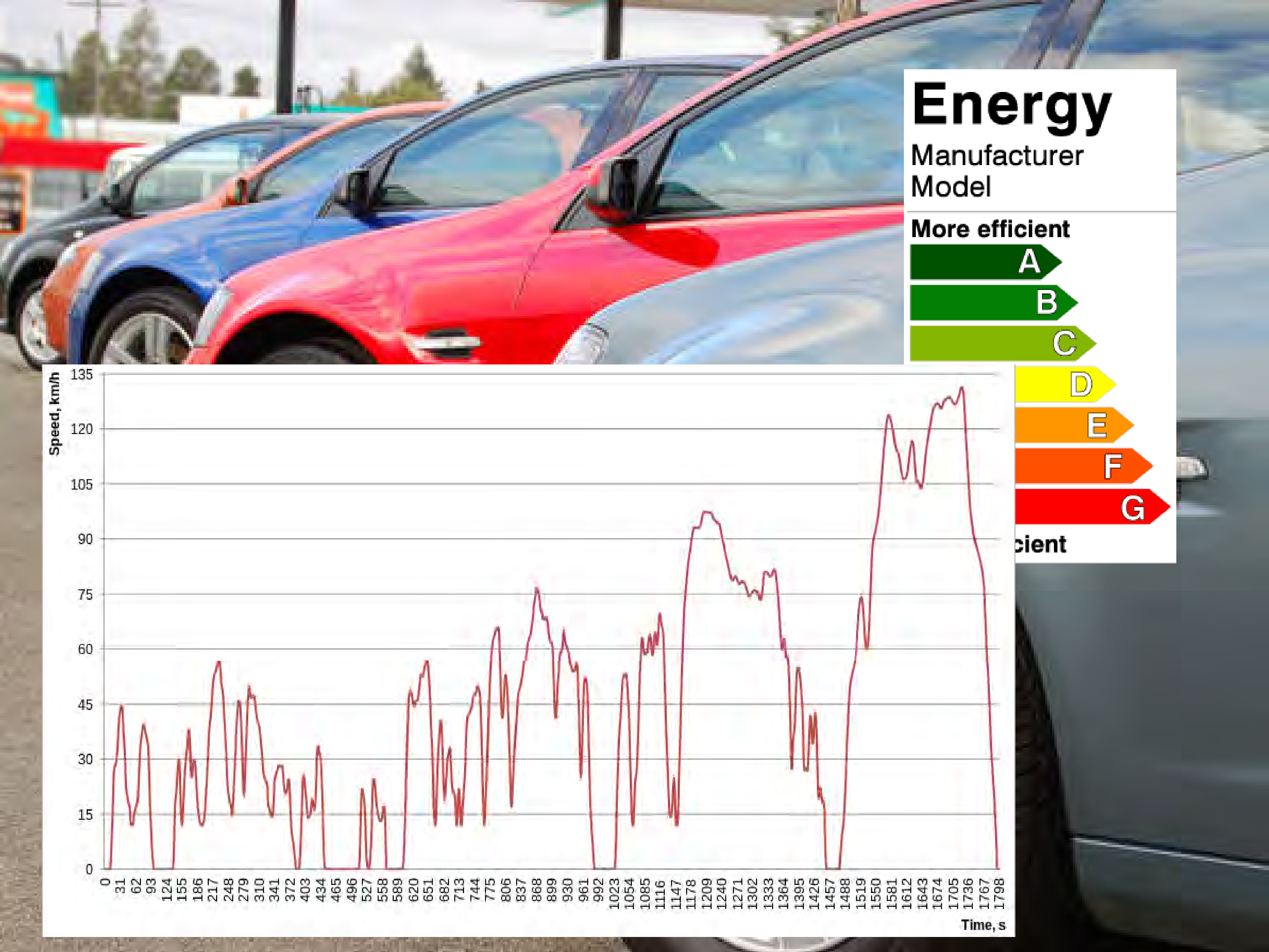
Cutting fuel consumption in the design stage of hopper dredges



WODCON XXI 2016, Miami

Leonard den Boer, Royal IHC

The technology innovator.

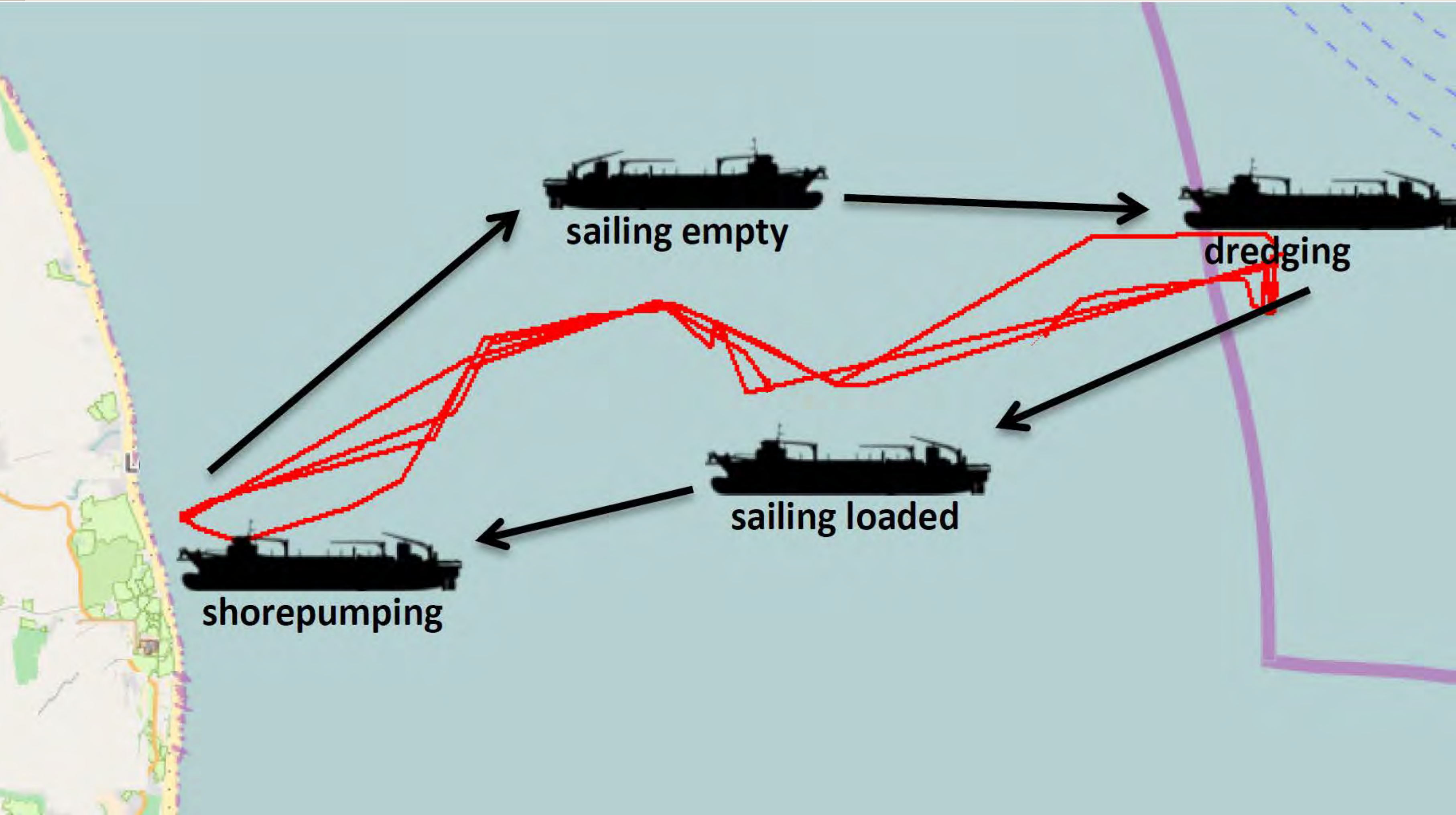

Energy
Manufacturer
Model
More efficient
A
B
C
D
E
F
G
Speed, km/h
135
120
105
90
75
60
45
30
15
0
Time, s

Agenda

1. **Operational profiles**
   - **Real-life project**
   - Standard project (Standard Dredge Cycle)
2. Fuel Consumption Tool
3. Comparison of drive trains

Real-life project

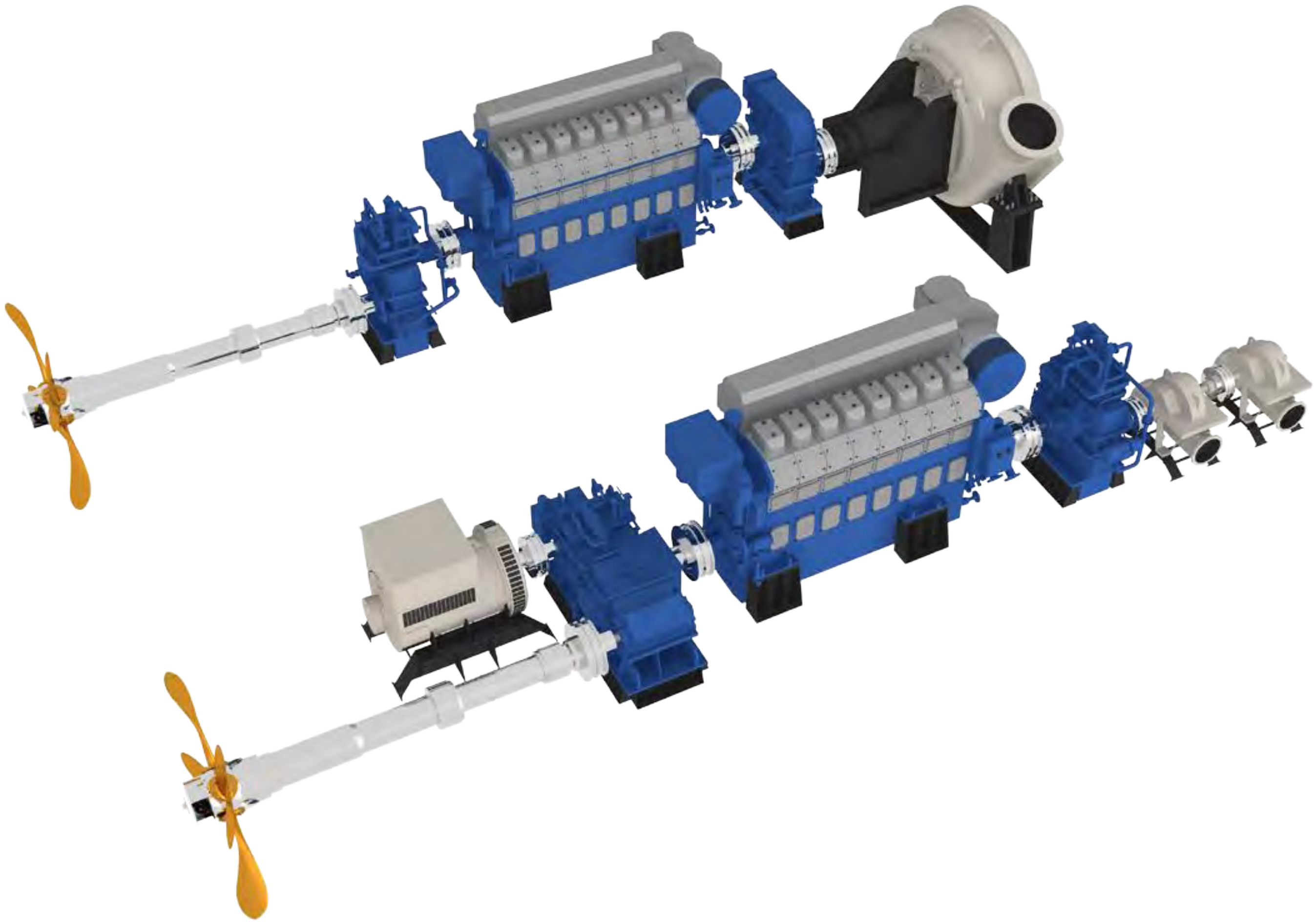
Understand the operational profile...



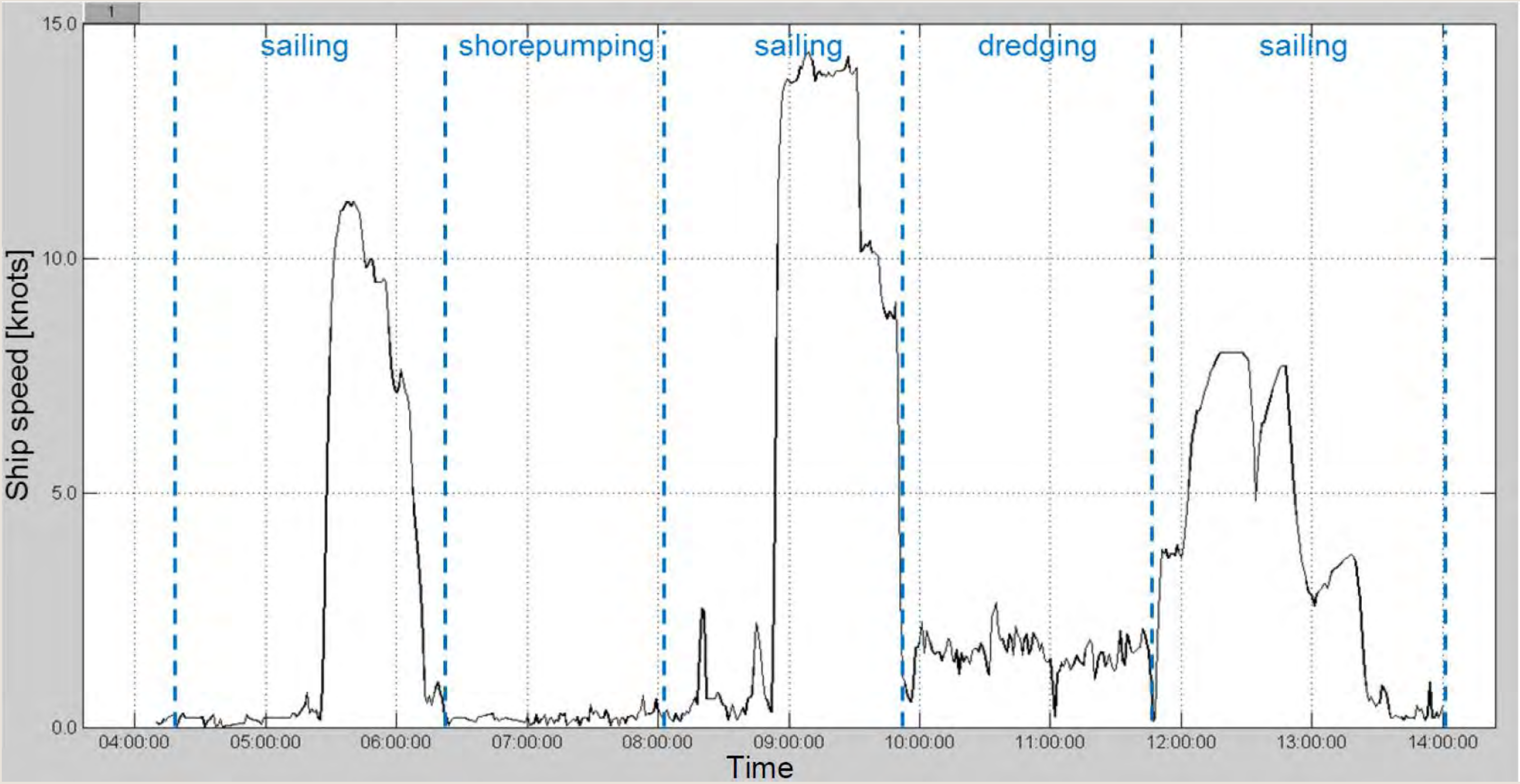
Real-life project

Real-life project

CPP drive train

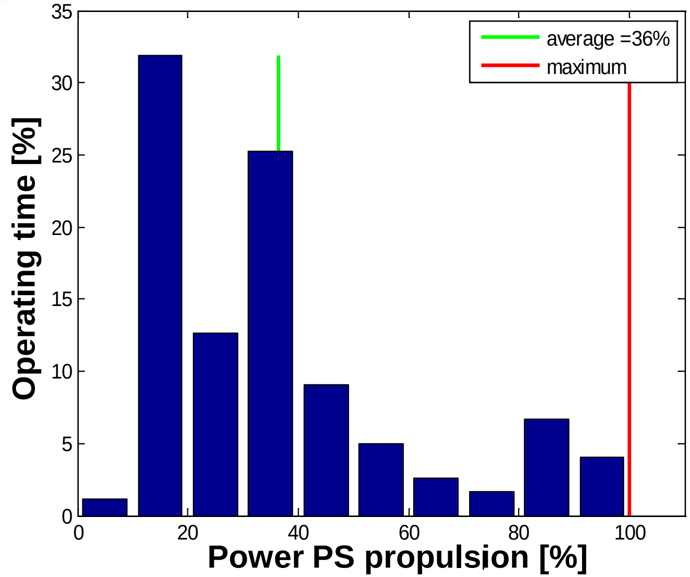


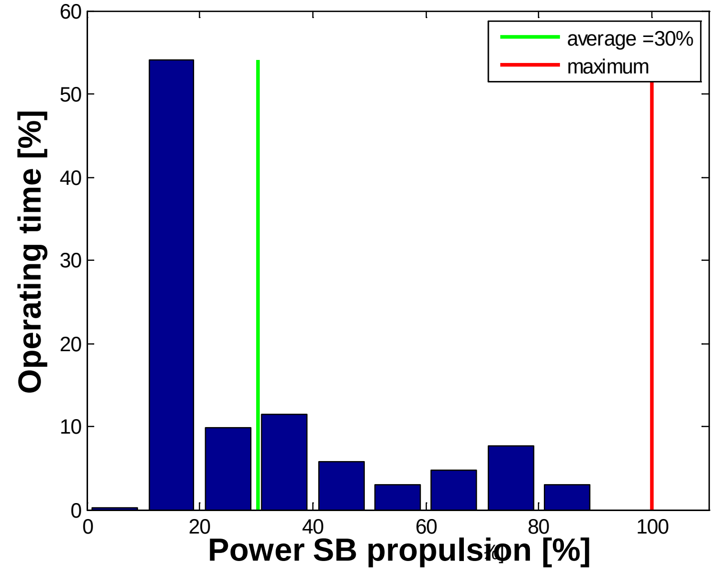
Real-life project



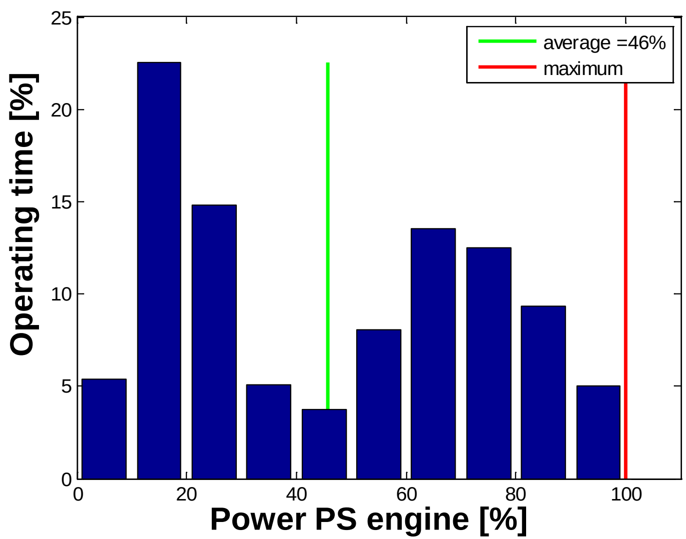
Real-life project

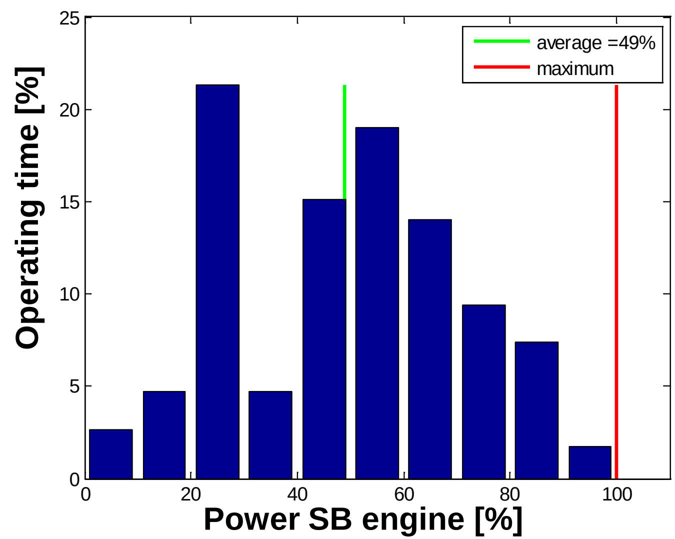
Propulsion power





Engine power





Agenda

1. **Operational profiles**
   - Real-life project
   - **Standard project (Standard Dredge Cycle)**
2. Fuel Consumption Tool
3. Comparison of drive trains

Standard Dredge Cycle

How to define a **Standard Dredge Cycle**?

- Use measurement data.

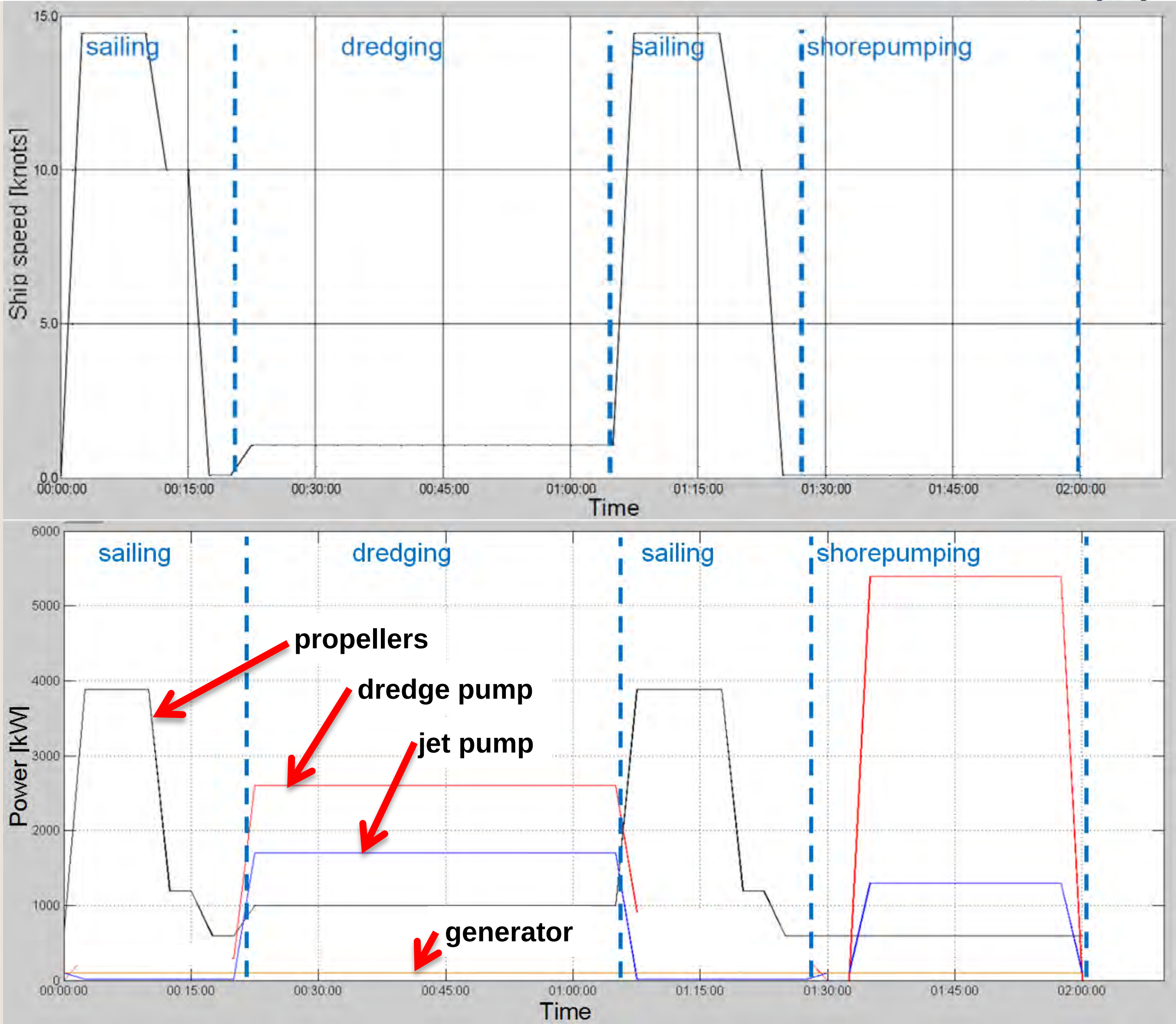
- **Cycle distribution** (based on thousands of dredge cycles)

	Operating Time
Sailing	35%
Dredging	34%
Mooring/maneuvering	8%
Discharge	19%

- **Average power** (based on 18 different dredge projects)

	Operating Time
Propulsion	35%
Main engines	62%

Standard Dredge Cycle

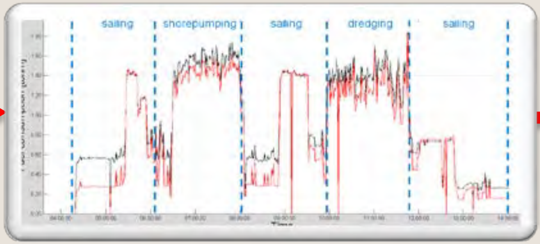


Agenda

1. Operational profiles
2. **Fuel Consumption Tool**
3. Comparison of drive trains

Fuel Consumption Tool

Fuel Consumption Tool



Input:

- power propulsion
- power pump
- power jetpump
- power generator

Fuel consumption:

- Drive train 1
- Drive train 2
- Drive train 3
- Drive train 4

Agenda

1. Operational profiles
2. Fuel Consumption Tool
3. **Comparison of drive trains**

Comparison of drive trains

How much fuel can be saved with alternative drive trains?

Drive trains to be compared:

- Normal drive train
- Alt.1 TwoSpeedGearbox
- Alt.2 CombinatorCurve
- Alt.3 Hybrid
- Alt.4 TwoSpeedGearbox + CombinatorCurve + Hybrid

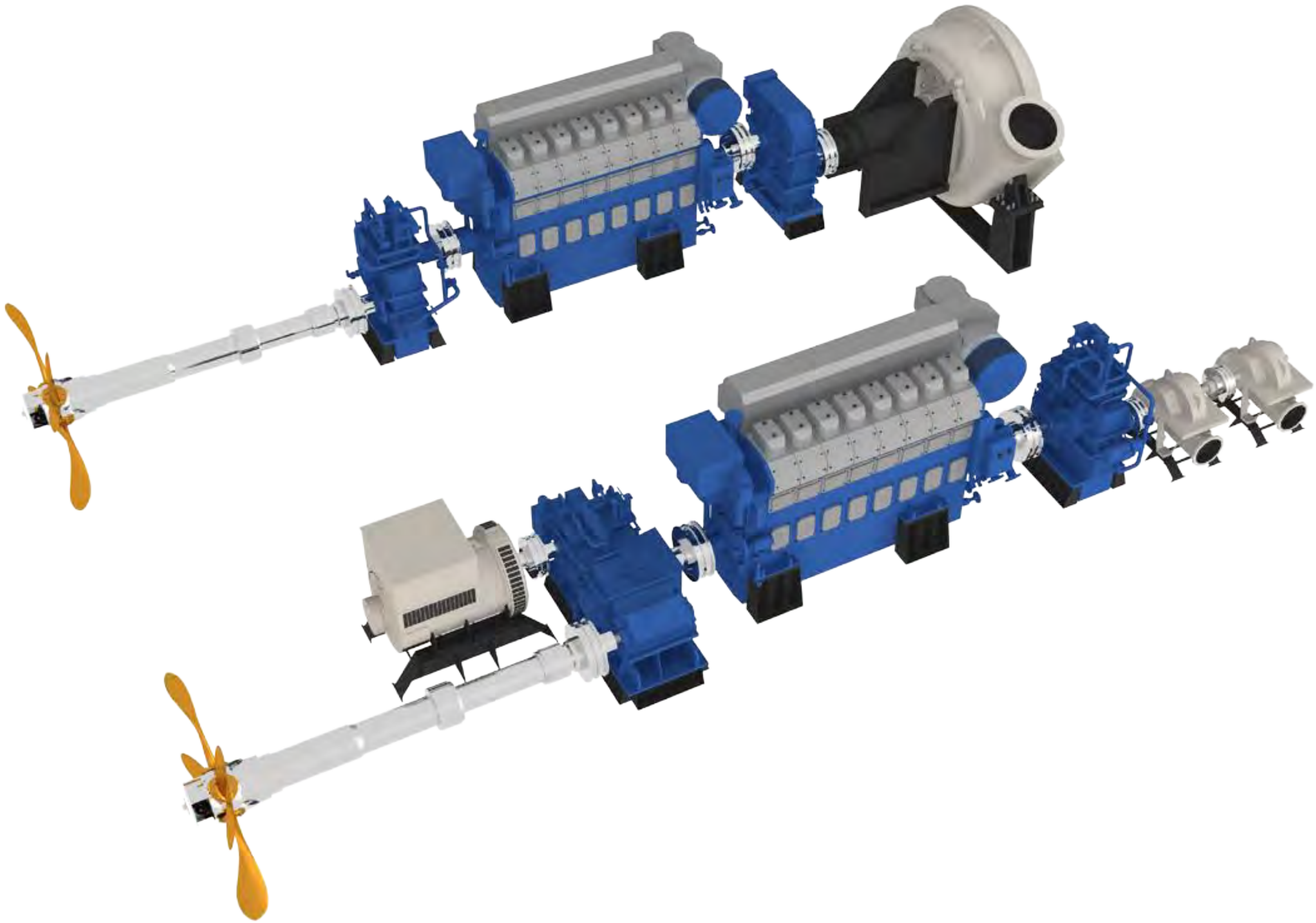
Comparison of drive trains

Assumptions:

- Same sailing speed during cycle
- Same hull shape
- Same production

Alt.1 TwoSpeedGearbox

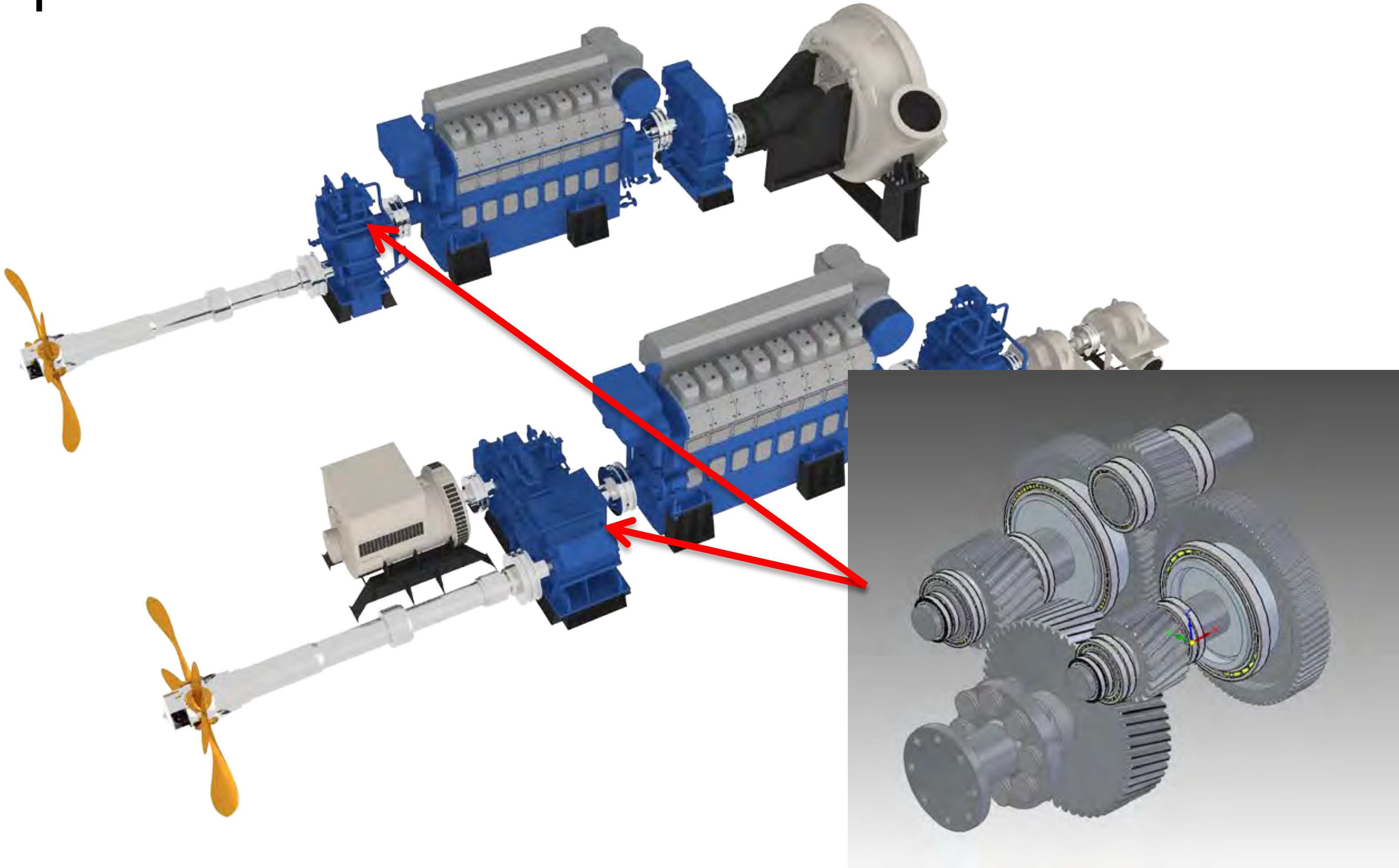
CPP drive train



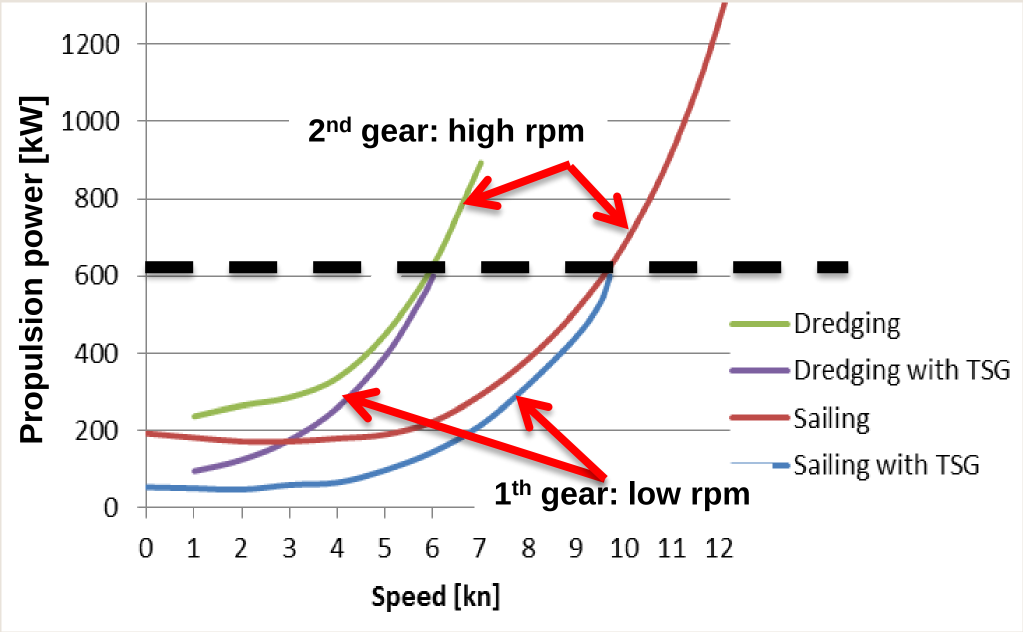
Alt.1 TwoSpeedGearbox

CPP drive train +

TwoSpeedGearbox



Alt.1 TwoSpeedGearbox

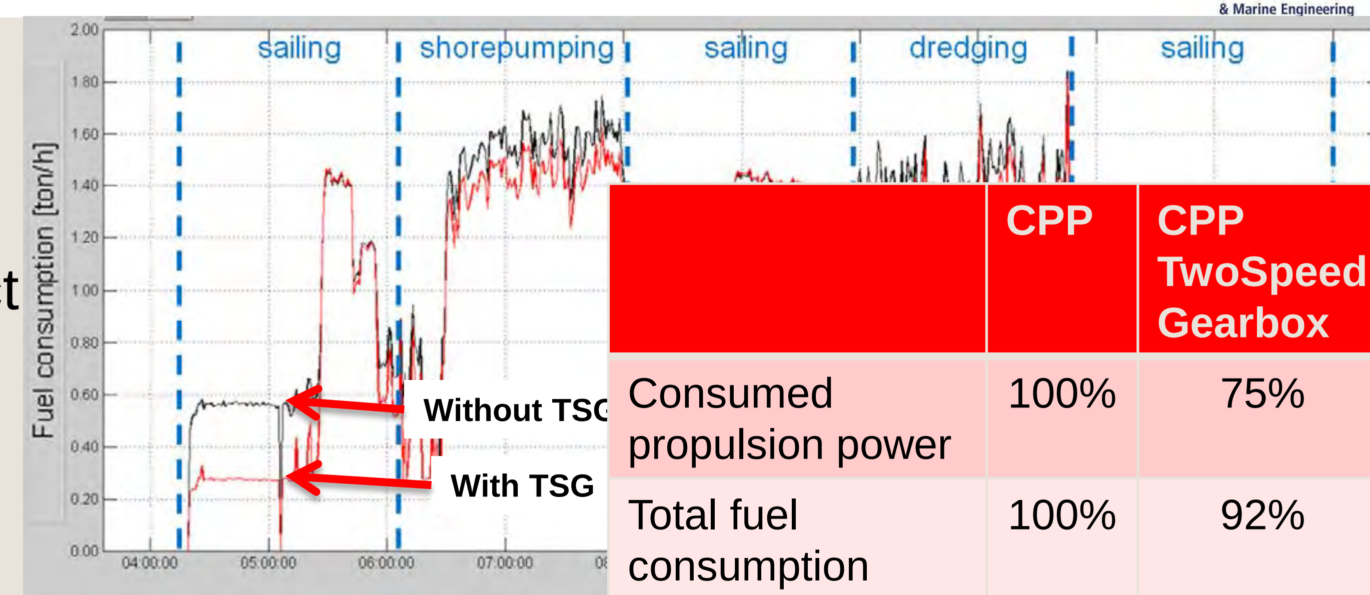


Propulsion

- Only propeller higher efficiency
- Low power > Low rpm
- High power > High rpm

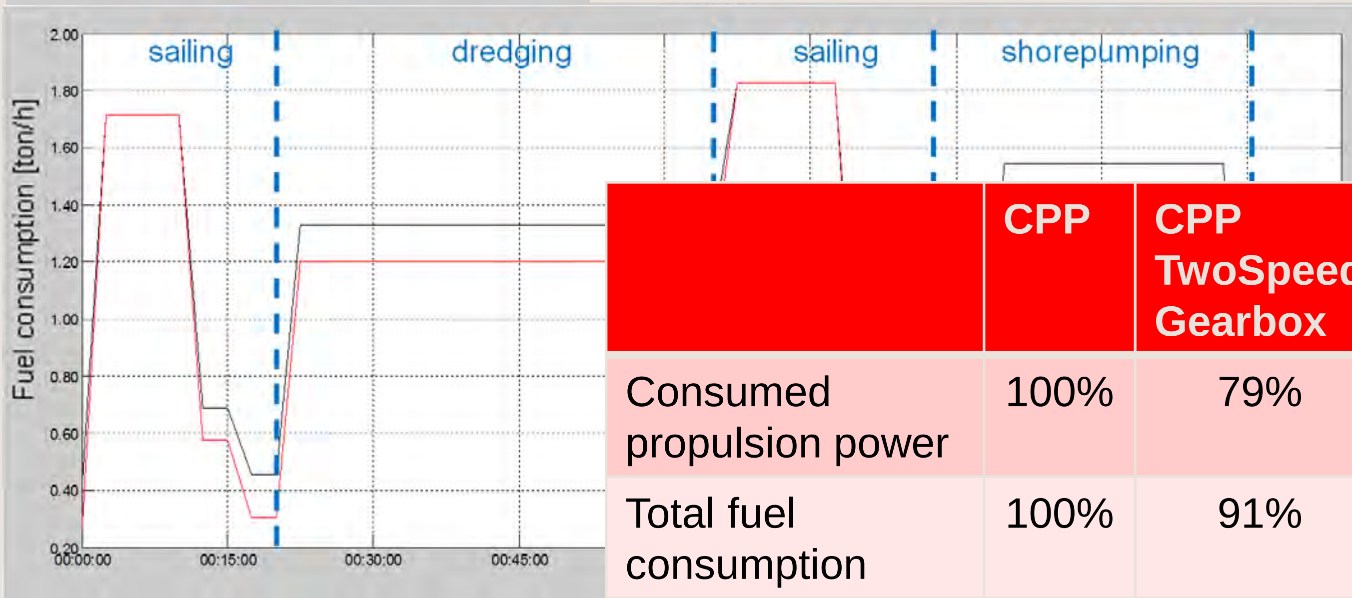
Alt.1 TwoSpeedGearbox

Real life project



	CPP	CPP TwoSpeed Gearbox
Consumed propulsion power	100%	75%
Total fuel consumption	100%	92%

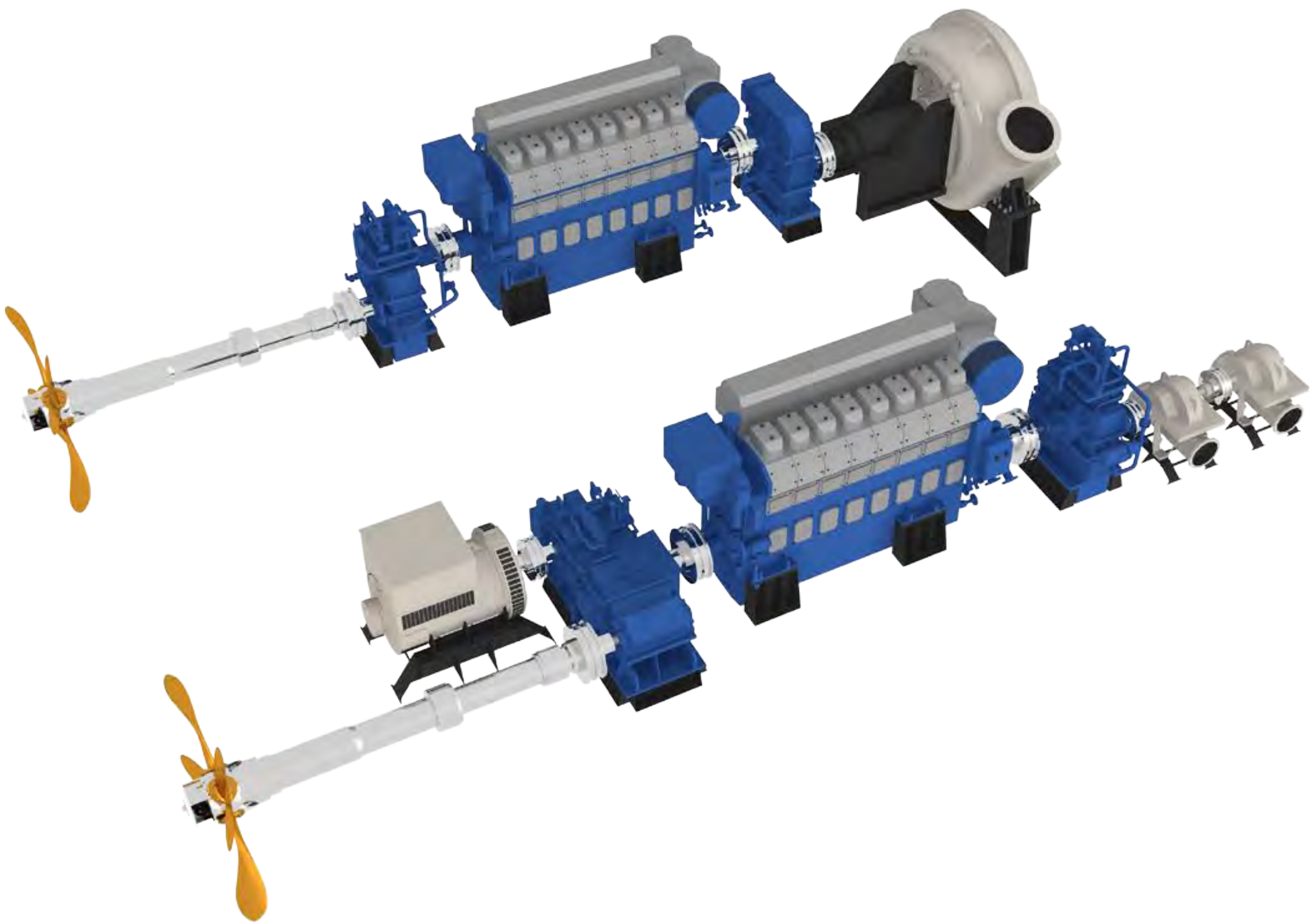
Standard Dredge Cycle



	CPP	CPP TwoSpeed Gearbox
Consumed propulsion power	100%	79%
Total fuel consumption	100%	91%

Alt.2 CombinatorCurve

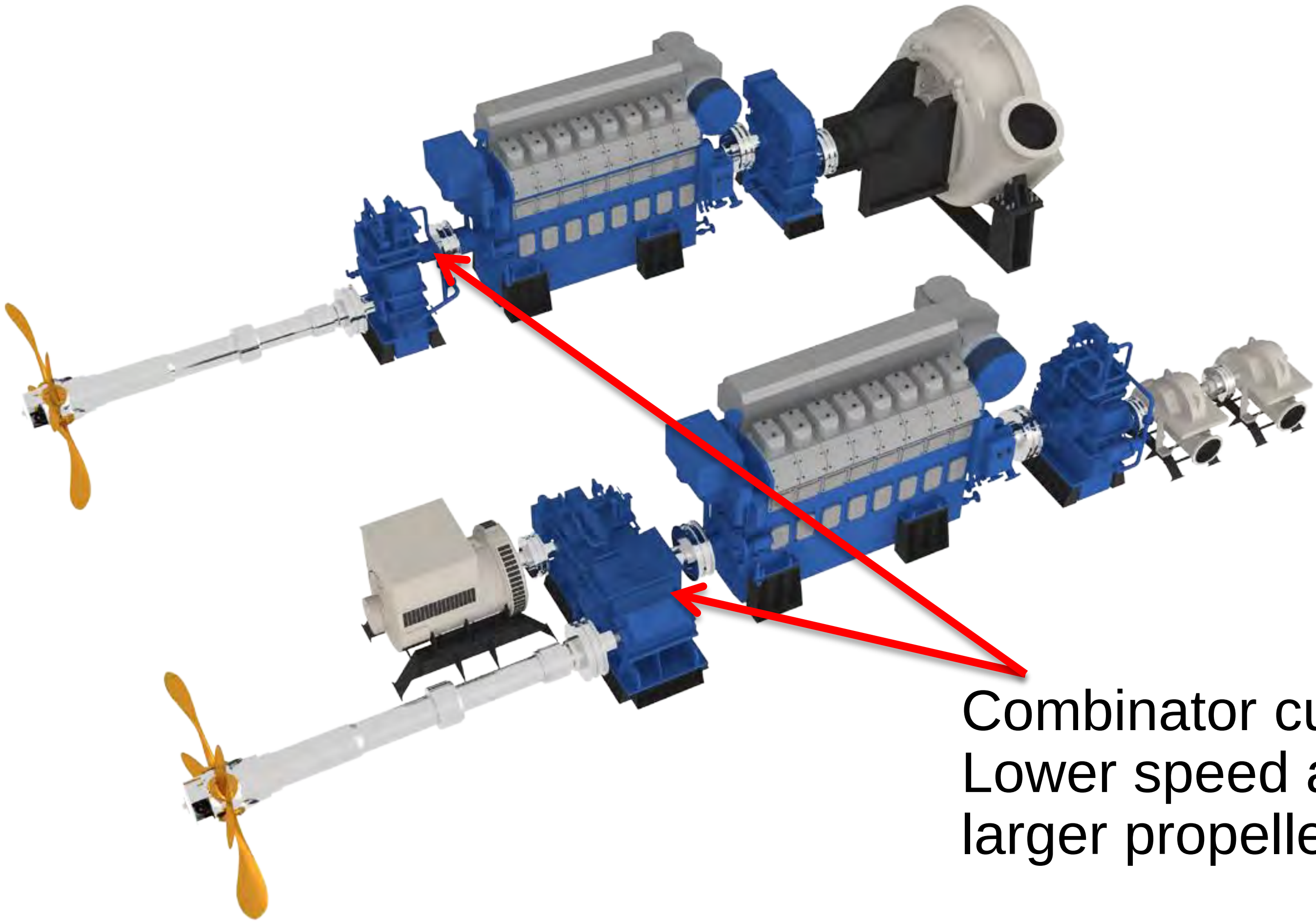
CPP drive train



Alt.2 CombinatorCurve

CPP drive train +

combinator curve



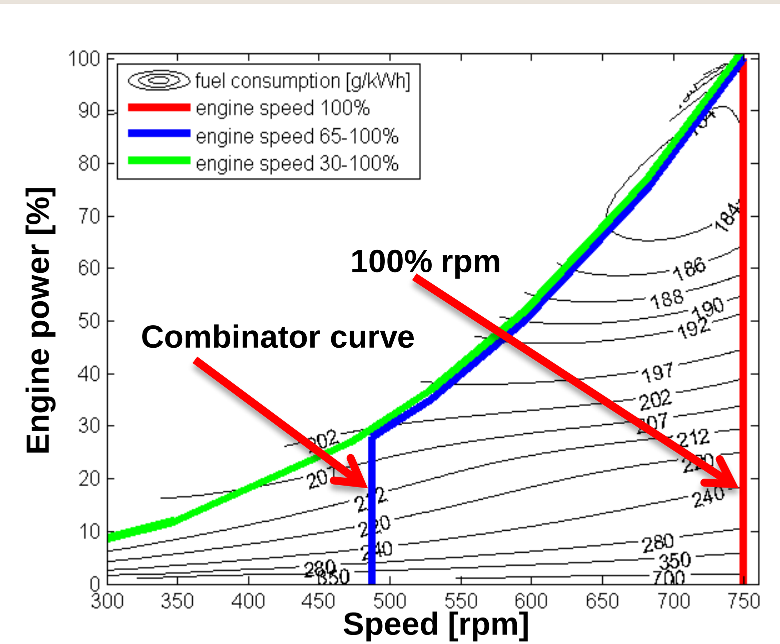
Combinator curve:
Lower speed and
larger propeller pitch

Alt.2 CombinatorCurve

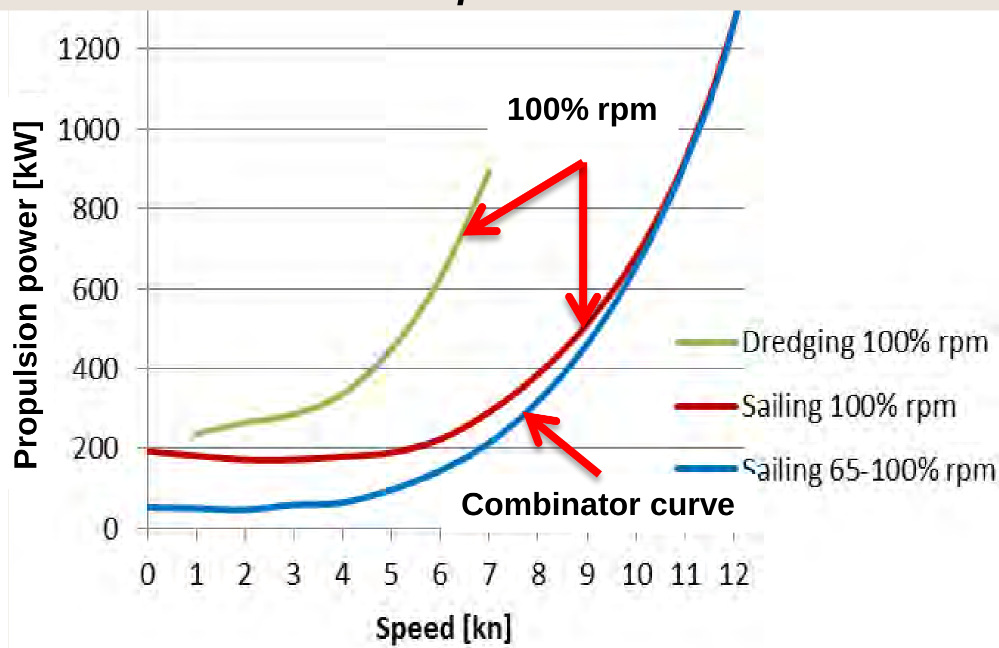
- Engine and propulsion higher ef
- Pumping: - no cor
- Sailing/manoeuvring: - combi

	CPP	CPP Combinator Curve
Consumed propulsion power	100%	95%
Total fuel consumption	100%	96%

Engine



Propulsion



Alt.3 Hybrid

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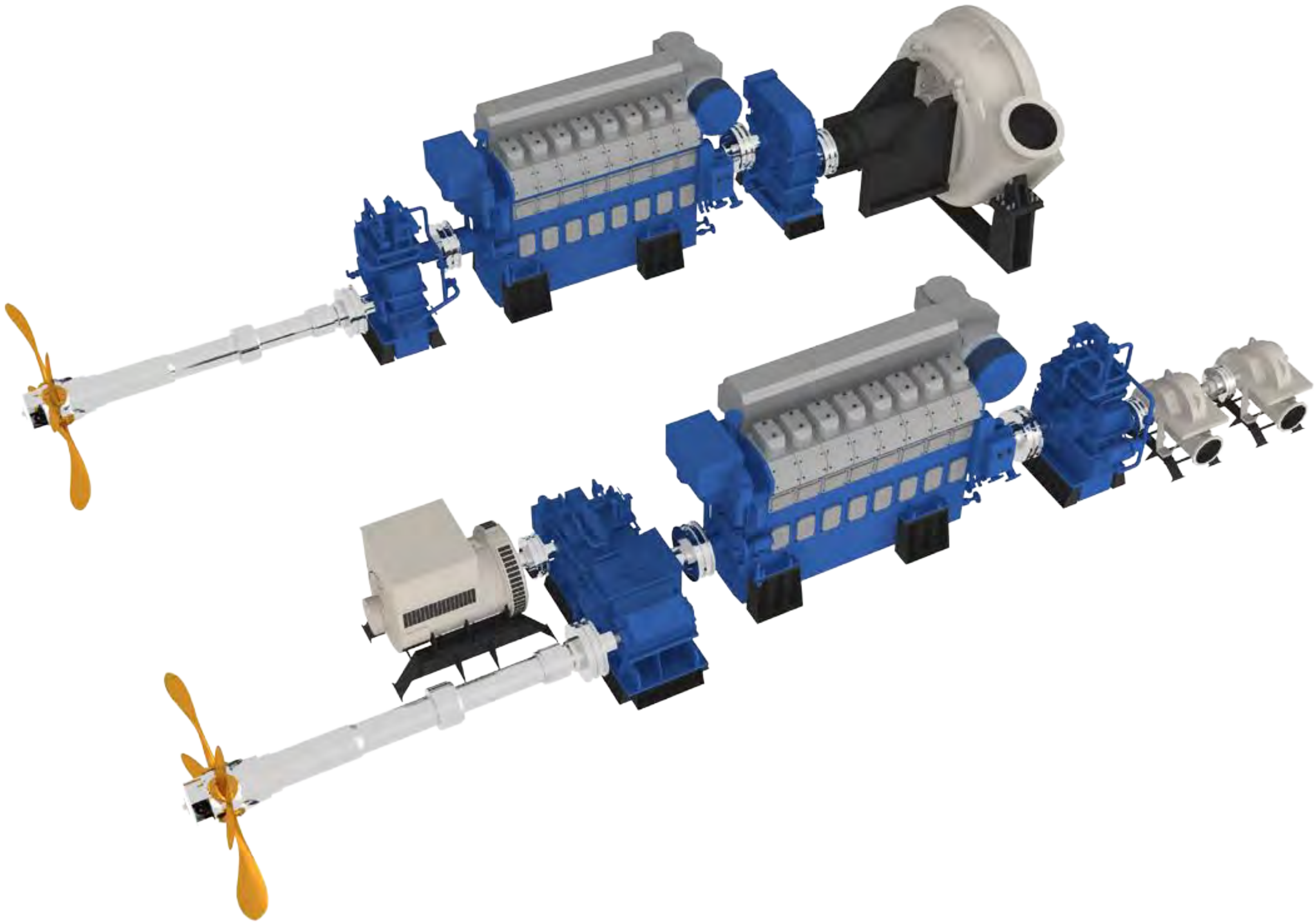
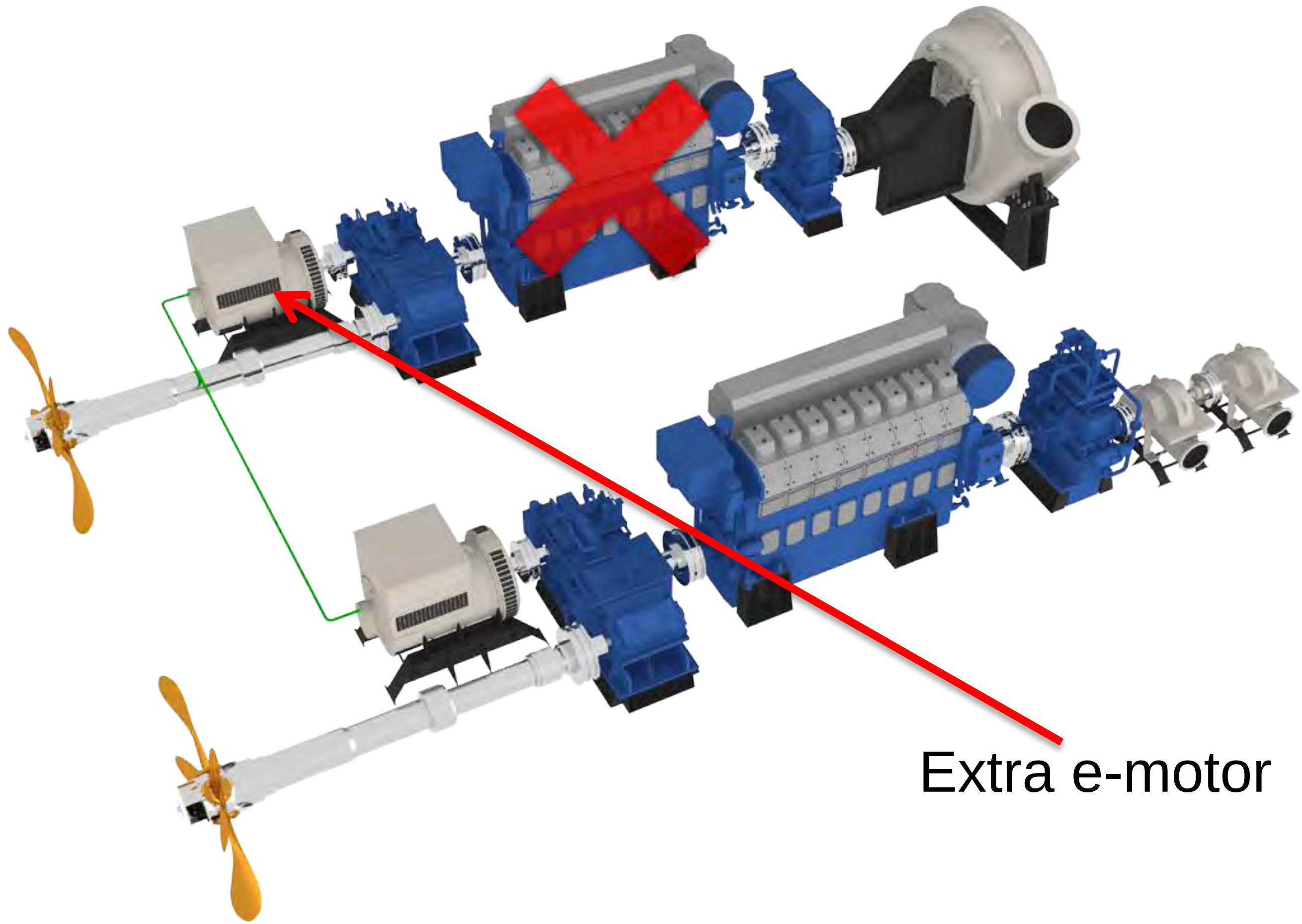
CPP drive train



Alt.3 Hybrid

CPP Hybrid drive train

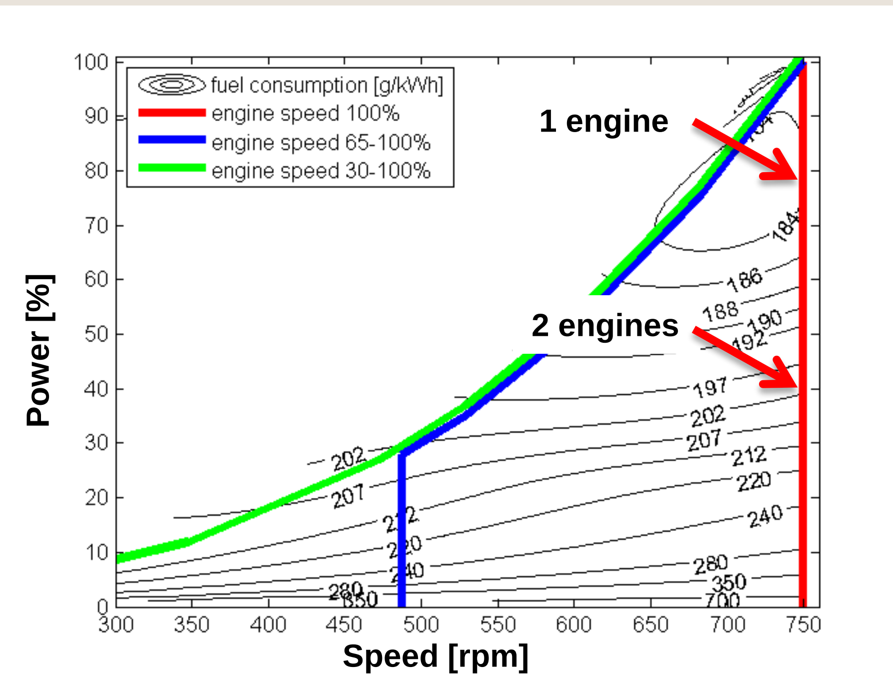


Alt.3 Hybrid

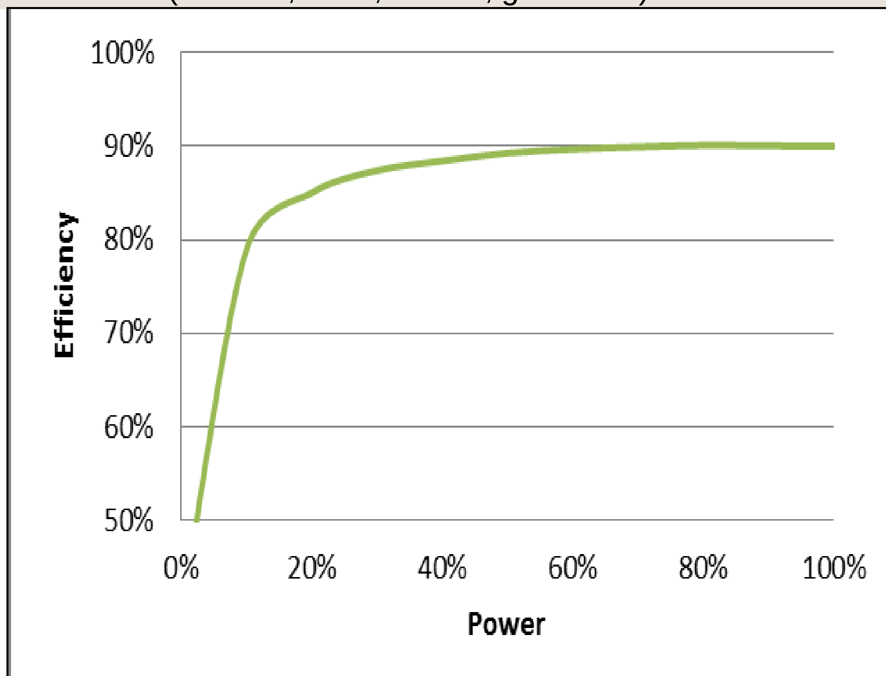
- Only engine more fuel efficient, l

	CPP	CPP Hybrid
Consumed propulsion power	100%	100%
Total fuel consumption	100%	98.5%

Engine

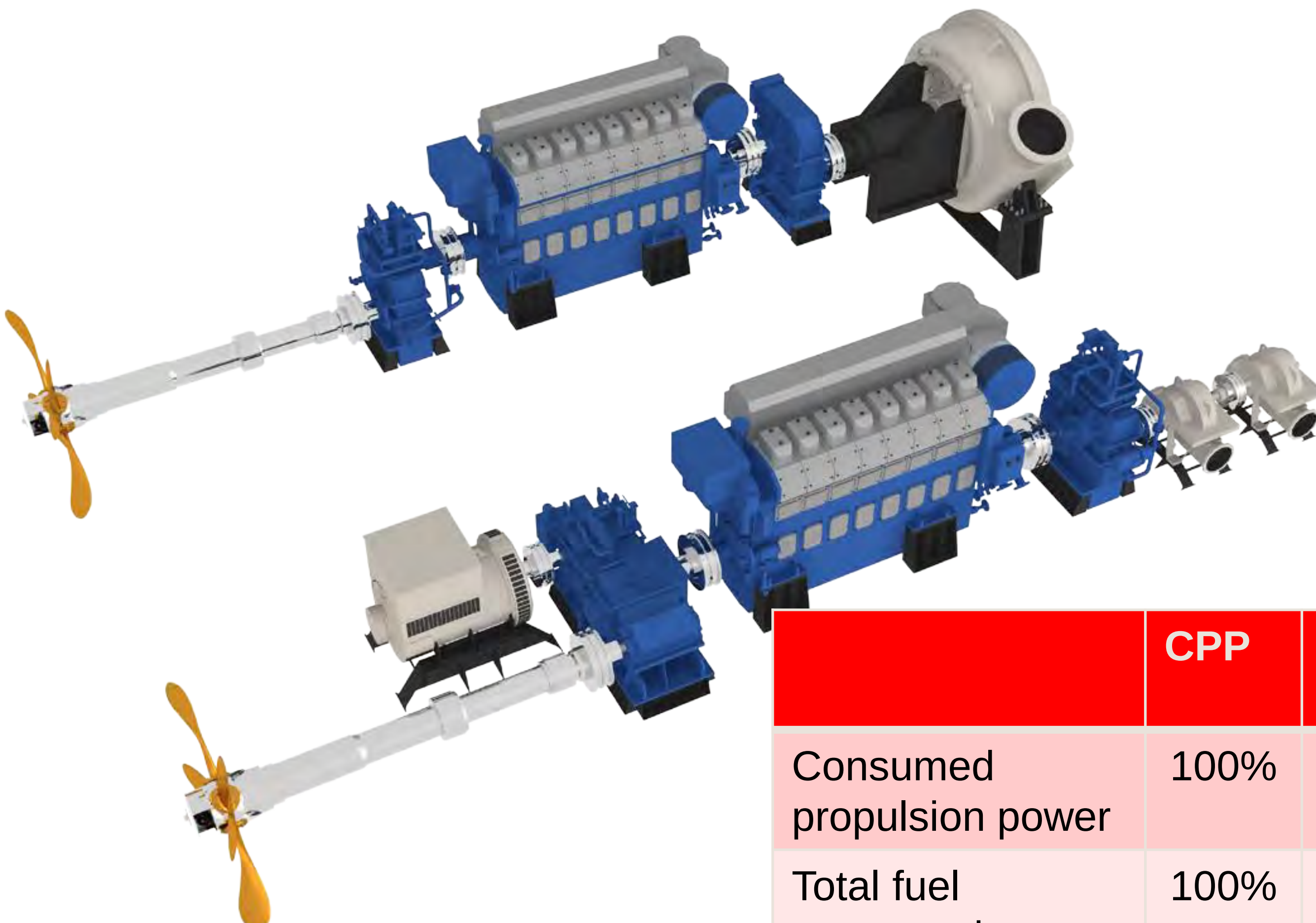


Electric efficiency
(e-motor, drive, cables, generator)



Alt.4 TSG+CC+H

CPP drive train



	CPP	CPP TSG+CC+H
Consumed propulsion power	100%	78%
Total fuel consumption	100%	88%

Comparison of drive trains

Real life project

	CPP	CPP TwoSpeed Gearbox	CPP Combinator Curve	CPP Hybrid	CPP TSG+CC	CPP TSG+CC +Hybrid
Consumed propulsion power	100%	75%	87%	100%	71%	71%
Total fuel consumption	100%	92%	92%	95%	87%	83%
Energy label	D	C	C	C	B	A

Standard Dredge Cycle

	CPP	CPP TwoSpeed Gearbox	CPP Combinator Curve	CPP Hybrid	CPP TSG+CC	CPP TSG+CC +Hybrid
Consumed propulsion power	100%	79%	95%	100%	78%	78%
Total fuel consumption	100%	91%	96%	98.5%	89%	88%
Energy label	D	C	C	D	B	B

Comparison of drive trains

World's first hopper dredgers with
Two Speed propulsion Gearbox…

15.000 m³

3.500 m³

8.000 m³

Conclusions

- Engines and Propulsion often used at **partial loads**
  - Opportunity for fuel optimization
- **Standard Dredge Cycle** is defined
  - Based on many measured dredge cycles
- With **Fuel Consumption Tool** drive trains can be compared

- Alternative drive trains can result in **significant fuel savings**
  - 17% fuel saving with Two Speed Gearbox, Combinator Curve and Hybrid drive train
- **World's first hopper dredgers with Two Speed Gearbox** ordered by DEME under construction at Royal IHC