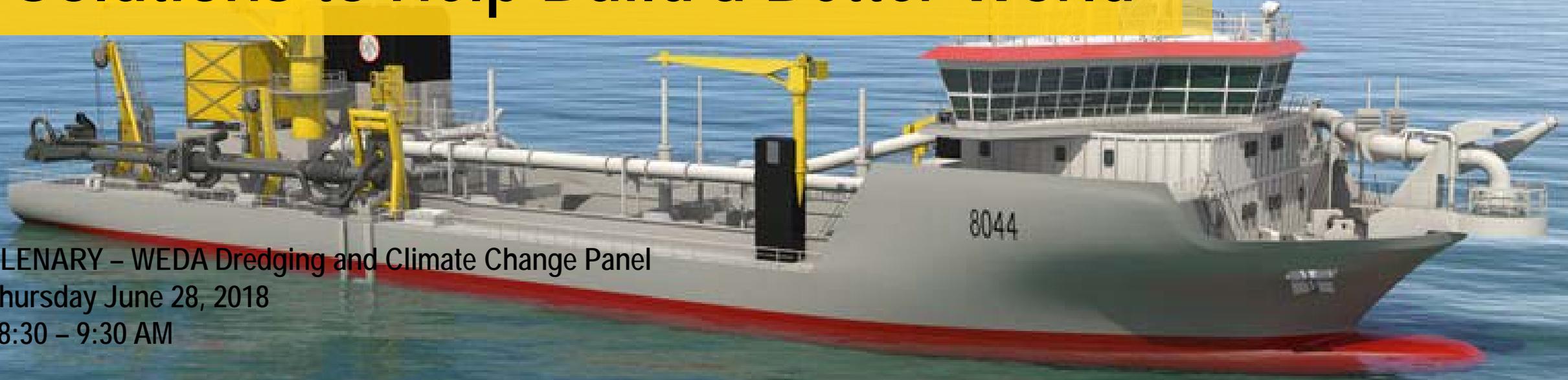


# Innovative and Sustainable Dredging Solutions to Help Build a Better World



PLENARY – WEDA Dredging and Climate Change Panel  
Thursday June 28, 2018  
08:30 – 9:30 AM

Jim Mundth

marine

# OUR SOLUTIONS HELP OUR CUSTOMERS BUILD A BETTER WORLD.



Caterpillar develops products that help customers use less fuel and generate fewer GHG emissions.

Caterpillar provides the talent, technology and solutions that help build a world in which all people's basic needs are met in sustainable ways, protect our natural resources and support thriving communities. That's our vision of a better world.



# Energy, Efficiency, Technology: Enhancing the Harmony Between Dredging and Ecology

*“We are involved in dredging, oil & gas infrastructure and offshore wind projects around the world,” said Jaap de Jong, Staff Director Ship Management Department at Van Oord. “We must have 100% reliability and optimum efficiency wherever our vessels are operating, and we must also be able to demonstrate the sustainability of our operations to meet our own goals of corporate social responsibility and those of the authorities we work with”*

# Technology & Solutions

- Advanced Variable Drive (AVD)
- Hybrid Systems
- EPA T4, IMO II / III Switchable Ratings
- LNG System Solutions
- Multi-Engine Optimizer
- Propulsion – Hydrodynamic Efficiency
- Selection Tools
- Digital Solutions



## Mission

Enable economic growth through infrastructure and energy development, and provide solutions that support communities and protect the planet.

# Caterpillar Marine – Systems and Solutions

## Marine Product Portfolio

Integrated Monitor, Safety, Control System

Technology Enabled Solution

Hybrid Propulsion System

Propeller, Thruster, POD

Gas Fuel System

Aftertreatment

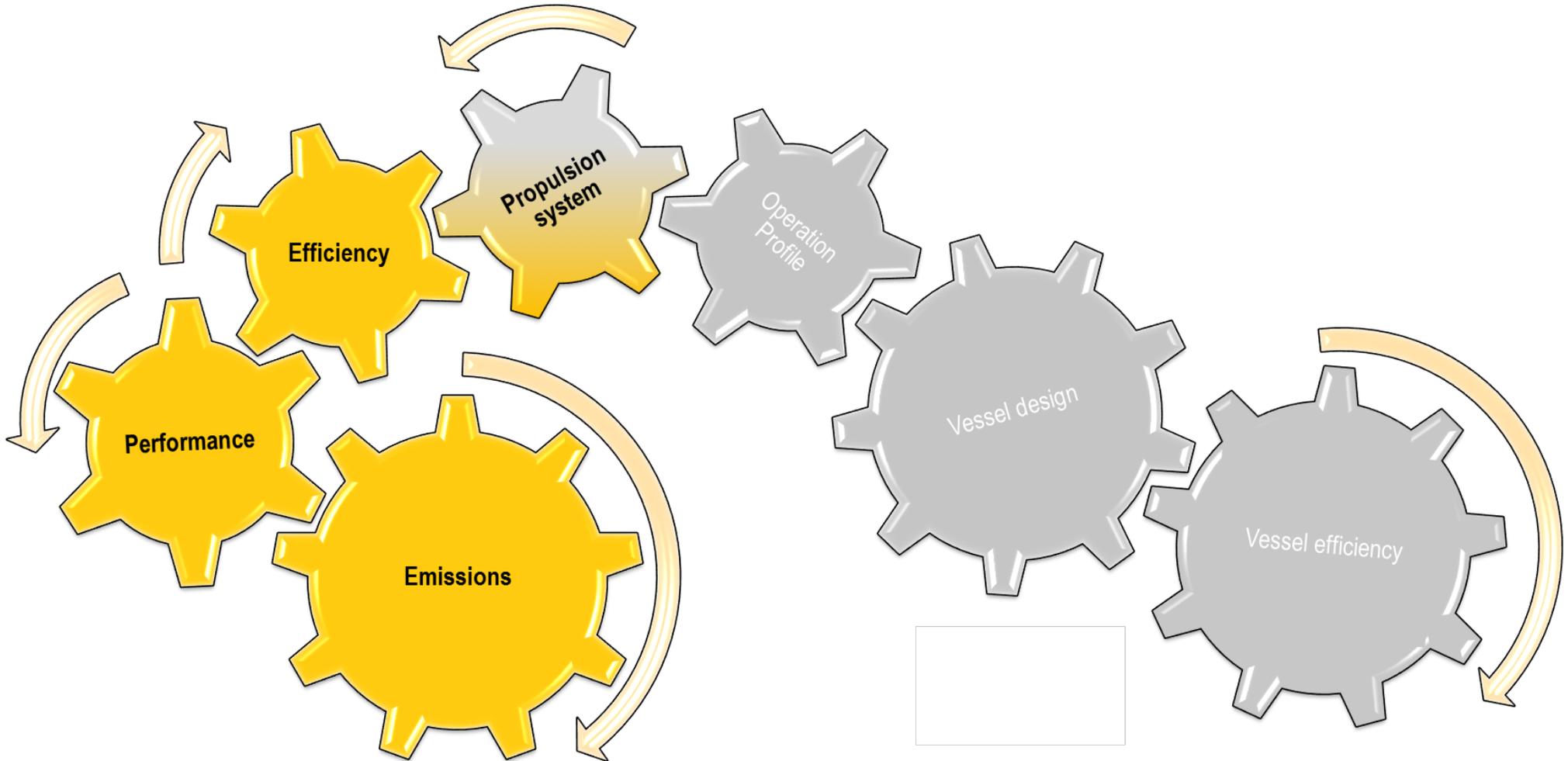
Auxiliary Engine

Generator Sets

Propulsion Engine



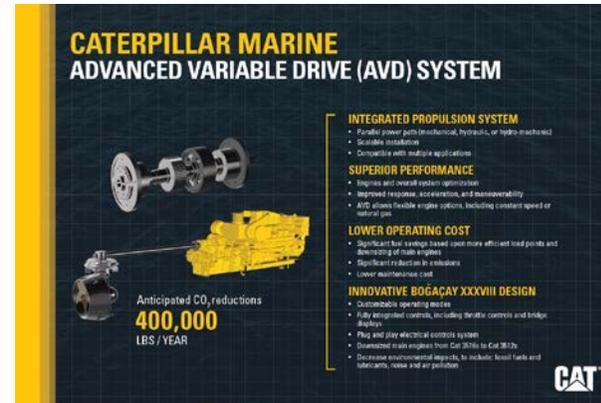
# New Technologies



# Advanced Variable Drive (AVD)

## INTEGRATED TRANSMISSION SYSTEM (PROPULSION/ PUMP)

- Parallel power path
- Patented design with CVT technology
- Scalable configuration
- Leverages existing technology

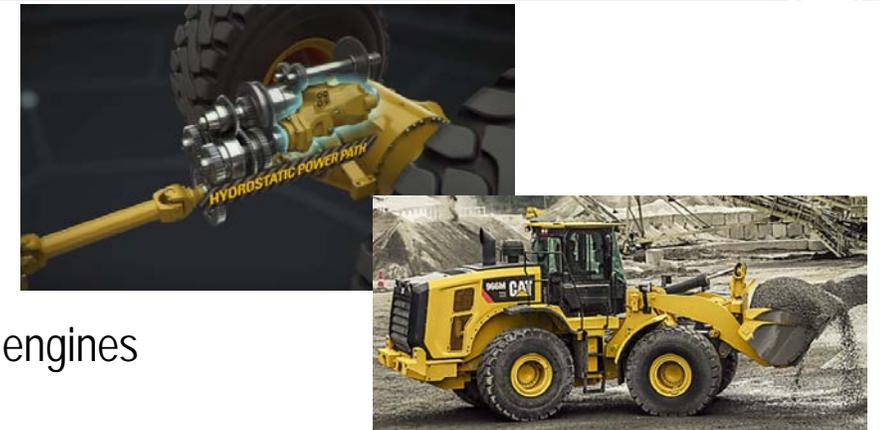


## SUPERIOR PERFORMANCE

- Engines and overall system optimization
- Improved response and acceleration

## LOWER OPERATING COST

- Significant fuel savings
- Lower cost and smaller package
- Reduced maintenance cost on main engines



# AVD Tug demonstrator

## PRODUCT INTRODUCTION

- Tug demonstrator planned in 2018
- Production availability for other markets planned in 2019

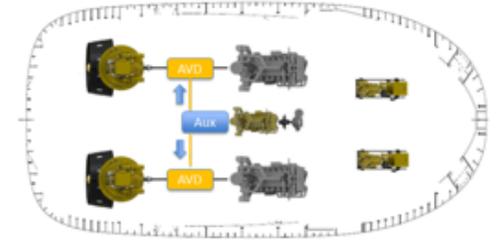
## CUSTOMIZABLE OPERATING MODES

- Individual modes optimized for vessel operation
- Fully integrated controls including throttle controls and bridge displays



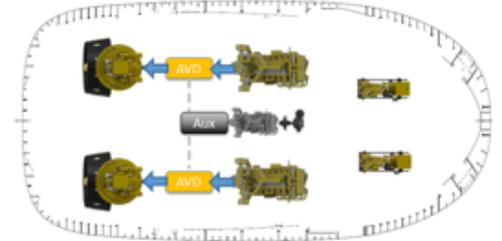
### **Mode 1 – Transit:**

- Hydrostatic only
- Aux engine only
- Transit Maneuvers
- 85% operating time



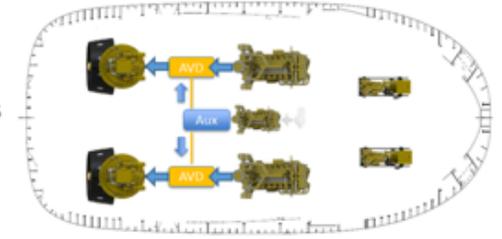
### **Mode 2 – Work:**

- Hydro-mechanical
- Main engines only
- Working maneuvers
- 12% operating time



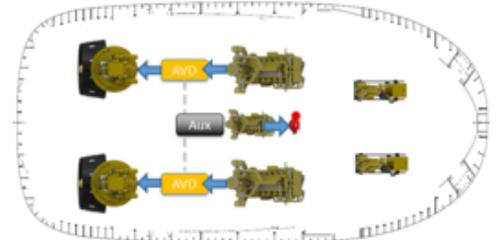
### **Mode 3 – Boost:**

- Hydro-mechanical
- Main and aux engines
- 100% power
- 2% operating time

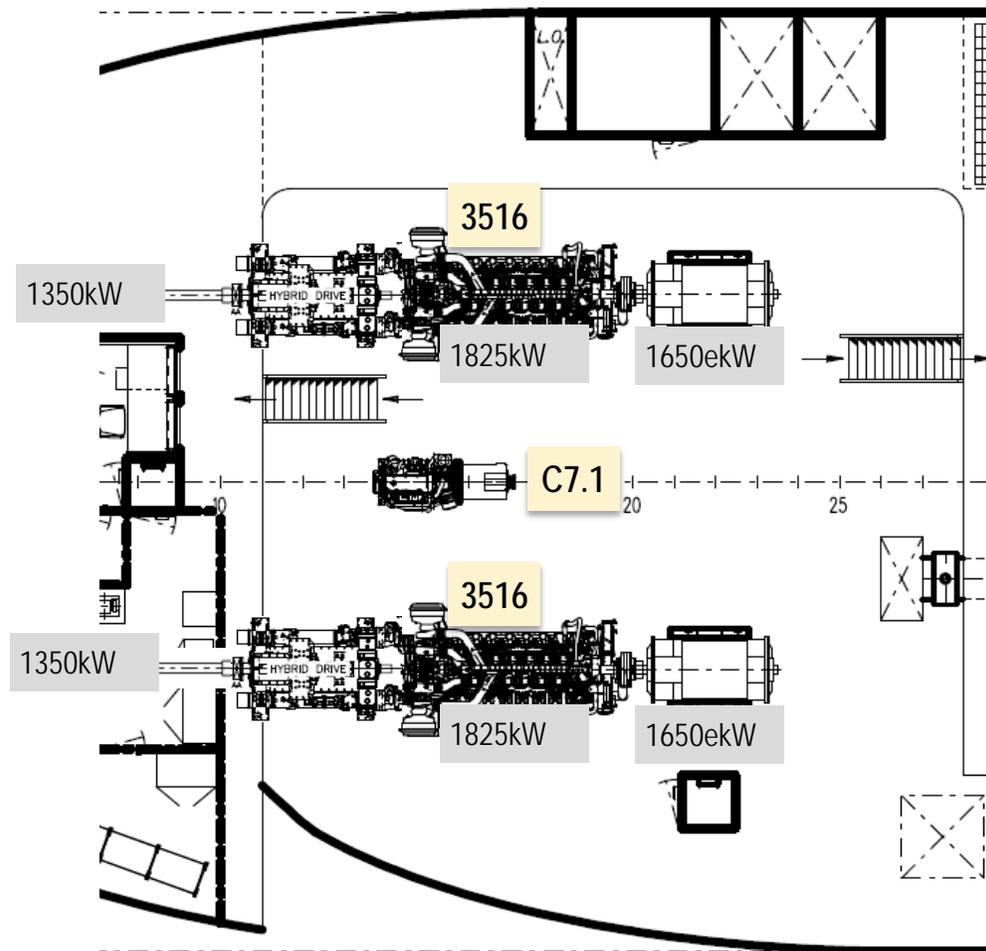


### **Mode 4 – Fifi:**

- Hydro-mechanical
- Mains – positioning
- Aux – fifi pump
- 1% operating time



# TSHD 1800m<sup>3</sup> - AVD Installation



AVD installation, two main gensets, aux genset, AVD, FPP

## Proposed drive train:

Generator: 1650kW 1500rpm

Flexible coupling: 1825kW 1500rpm

Engine: CAT3516C-HD 1825kW 1500rpm

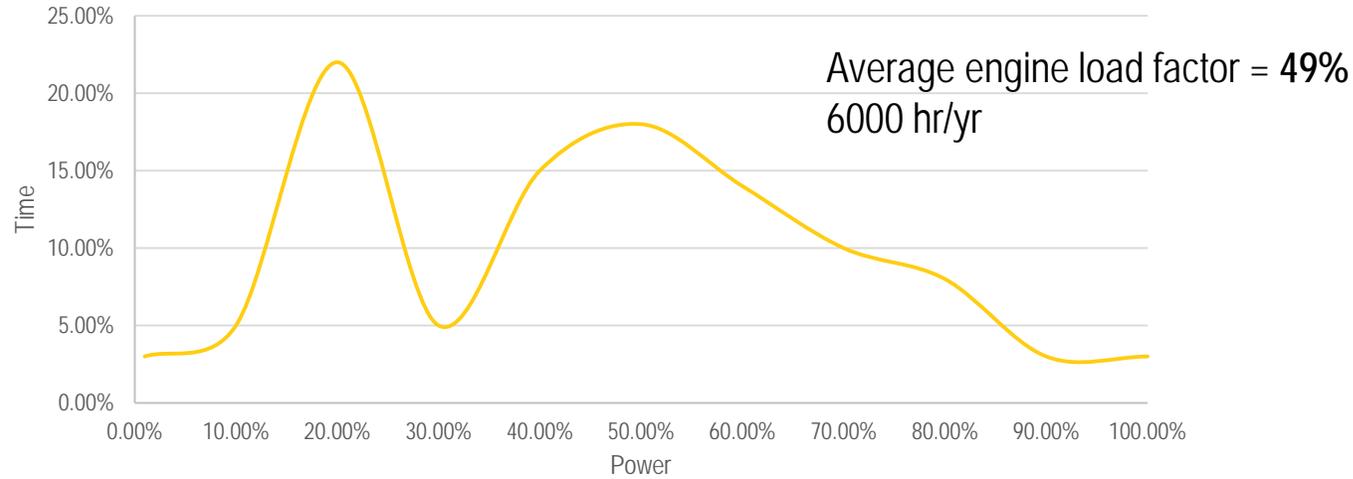
Flexible coupling: 1350kW 1500rpm

AVD gearbox:

- power: 1350kW
  - speed in: 1500rpm
  - speed out: 264rpm-0rpm
  - Overload protection: TBA
  - Clutching mechanism: electric
  - Gearbox offset: preferably vertical
- FPP: 264rpm-0rpm 1350kW

# Dredge Operating Profile

3516 Main Engine Load Profile



Operation	% Power	% Time
Mooring	10%	4%
Maneuvering	20%	8%
Shore pumping	80%	19%
Sailing empty	40%	15%
Dredging	70%	34%
Sailing loaded	20%	20%

# Dredge Operating Profile (AVD)

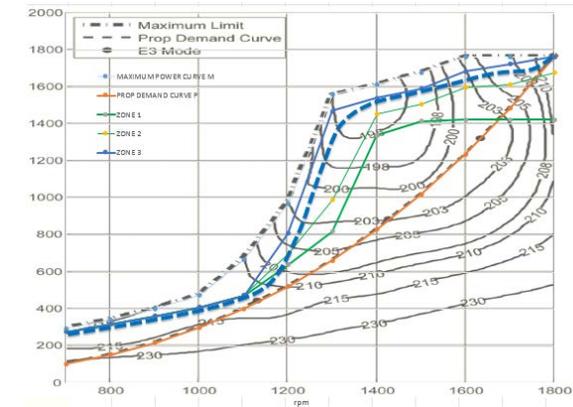
PERCENT LOAD	ENGINE POWER	FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)
%	BKW	G/BKW-HR	L/HR
100	1,940	200.8	464.2
90	1,744	203.3	422.7
80	1,550	207.7	383.6
75	1,453	207.8	359.8
70	1,356	206.7	334.1
60	1,162	206.3	285.7
50	968	208.3	240.5
40	775	213.8	197.4
30	581	224.4	155.4
25	484	233.2	134.6
20	387	246.7	113.9
10	194	316.5	73.1

With AVD, total vessel operation can be optimized:

1. Low load operations can be accomplished with **one engine**
  - 47% time spent mooring, maneuvering, or sailing
  - Operating one main engine results in lower overall engine hours
  - Operating one main engine at higher load factor increases efficiency
2. High load operation can be accomplished at **optimal efficiency**
  - 53% time spent dredging or shore pumping
  - Variable speed propulsion ratings can be utilized to achieve optimal efficiency at any operating speed
3. **Optimal gearbox ratios** can be selected based on operating mode
  - Two-speed gearboxes provide significant fuel savings especially during sailing
  - AVD provides a wide range of ratios to optimize operational efficiency

1.

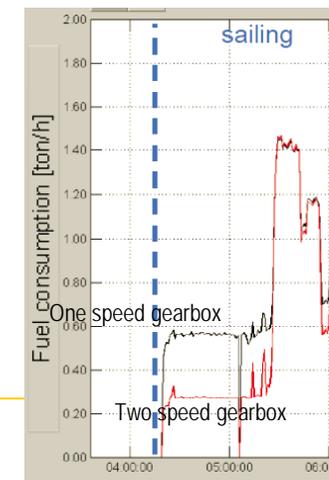
2.



Based on a dredge load profile, AVD provides a total **fuel savings of 16.5%**.

- All the benefits of a variable speed DEP system at a fraction of the size and cost

3.



Thank you  
Your Questions please