DYNAMIC POSITIONING CONFERENCE
October 11-12, 2016

OPERATIONS

Fuel Efficient Power Plant Featuring Variable Speed Generation Systems for DP Drilling Units

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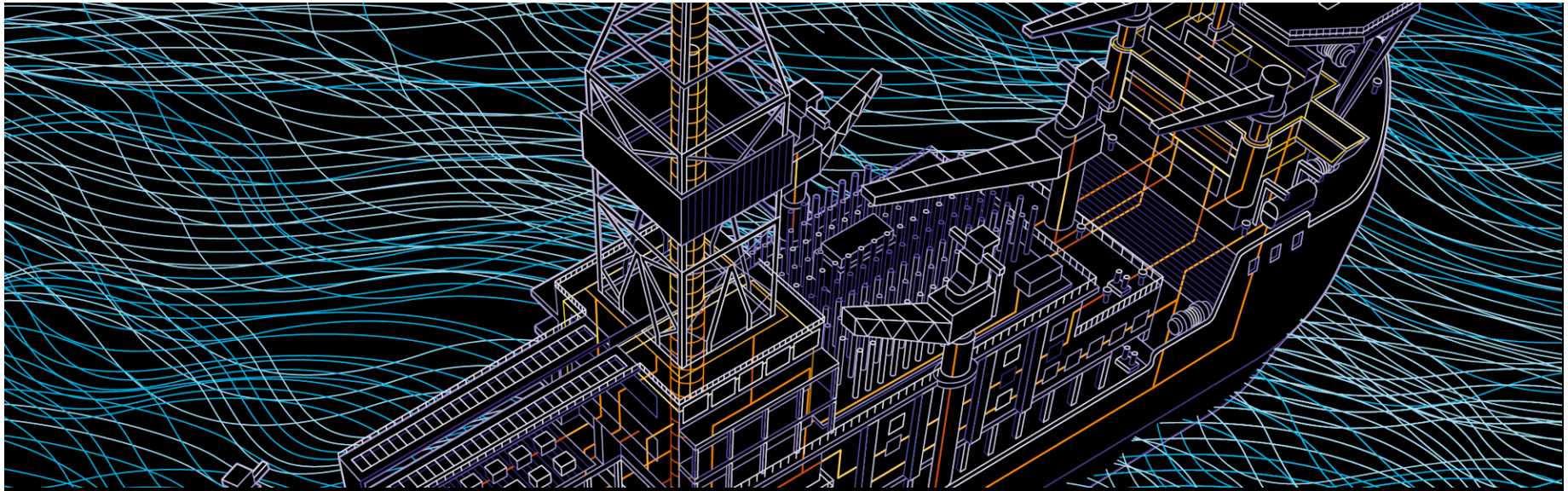
ABB



Jan Fredrik Hansen @ MTS Dynamic Positioning Conference Houston October 2016

Operations Session

Fuel-efficient power plant featuring variable speed generation system for DP drilling units

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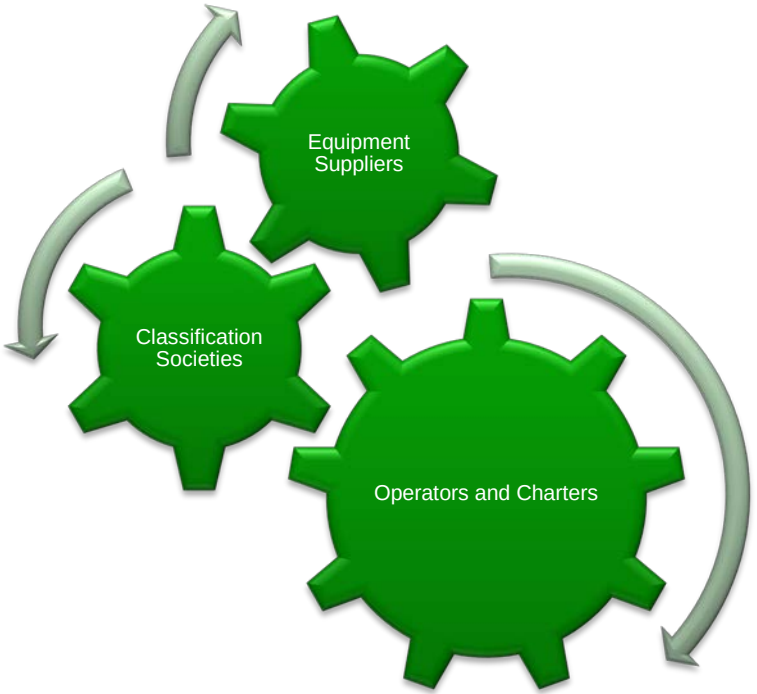
Introduction
Background

- Growing focus on:
  - Safety
  - Fuel cost
  - Maintenance cost
- Higher demand for:
  - Optimized power systems



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Introduction
Agenda

1. Motivation & Potentials
2. Examples for drilling vessel
3. Case study
4. Closing remarks

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Motivation & Potentials

Motivation & Potentials
Evolution, DP drilling vessels

1997

- Thruster drives
- Power phase back
- Engine utilization
- Event based protection
- Closed bus operation
- Energy storage

2016

- **Variable speed power generation**

Safety – Fuel Cost – Maintenance Cost

References

[1] A. K. Ådnanes, A.J. Sørensen, T. Hackman, "Essential Characteristics of Electrical Propulsion and Thruster Drives in DP Vessels", MTS Dynamic Positioning Conference, Houston, 1997.

[2] T. Lauvdal "Power Management System With Fast Acting Load Reduction For DP Vessels", MTS Dynamic Positioning Conference, Houston, 2000.

[3] J.J. May "Improving Engine Utilization on DP Drilling Vessels", MTS Dynamic Positioning Conference, Houston, 2003

[4] J.F. Hansen, F. Wendt, T. Jehkonen, J. Varis, L. Tiainen, "Improved and Efficient Power and Thruster System for DP Drilling Vessels with New Generation Protection System and Azipod® CZ", MTS Dynamic Positioning Conference, Houston, 2012

[5] J. O. Lindtjørn, F. Wendt, B. Gundersen, J.F. Hansen, "Demonstrating the Benefits of Advanced Power Systems and Energy Storage for DP Vessels", MTS Dynamic Positioning Conference, Houston, 2014

[6] J.F. Hansen, J.O. Lindtjørn, K. Vanska, "Onboard DC Grid for enhanced DP operation in ships", MTS Dynamic Positioning Conference, Houston, 2011

[7] I. Fazlagic, J.F. Hansen, A.K. Ådnanes "Onboard DC Grid – One year in operation" ABB Generations, 2014

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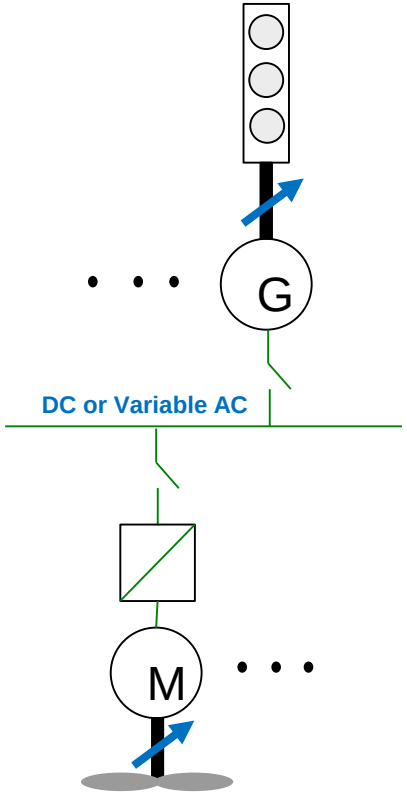
Motivation & Potentials
Variable speed generation in **electric propulsion** systems

- Variable speed thruster drives – a standard since 80's (0 to 100%).
- Now: variable speed generation on the power plant.
- Implemented in several vessels, basically LV systems.
- Specially successful for DP operation.
- Typical speed variation from 60% to 100% of nominal.



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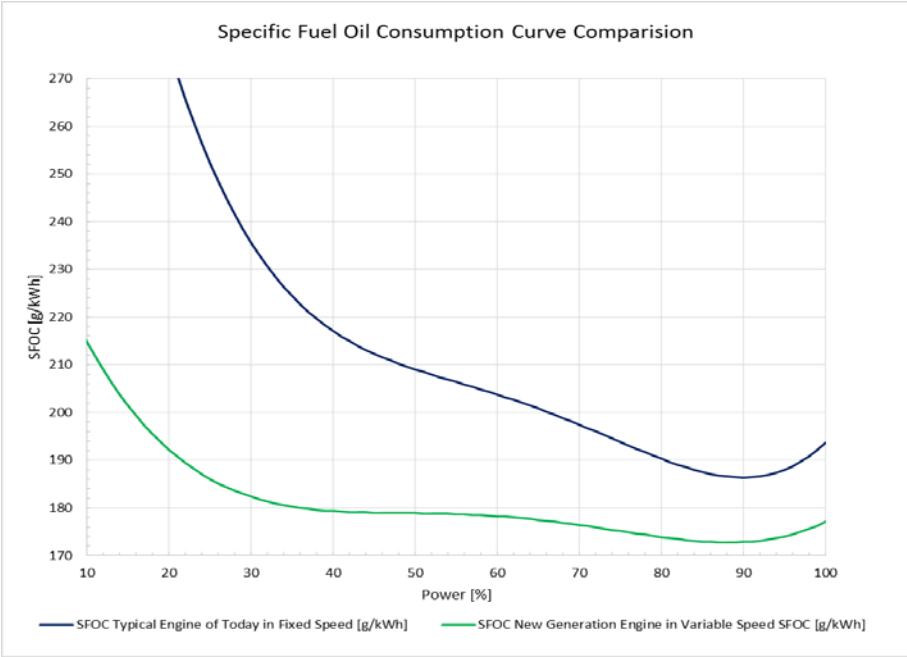
Motivation & Potentials
Engine performance

- Less specific fuel consumption if RPM is adjusted with power consumption.
- Savings increase with lower load.
- Different engine types and sizes, may yield different curves.
- Comparing todays engines with tomorrow engines.
- Fuel saving potential from 10% to 30% on engine operation below 50%.



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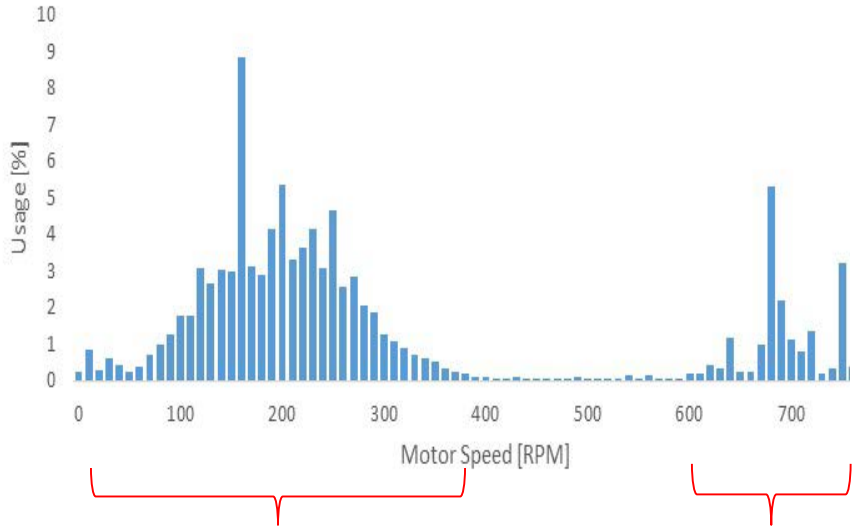
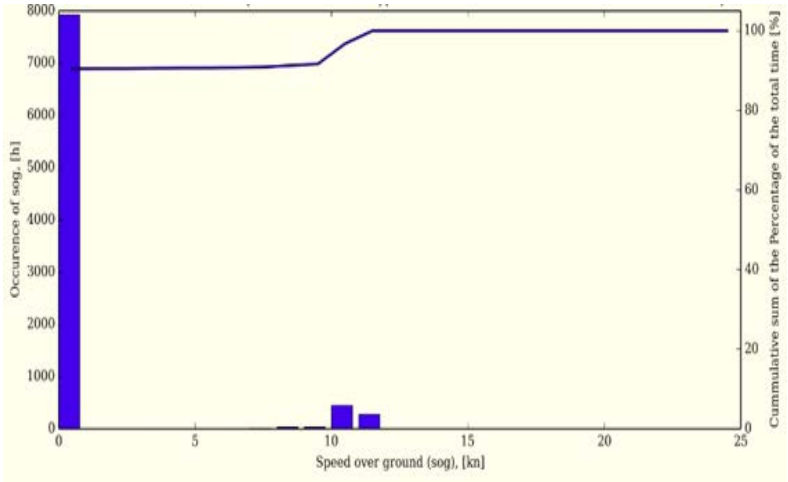
Motivation & Potentials
Drilling vessel operation; Speed & thruster profile





- DP operation in 85% of time, with thruster loading less than **7%**
- Leads to Generator loading of less than 30% (with some assumptions)

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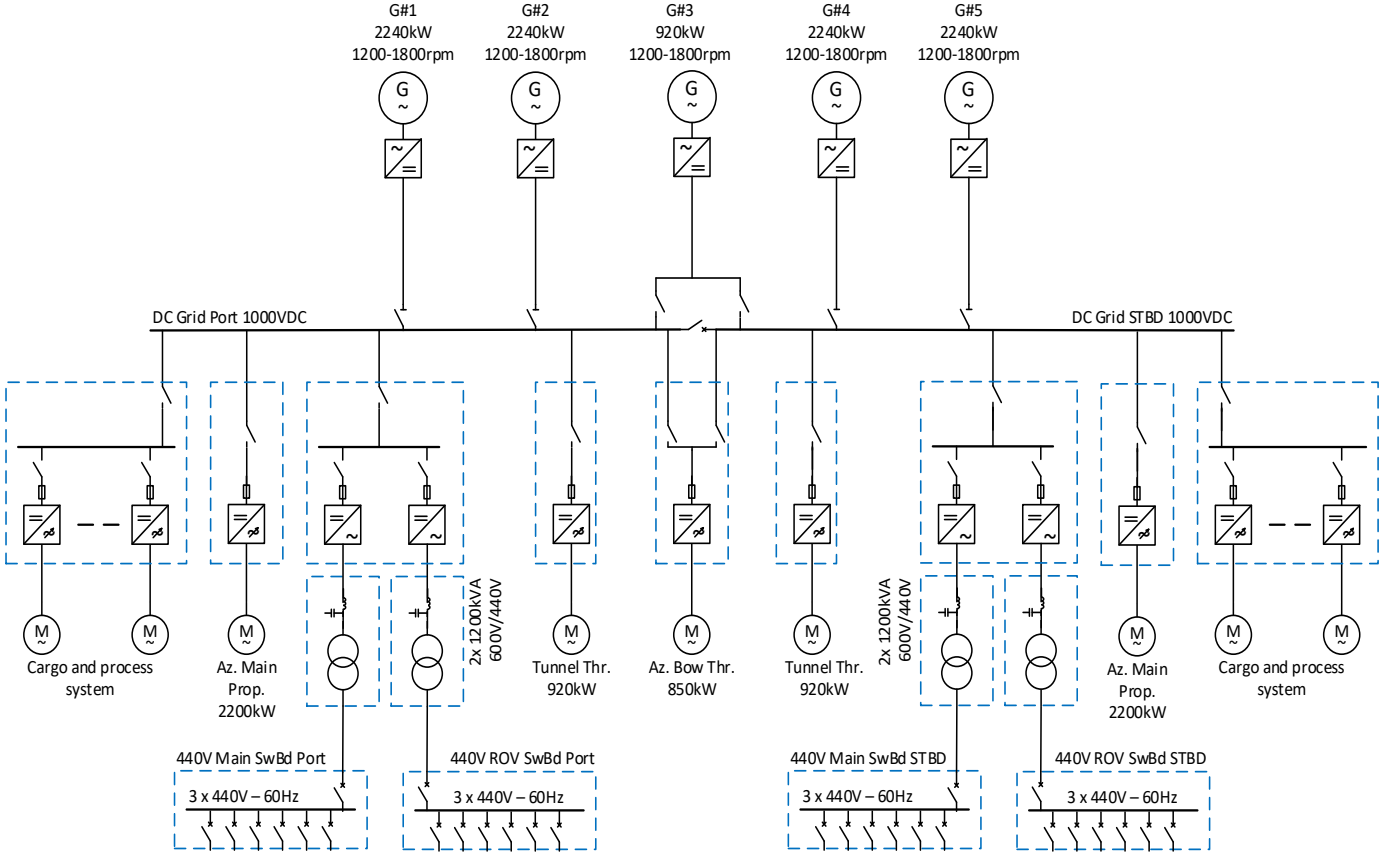
Motivation & Potentials
Reference case, LV DC Grid for DP OSV vessel



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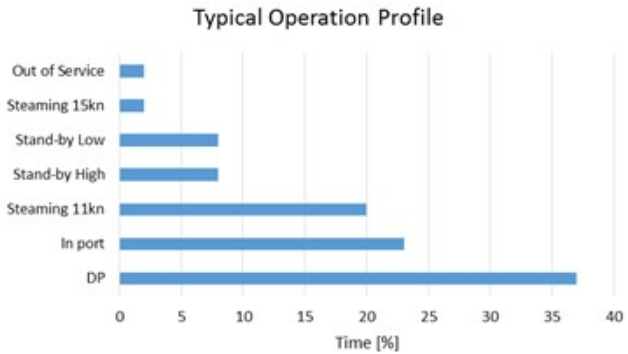
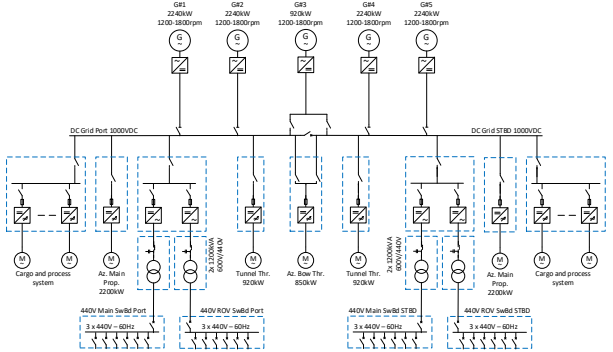
Motivation & Potentials
Reference case, LV DC Grid for DP OSV vessel

- DC Grid solutions proven on OSV type of vessels.
- Recorded fuel saving of up to **27%**, and average **14%** on total profile measured.
- High speed (1800 RPM) engines running on medium speed (1200-1300 RPM) for most of the time.
- Reduced noise level.





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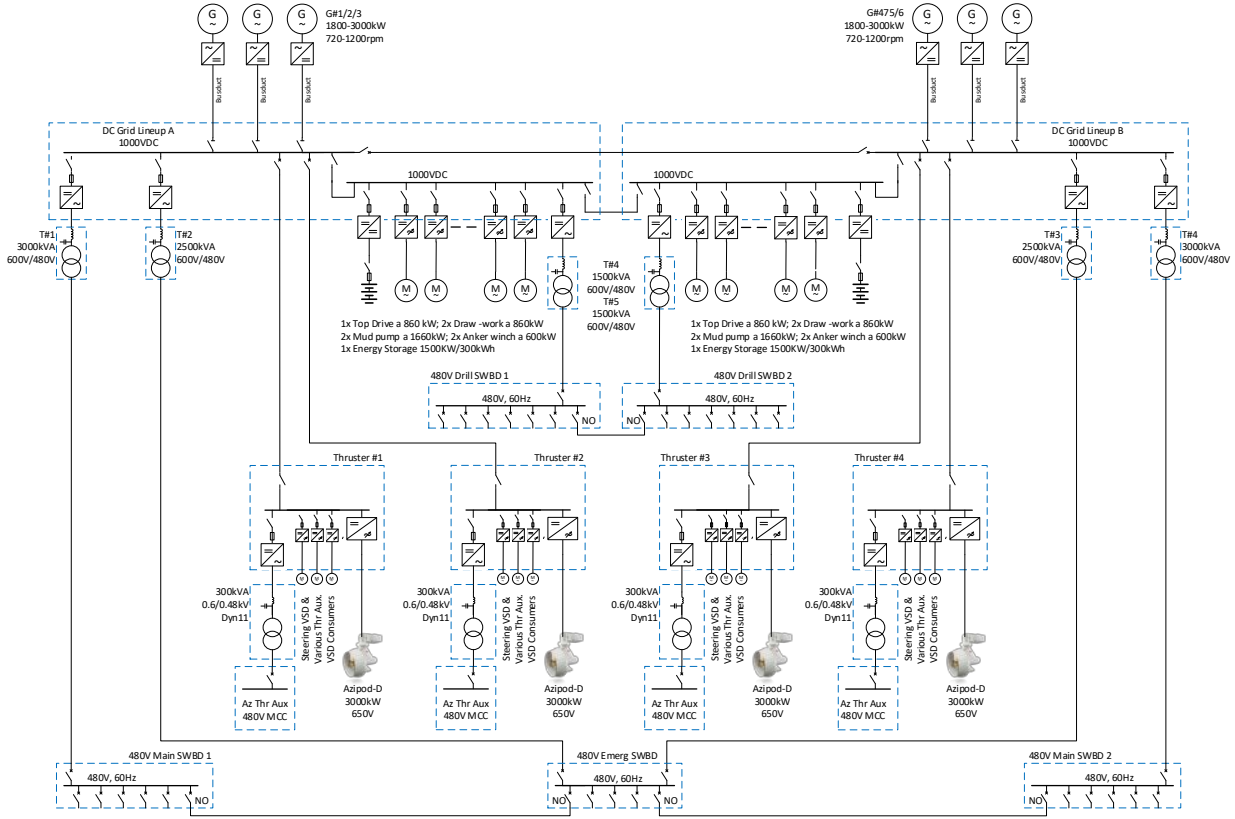
Example for drilling vessels

Example for drilling vessels
Mid size segment with LV DC Grid



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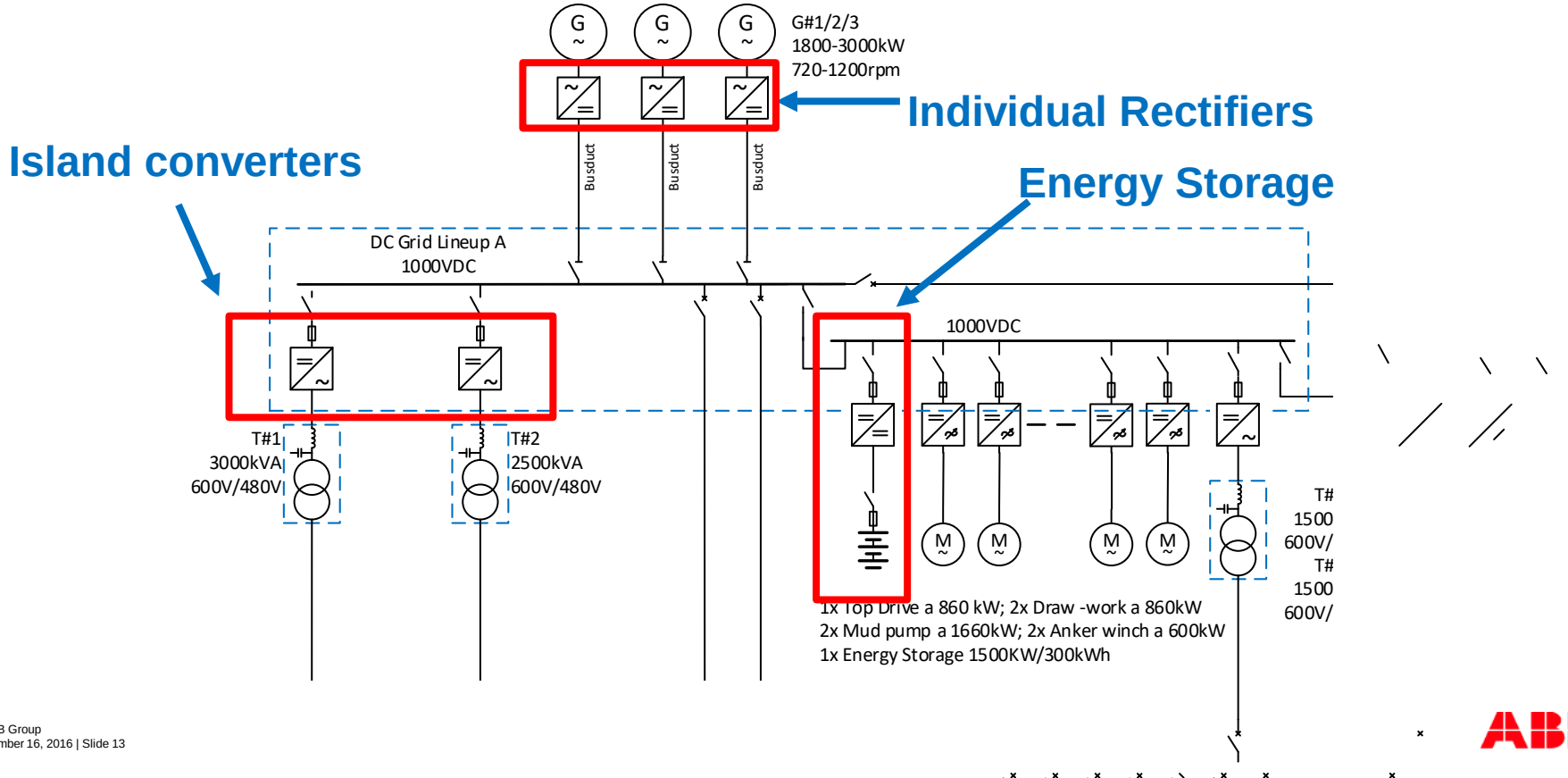

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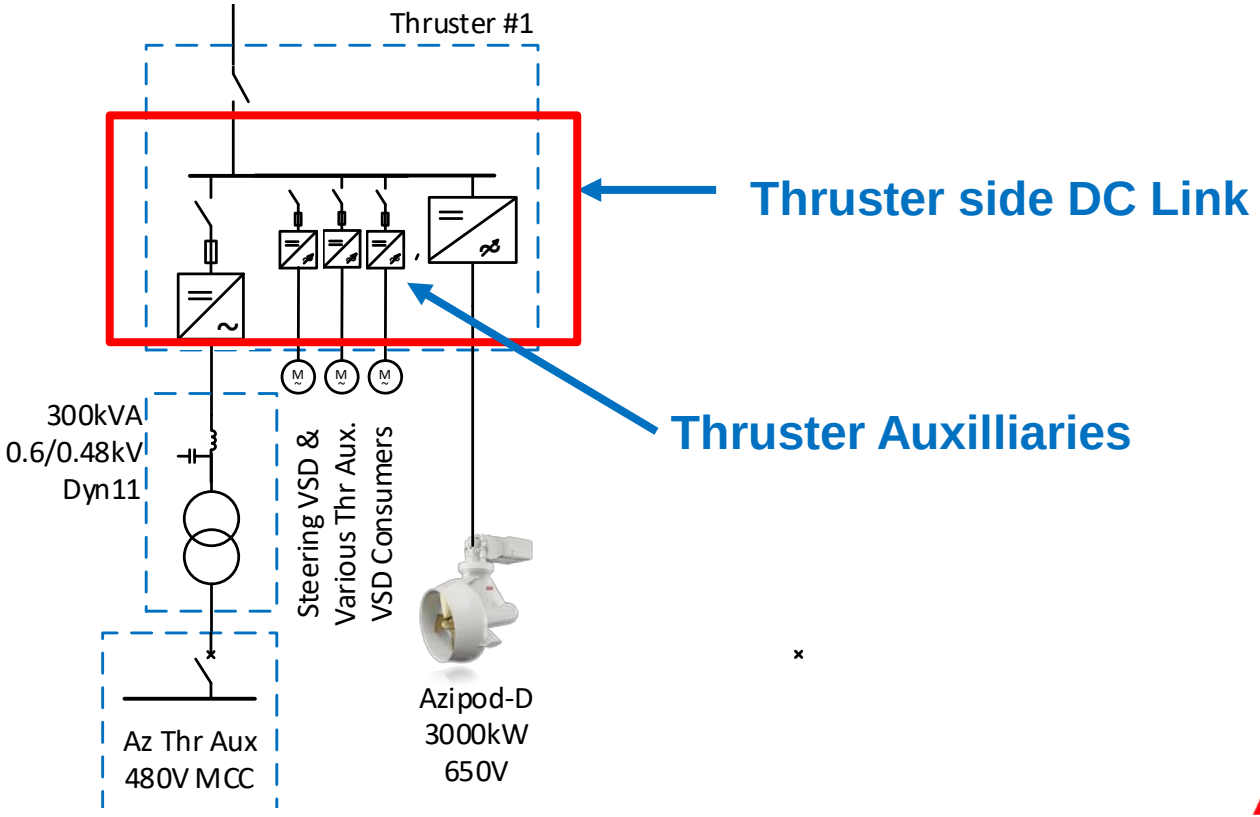

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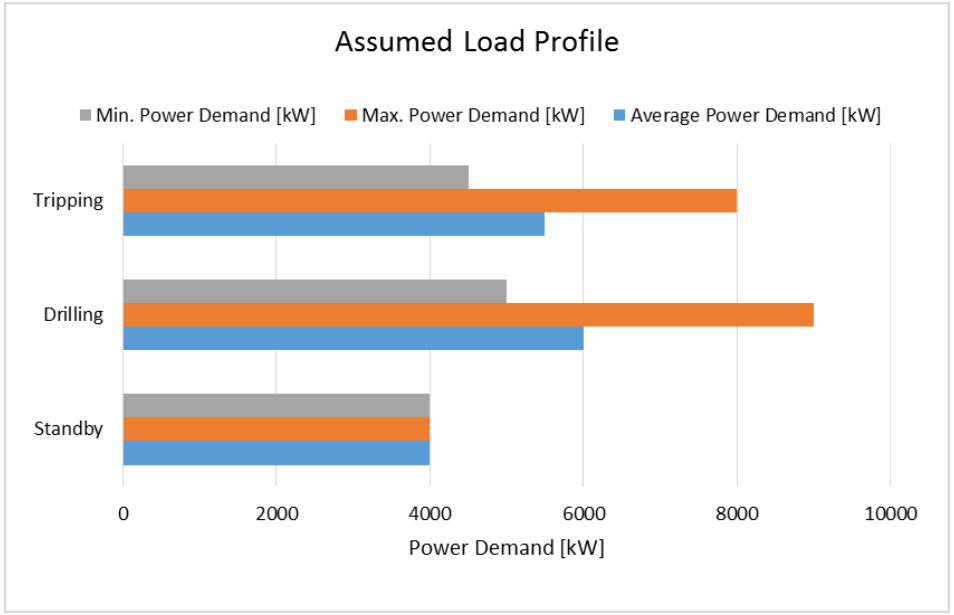

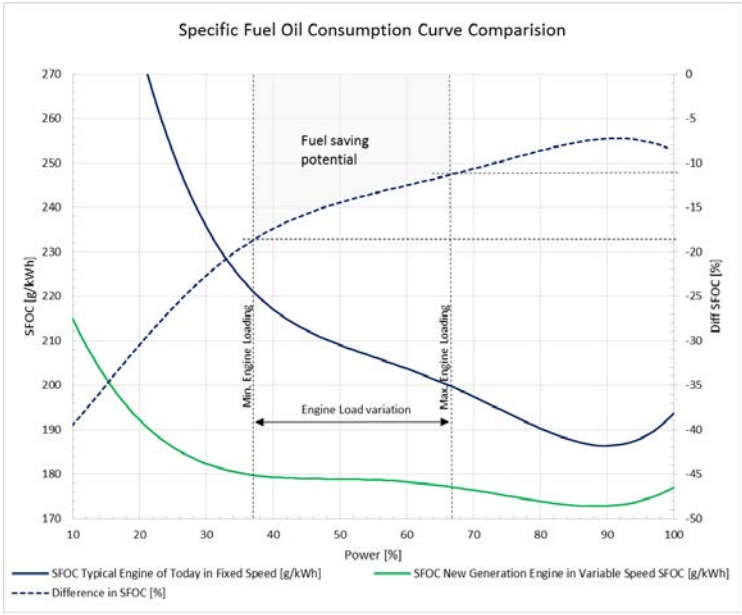

Fuel saving potential from 12% to 18%

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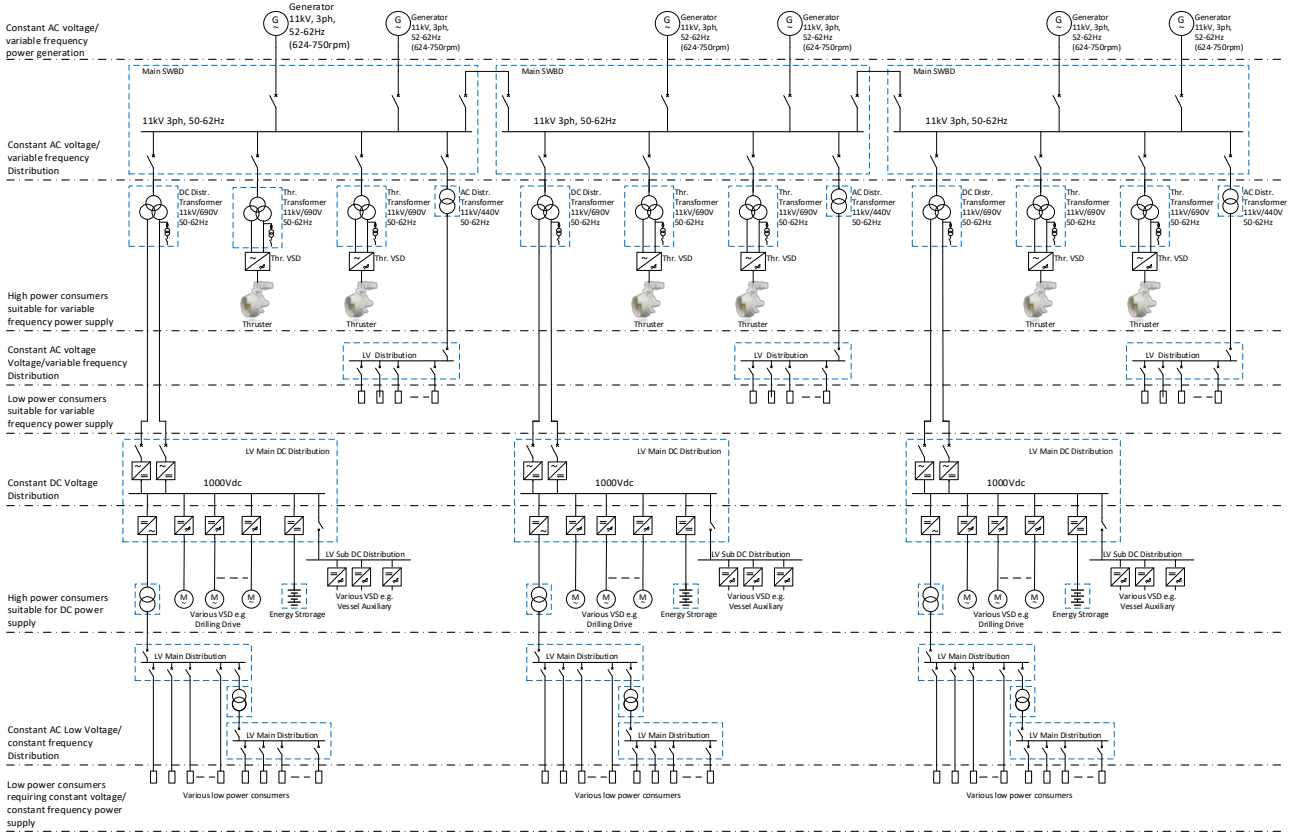
Example for drilling vessels
Large size segment with MV Variable AC



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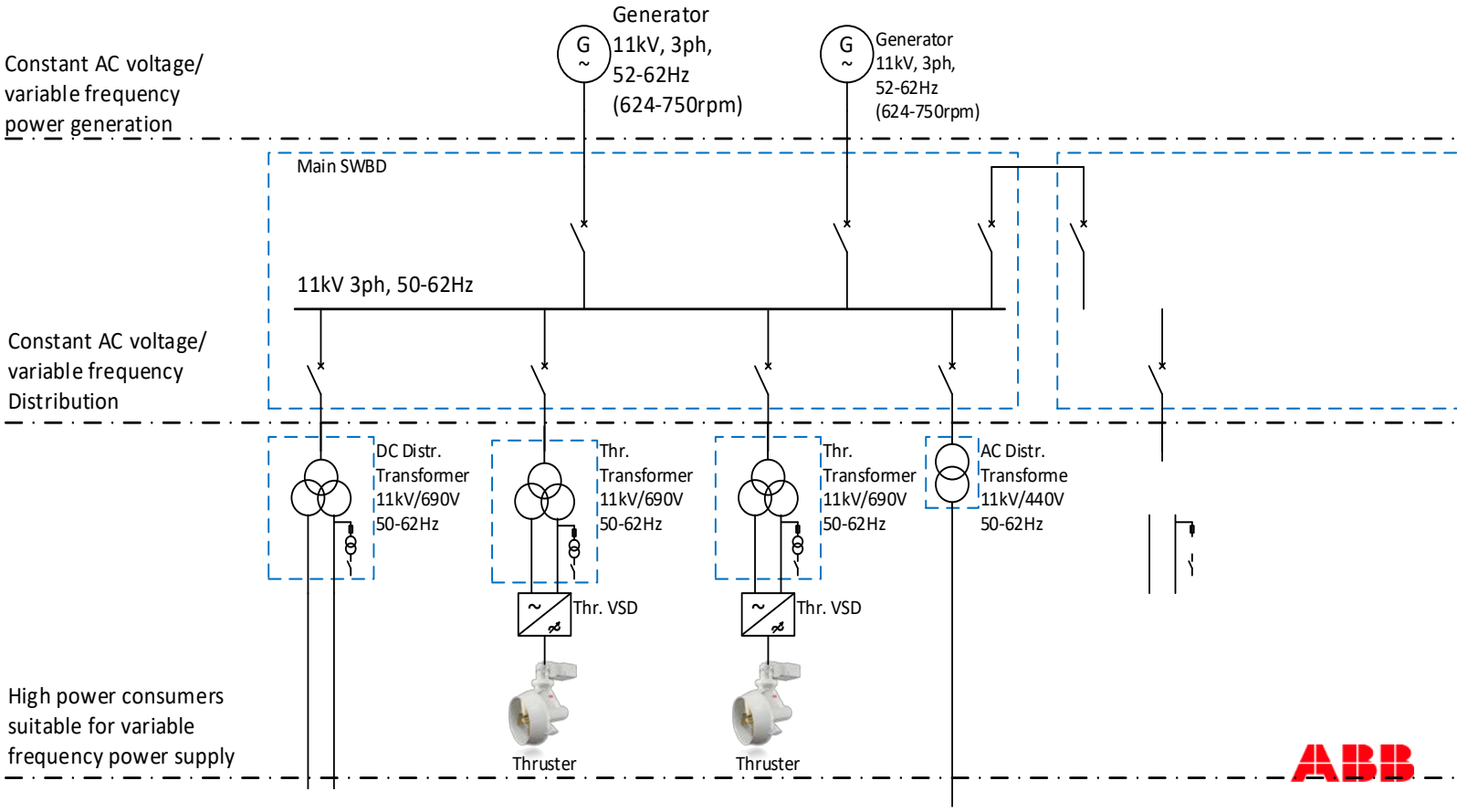

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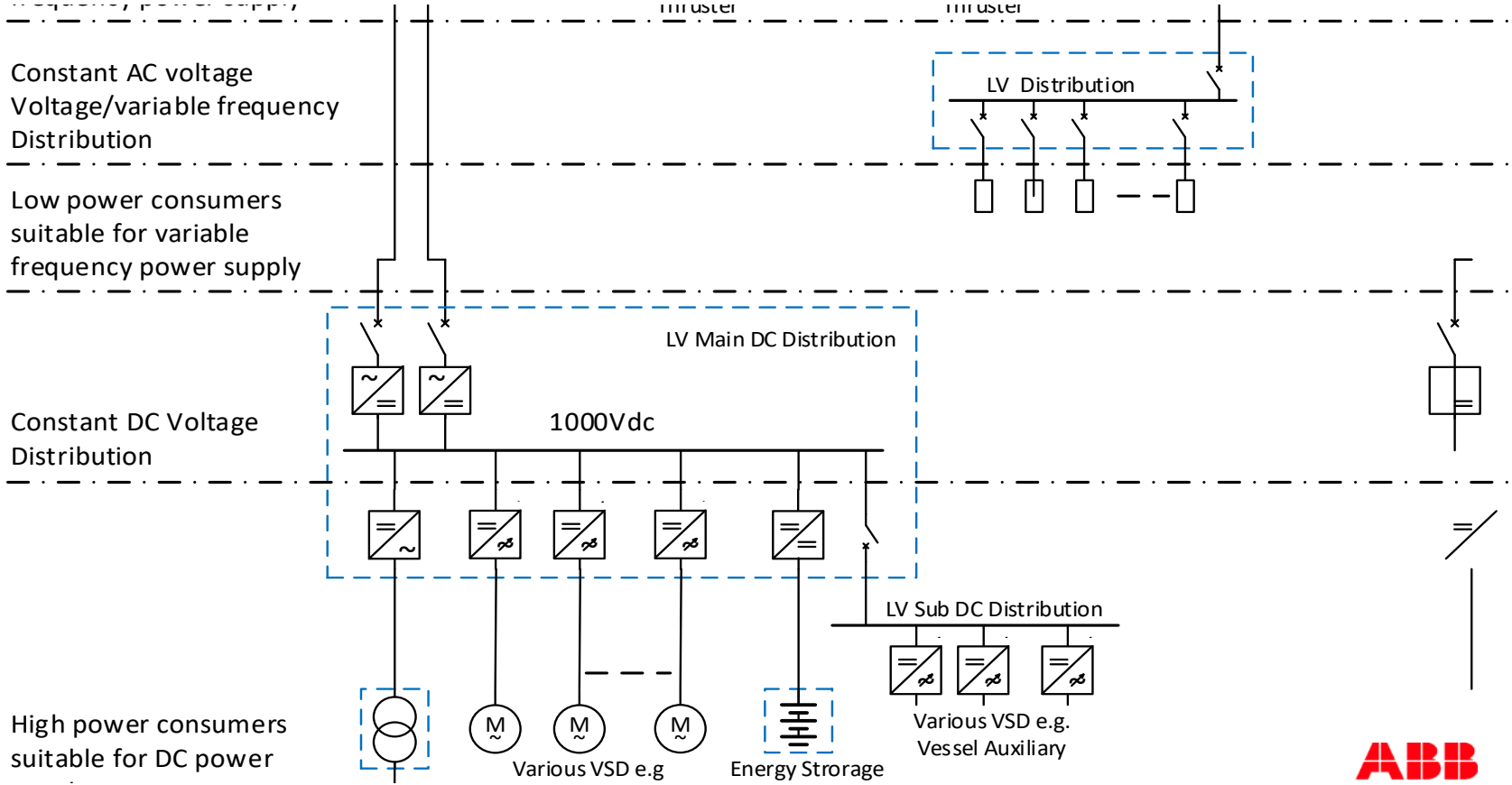

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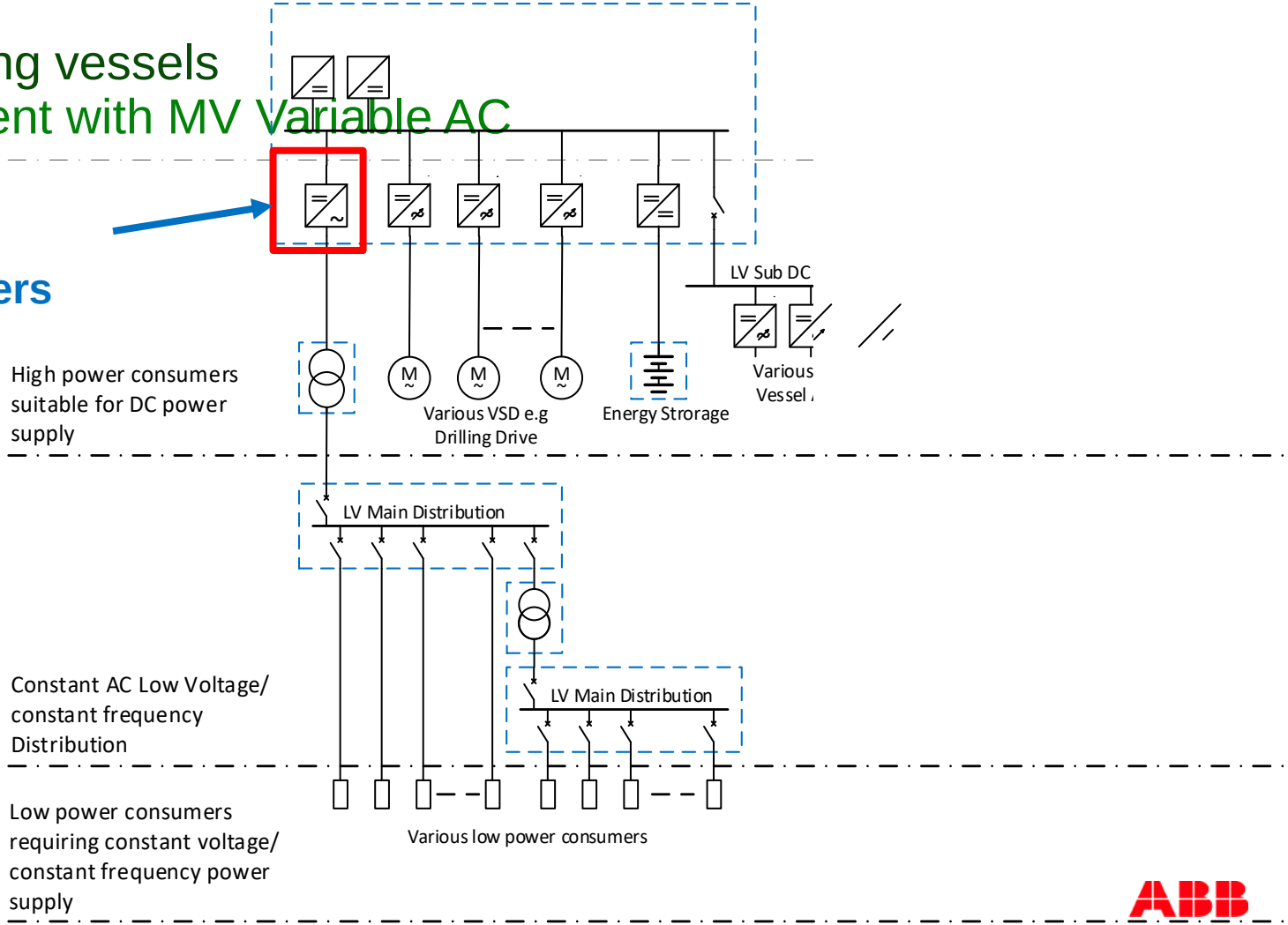

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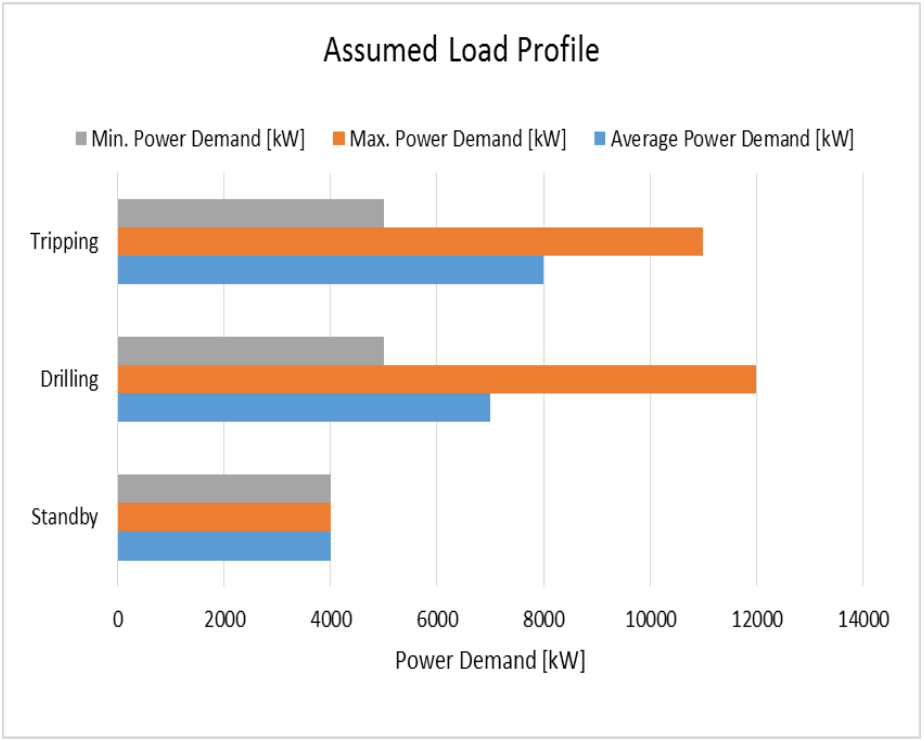

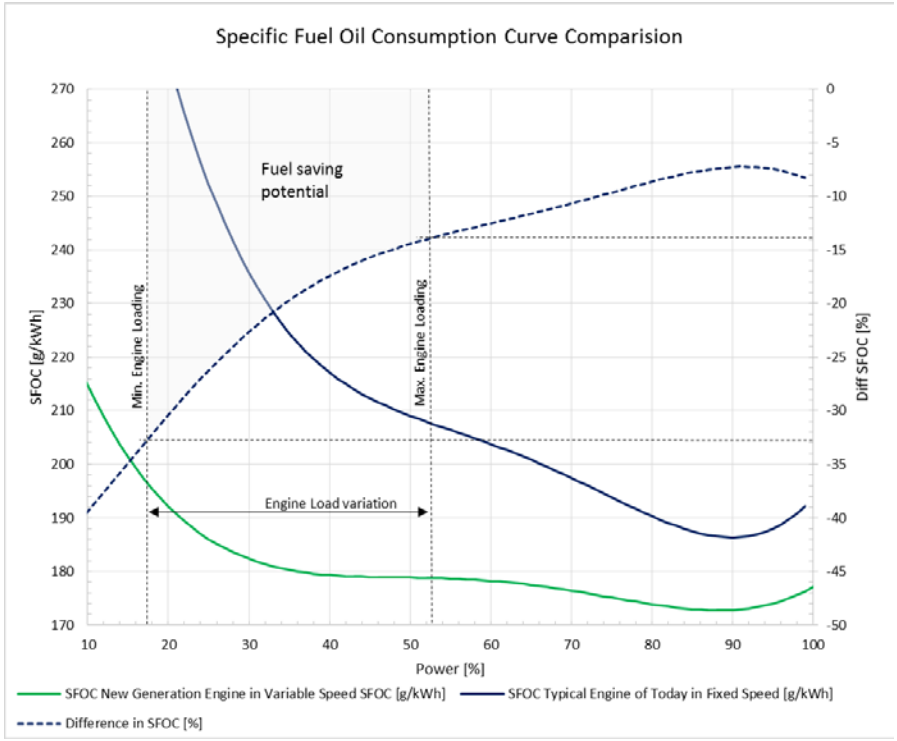

Fuel saving potential from 14% to 33%

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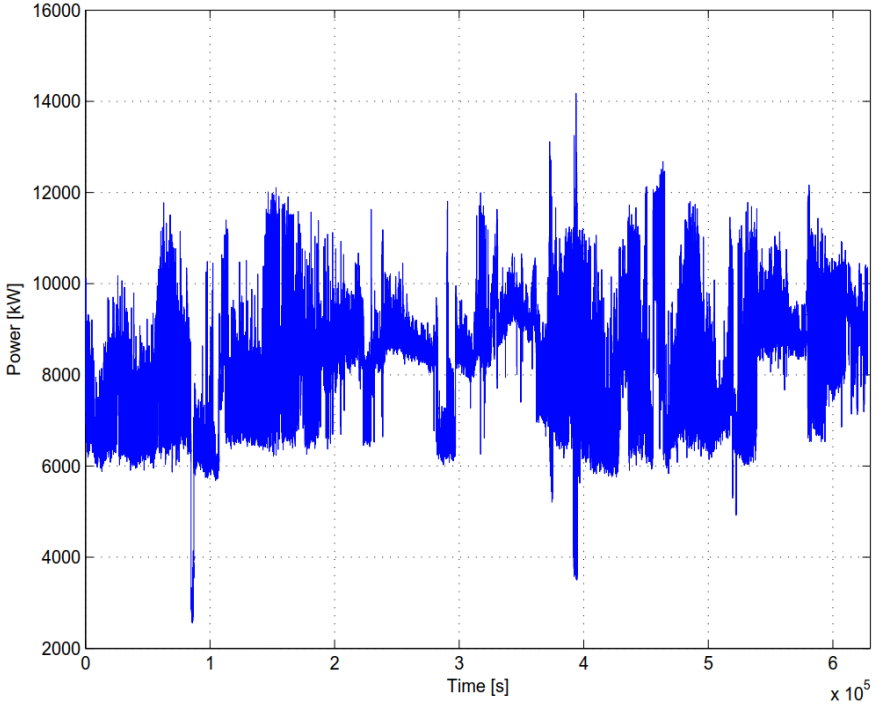
Case Study

Example for drilling vessels
Large size segment with MV Variable AC

- Power plant data; one week recording from a drillship
- Baseload around 6 MW (MW in periods); Thrusters, auxiliaries, hotel load etc.
- Additional power variations of 6MW on top of the baseload; Drilling operation.



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Example for drilling vessels
Large size segment with MV Variable AC

Engine/operation type	Q'ty Gen sets	Fuel consumption [t]
Fixed speed operated typical medium speed marine engine	3	318,8
	2	294,7
Variable speed operated common rail engine	3	257,6
	2	254,9

- 20% fuel saving going from fixed speed 3 engines to variable speed 3 engines.
- Max potential in this case about 63t fuel per week saved => Annually 3200t fuel savings
- With variable speed engines, there difference between 2 and 3 generators online is relative small, operation with open bus?

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Closing Remarks

Closing Remarks
Pros & Cons

- Variable speed power generation increases fuel efficiency in DP operation.
- Applicable for most types of DP vessels.
- For LV DC Grid applications each generator is can be individually controlled.
  - No synchronization
  - Free load sharing
  - No system harmonic distortion on main distribution.
- Some additional equipment and modifications:
  - Generators need to be dimensioned for full voltage at reduced RPM.
  - Generators need to be dimensioned for individual rectifier operation (LV DC Grid)
  - Island converters needed for fixed frequency distribution.
  - Modification of SWBD protection (frequency range) for MV variable AC networks.
  - Energy storage for dynamic support, however already today highly discussed for standard AC systems.
- High speed vs medium speed engines?

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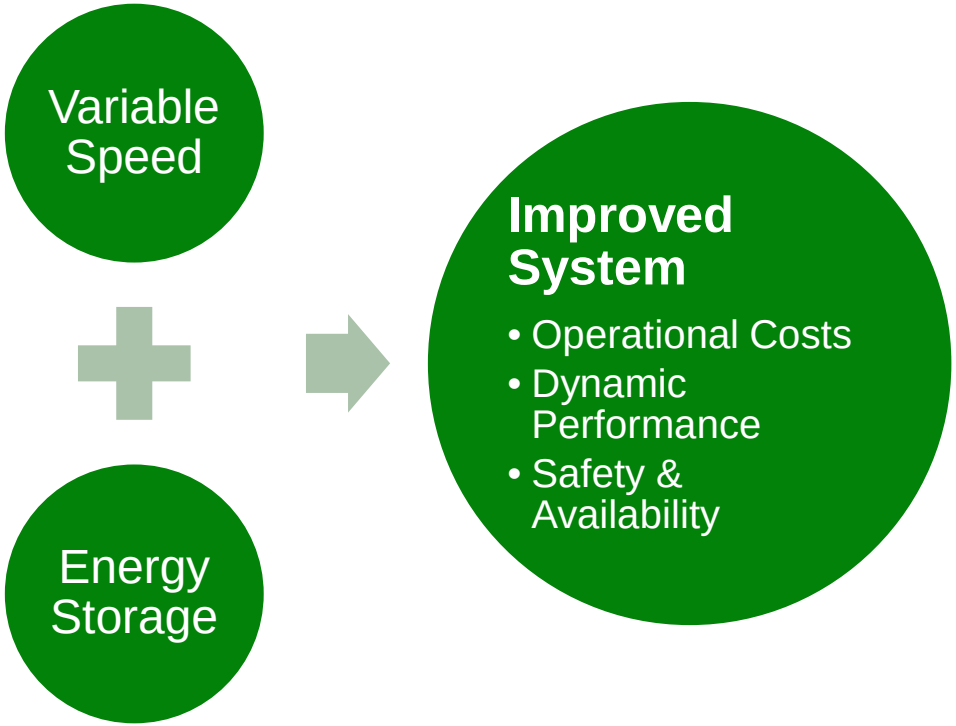
Closing Remarks



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