SUMMARY OVERVIEW

The idea to use limited DC distribution architectures on modern vessels has been around for over a decade.

The DC architecture provides a flexible solution with multiple opportunities for improving efficiency within the system.

A Energy Storage System (ESS) provides the opportunity to do more by optimizing the EMD load level, providing the necessary transition power during peak loading, and by providing redundancy for emergency operations.

In this case, the ESS will serve to force the EMD’s to operate more efficiently.

Hybridization is best for repetitive duty cycles that provide an opportunity for peak shaving using an Energy Storage System (ESS).
Example:
EMD 16710G7C-T2– 4000 HP
Rolls Royce CPP
KRW 1700kW PM Motor/Generator (LC)
A necessary method must be established and applied early on in the design to produce the calculations & information necessary to dimension all of the electrical components before the selection process of the various components.

This may include but is not limited to load analysis, short circuit and coordination studies, and review of harmonic analysis based upon various component arrangement topologies.

Particular emphasis should be placed in the area of harmonic mitigation, and component compatibility with floating frequency.
EMD 16 – 710G7C- T2 – FINNOY GEAR & CPP WITH CONVERTER & ENERGY STORAGE ARRANGED ON DC LINK MULTI MOTOR ARRANGEMENT.
JMC HYBRID DE HYBRID DC LINK MULTI-INFEED
MULTI MOTOR/INVERTER ARRANGEMENT
ONE -LINE
EXAMPLE OF 2Q
NON – REGENERATIVE DRIVE

Simple PWM Drive with Dynamic Braking

Power flow in one direction only

Power flow in two directions

CONTROLLER
EXAMPLE OF 4Q REGENERATIVE ARRAGEMENT WITH ACTIVE ENERGY MANAGEMENT

Active Energy Management Drive

Power flow in two directions

Controller

DC LINK

Controller

Power flow in two directions

USE THE SAME BI-DIRECTIONAL TOPOLOGY AS THE MACHINE BRIDGE ON THE MAINS SUPPLY SIDE
KRW TECHNOLOGIES
MODULAR LC DRIVE ALPSA MV 3000e
RAPP HYDEMA TRAWL WINCH WITH MULTI MOTOR (LC) DRIVE

Operation benefits with Electric driven winches

- Electric winch systems give more possibilities & flexibility in operation.
- In haul the winches can be operated in constant power mode, and then the winches are running with the speed versus load which gives maximum power.
- This gives more optimized haul in where the system regulates with variable speed instead of speed steps.
- Our experience is that the control of the winch is better and smoother than on hydraulic winches, the operator have better control and feeling while operating the load.

Rapp Hydemar Electric Trawl Winch system

Advantage with Multi motor drive concept:

a) Redundancy

- The motors and drives are sized to obtain minimum 80% winch pull if one out of three or four motors/ (VFD) drives should be out of duty.
- To ensure continued fishing and finishing the trip before repair is required.
- The winches can be operated in emergency mode in case the control system is out of duty – “direct connection between the joystick and the VFD”.

b) Stiffness – moment of inertia

- Three or four “small FC motors” give a moment of inertia 3…4 times less than single motor electric drives.
- More or less same moment of inertia as for one directly connected permanent magnet electric motor.
- Gives excellent response and fast reaction for compensation during towing.
RAPP HYDEMA MULTI MOTOR DRIVE (CONTINUED)

Overall Efficiency:
- In general, the total grade of efficiency for hydraulic winch systems is about 60% - 70%, due to the many steps in the power train and pressure losses in control valves and piping.
- In electric winch systems the total grade of efficiency is about 80% - 85%.
- For comparison of a Trawl Winch of 50 ton on the first layer @ 42m/min speed;
  - Power requirement with electric drive is approx. 405kW
  - Power requirement with hydraulic drive is approx. 525kW
- Meaning minimum 20% lower power requirement with electric winches versus hydraulic.
- Regeneration of power during pay-out and towing on electric winches gives additional energy savings compare to hydraulic driven winches without the possibility for regeneration.

Power consumption during fishing operation:
During the three main stages of trawling operation, pay out, towing and haul in, we have different power scenarios.

Pay-out with regeneration
- During pay-out with electric winches we have a possibility to regenerate power back to the ship system.
- The pay-out operation does not usually take more than 20 - 30 min., so regenerating of power does not have that much influence on the total power consumption.
- Testing onboard one Icelandic trawler with our 30 ton electric winches showed up to 200kW regenerated power during pay-out. A 30 min. pay-out period would give 100 kWh saved energy.
- With 50 ton winches, there could be energy savings of approx. 170 kWh, all depending on the shooting speed and wire tension.

Towing with regeneration
- The towing operation has proven to be the stage where the difference in power consumption between electric and hydraulic winches is greatest.
- According to our surveys onboard the Icelandic trawler with our 30 ton electric winches the average power consumption during towing operation was about 20 kW for all three winches. Total power consumption for 5 hours of towing is then 100 kWh.
- For a hydraulic system where the oil flow to the winches is fixed/ or in steps and towing is controlled by varying the hydraulic pressure, most of the power is generated into heat. For a comparable hydraulic system with 30 ton winches, the power consumption during towing is in average minimum 100 kW for three winches. 5 hours towing operation would require a power consumption of approx. 500 kWh
- For a 50 ton twin trawl winch system, the estimated difference in power consumption between a traditional hydraulic winch system and an electric winch system during a 5 hours towing period would be minimum 600 kWh of saved energy.
The BMS system is a proprietary system which shall be integral with a programmable logic controller (PLC) based system. The key to a successful large energy storage array is the Battery Management Systems (BMS).

The BMS has internal communication so that each module can communicate with a master controller in order to fully monitor and maintain safe cell-to-cell operation. Corvus Energy provides a unique and scalable system providing cell level management with integration to the PMS and ICMS architecture. This topology provides optimization and monitoring of cell level - thermal levels, charge and discharge levels and fault conditions. In addition the cells are divided into separate strings of uniform energy blocks. In turn each string provides autonomy and is independently managed where connected to the DC link.

In the case of weak cells or a failure, then a single string can be divorced from the power grid allowing for the cell to be serviced. At the same time this scalable storage system architecture can maintain power continuity to the power and distribution system with negligible reduction in availability.