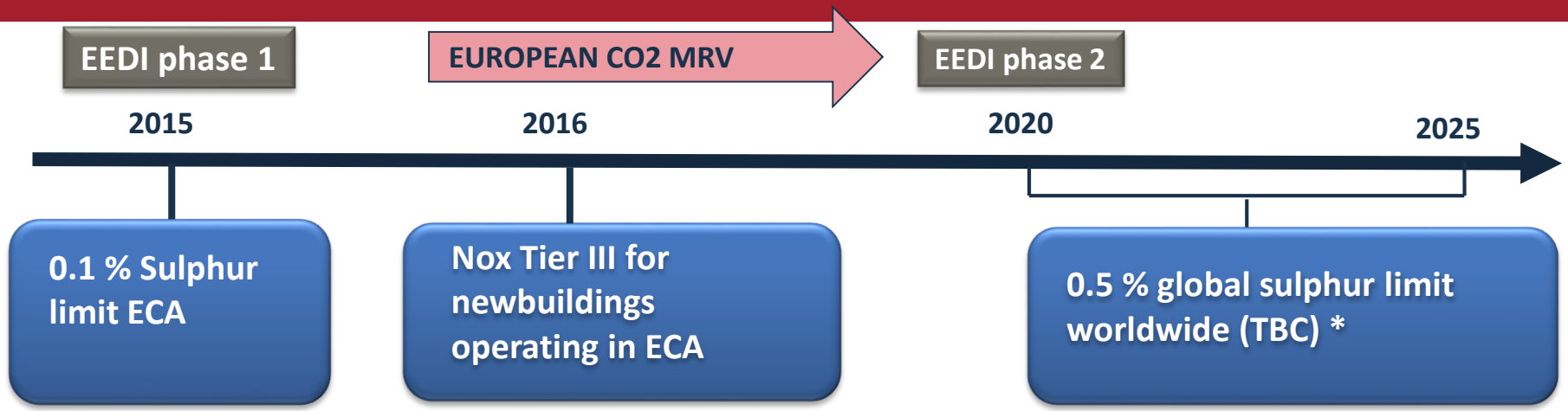
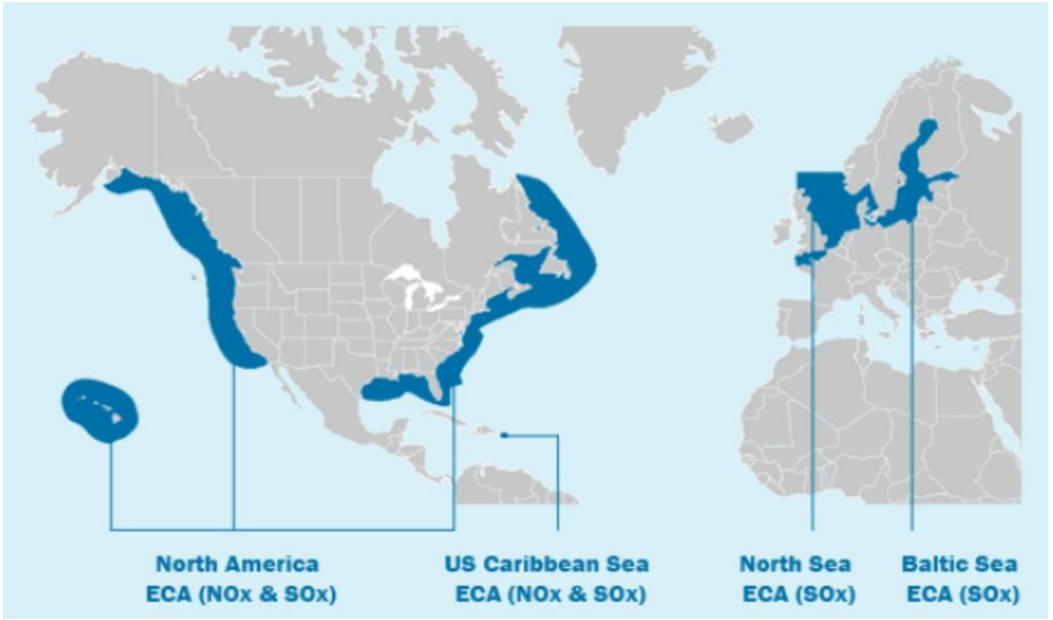
Environmental challenges

Martial CLAUDEPIERRE
LNG as fuel & environment matters
Business Development Manager

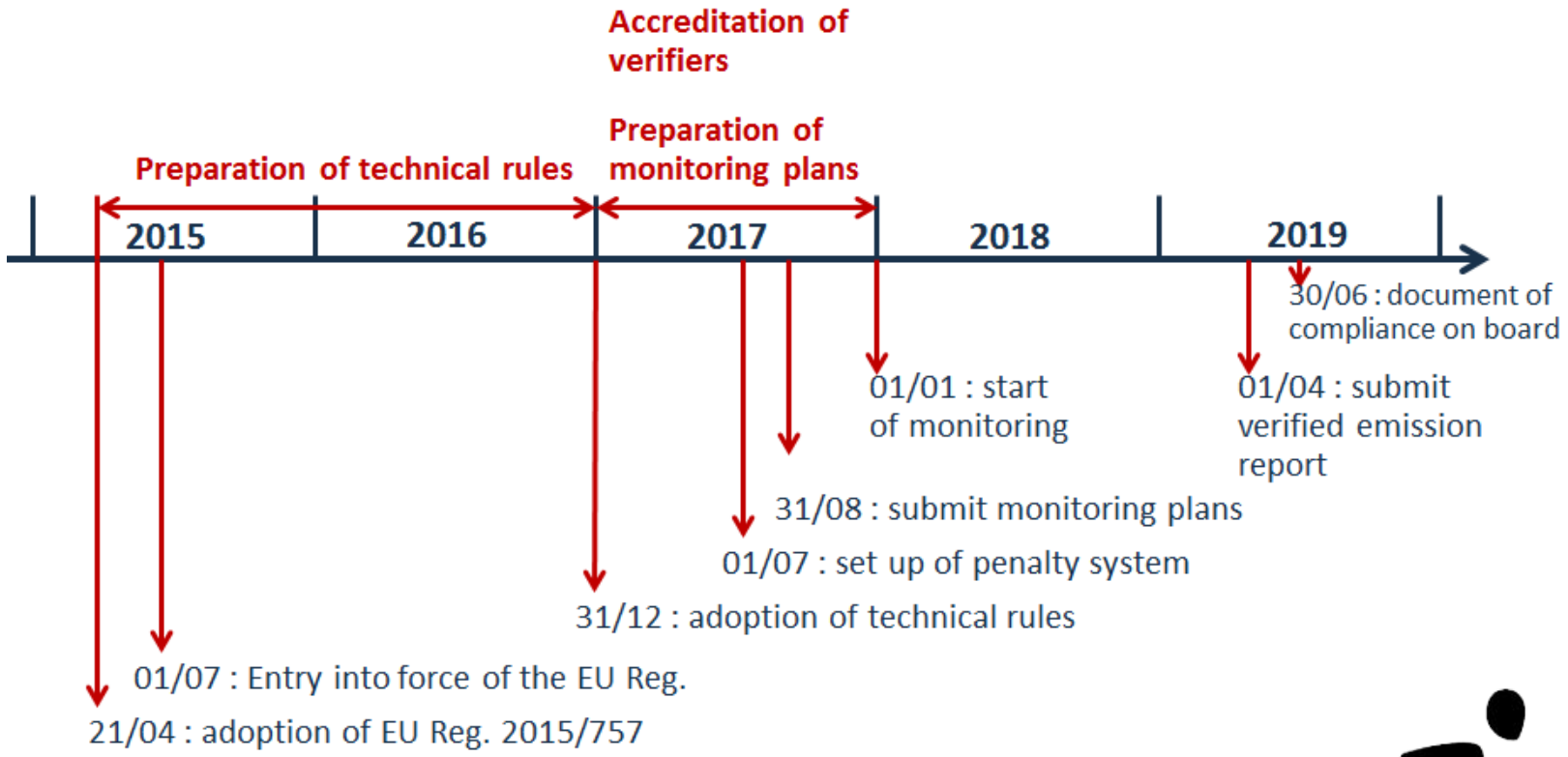
Global environmental regulation fosters the use of clean fuels





- European commission has already decided the implementation of 0.5% sulphur limit for **2020**.
- US & Canada will most probably do the same.

European MRV - Implementation schedule and IMO Data collection



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IMO AGREES ON MANDATORY DATA COLLECTION FOR SHIP FUEL CONSUMPTION

China – 3 new emissions control areas

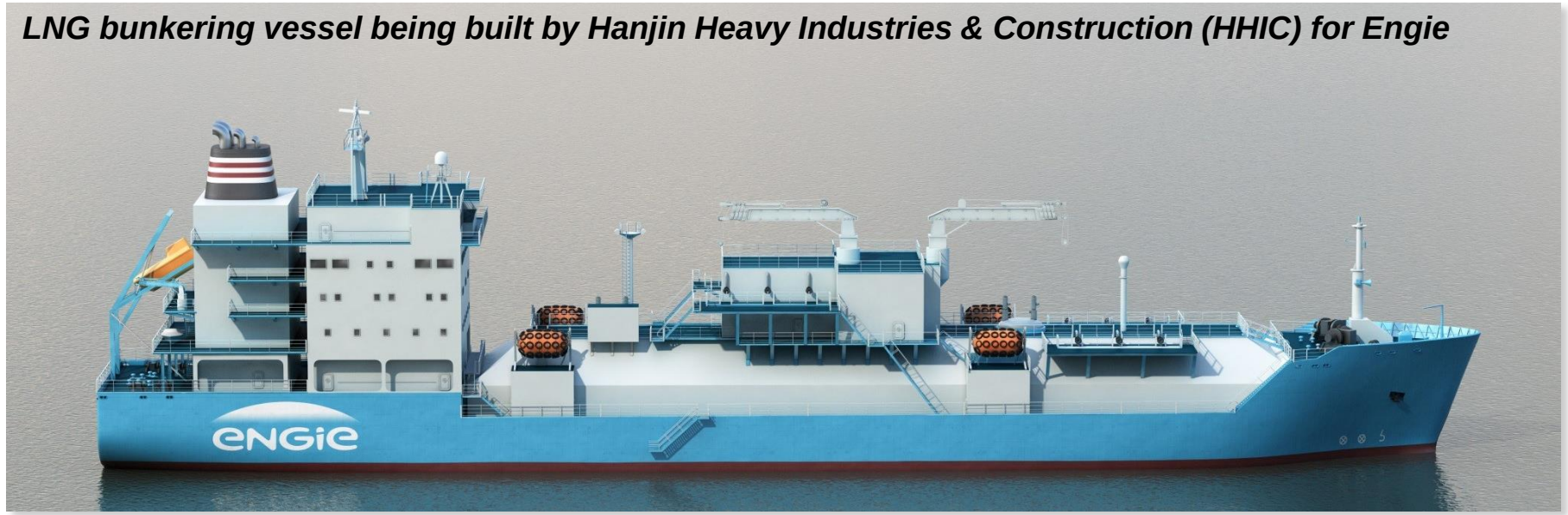
Three emission control areas are being established in the Zhujiang (Pearl River) Delta, the Yangtze River Delta, and in the Bohai Sea.

The new regulations will apply to all commercial trading vessels from 1 January 2016.

To comply with the new requirements, vessels are to use fuel oil with a sulphur content of no more than 0.5% m/m, or other equivalent measures to reduce emissions including exhaust gas scrubbing, alternative clean fuels and shore power (cold ironing).

Welcome to the gas age !

LNG bunkering vessel being built by Hanjin Heavy Industries & Construction (HHIC) for Engie



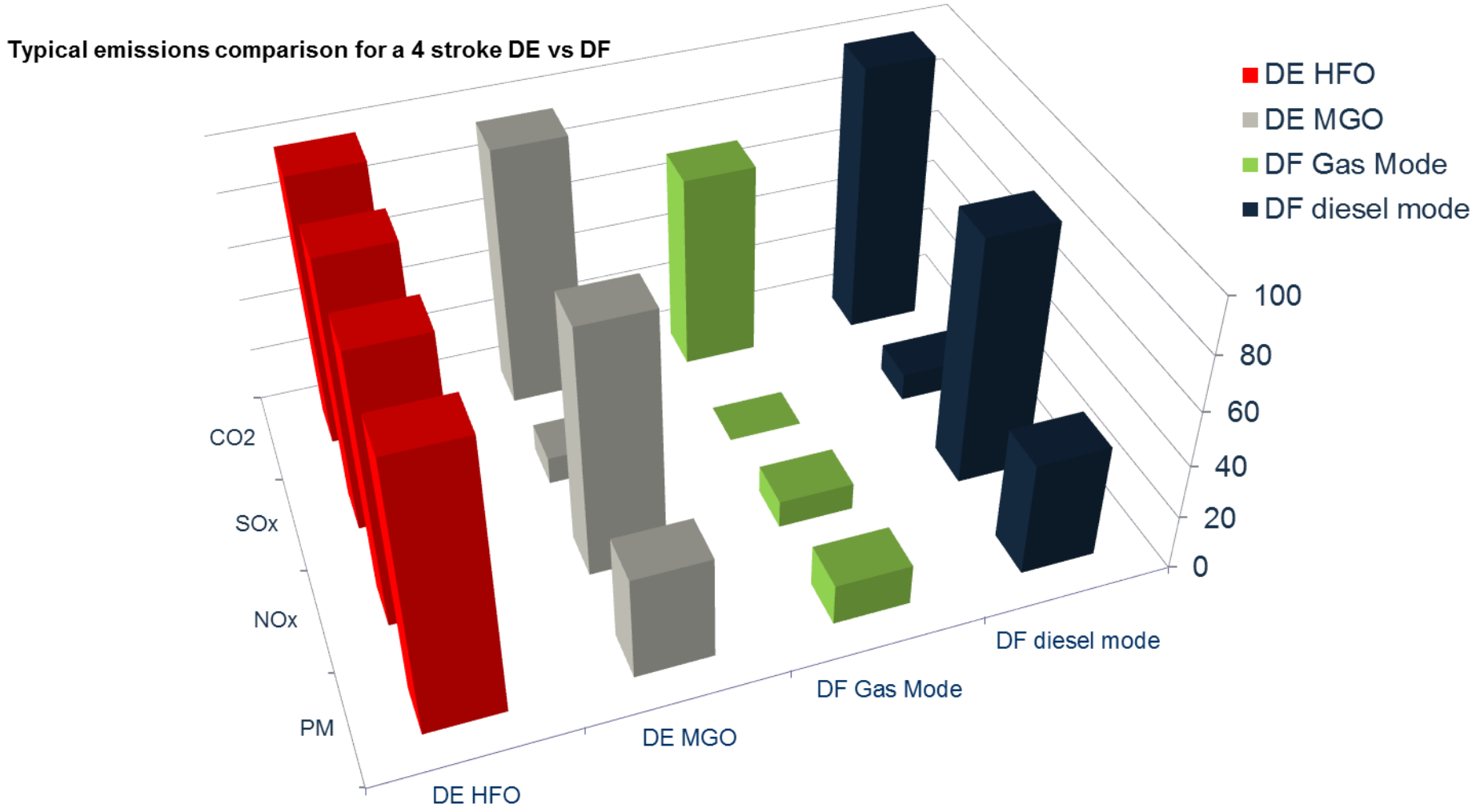
Dual-Fuel ferry (1,600 Pass.) being built by Shipyard Construcciones Navales del Norte for Balearia

Change of scale with MSC World Class 4 large LNG cruise ships

- **April 6, 2016** - MSC Cruises, the Swiss-based world's largest privately-owned cruise line and brand market leader in Europe, South America and South Africa, announced earlier today that it has signed a letter of intent (LOI) with STX France for the construction of up **to four new LNG-powered cruise** ships that will be more than 200,000 GRT. The four ships, the first one of which will be delivered in 2022, will be based on a new advanced next-generation prototype and will form what will be known as the "World Class" of MSC Cruises' ships.

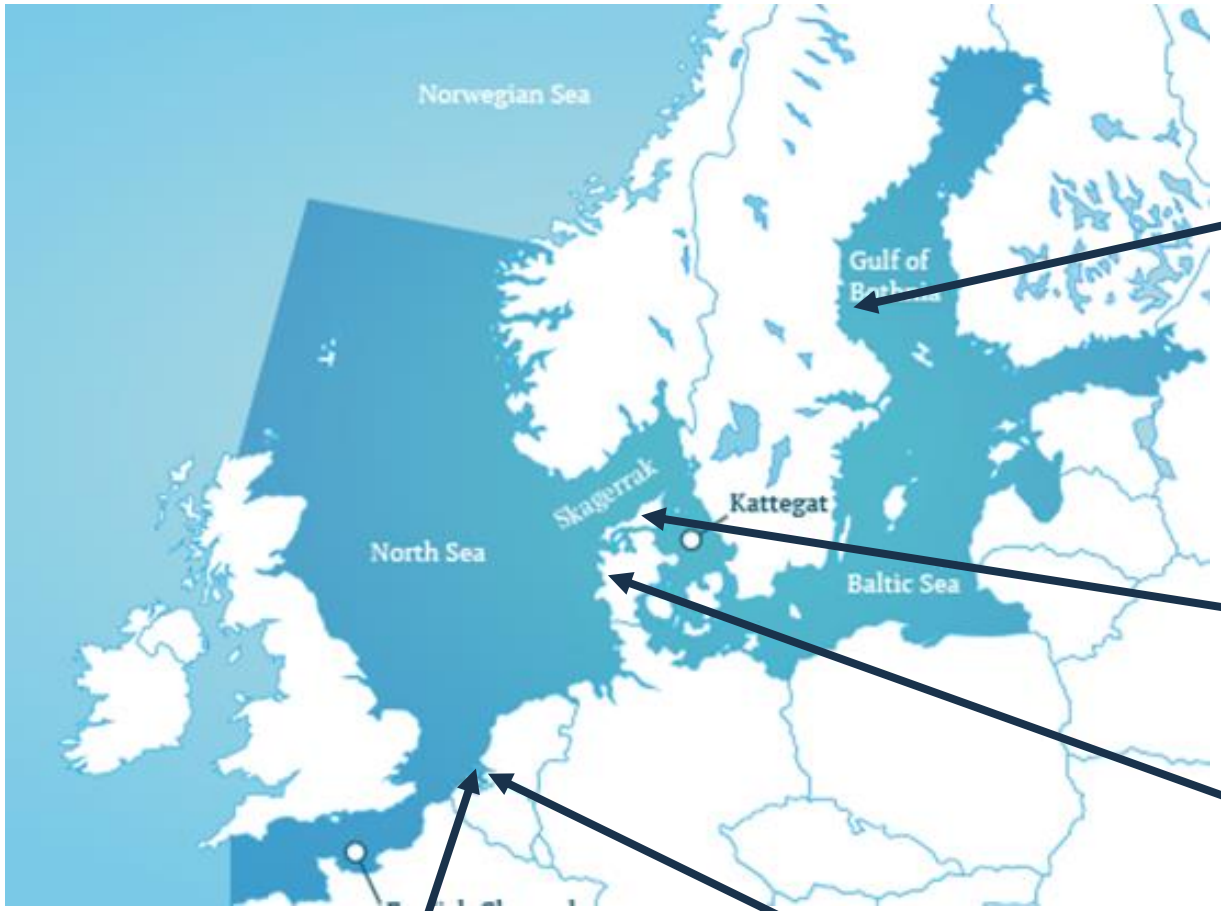
https://www.msccruisesusa.com/en-us/About-MSC/News/MSC-Cruises-Announces-World-Class-Ships-2026.aspx

Gas as fuel reduces air emissions



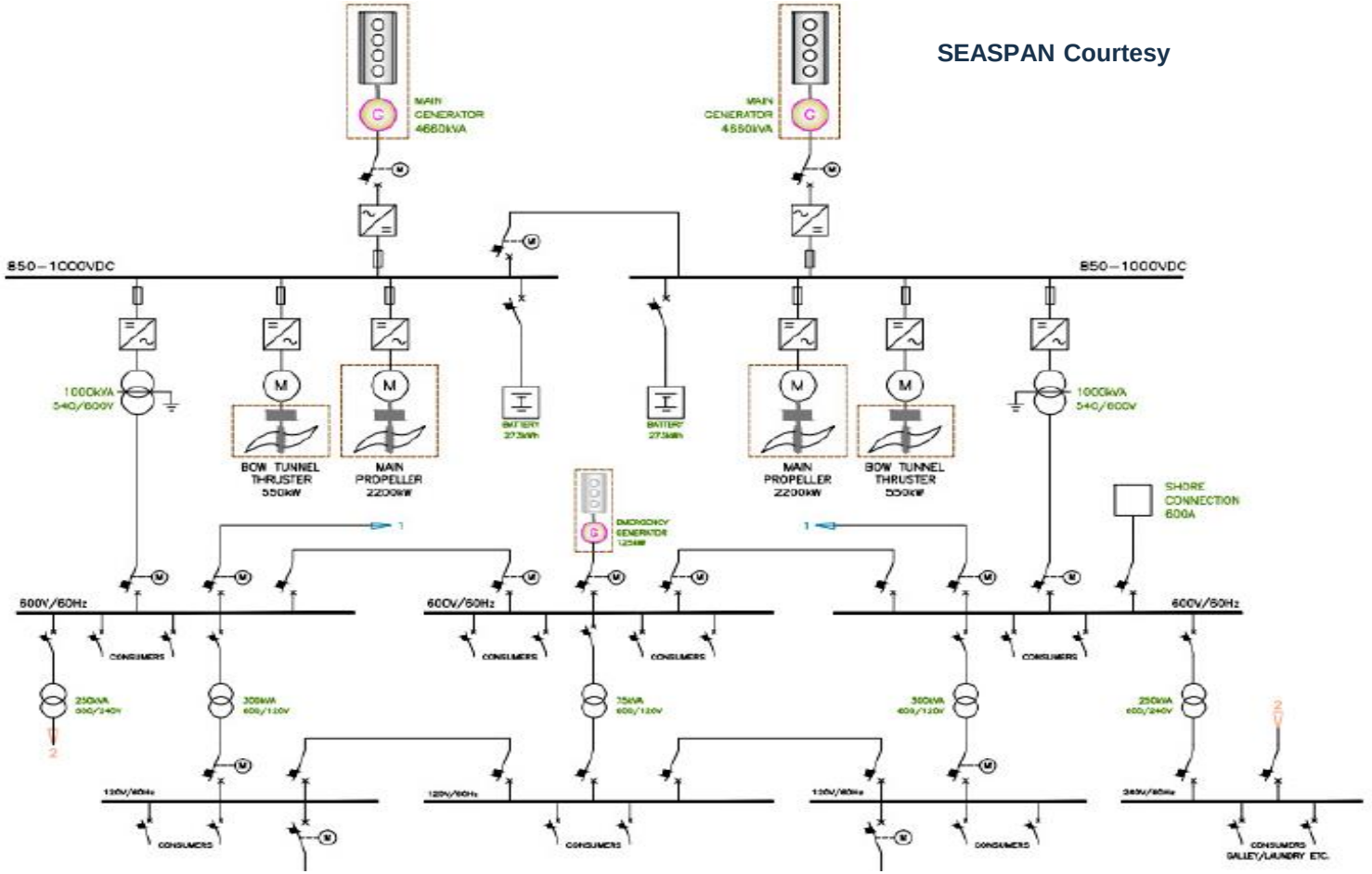
- * However methane slip which aggregate unburned methane specifically in Otto cycle and possible limited gas vent after engine stop should be taken into account as it might reduce significantly the CO_2 reduction advantage.

LNG bunker availability in European waters is increasing



ENGIE

Hybrid RoRo Ferries LNG fuel in BC - Canada

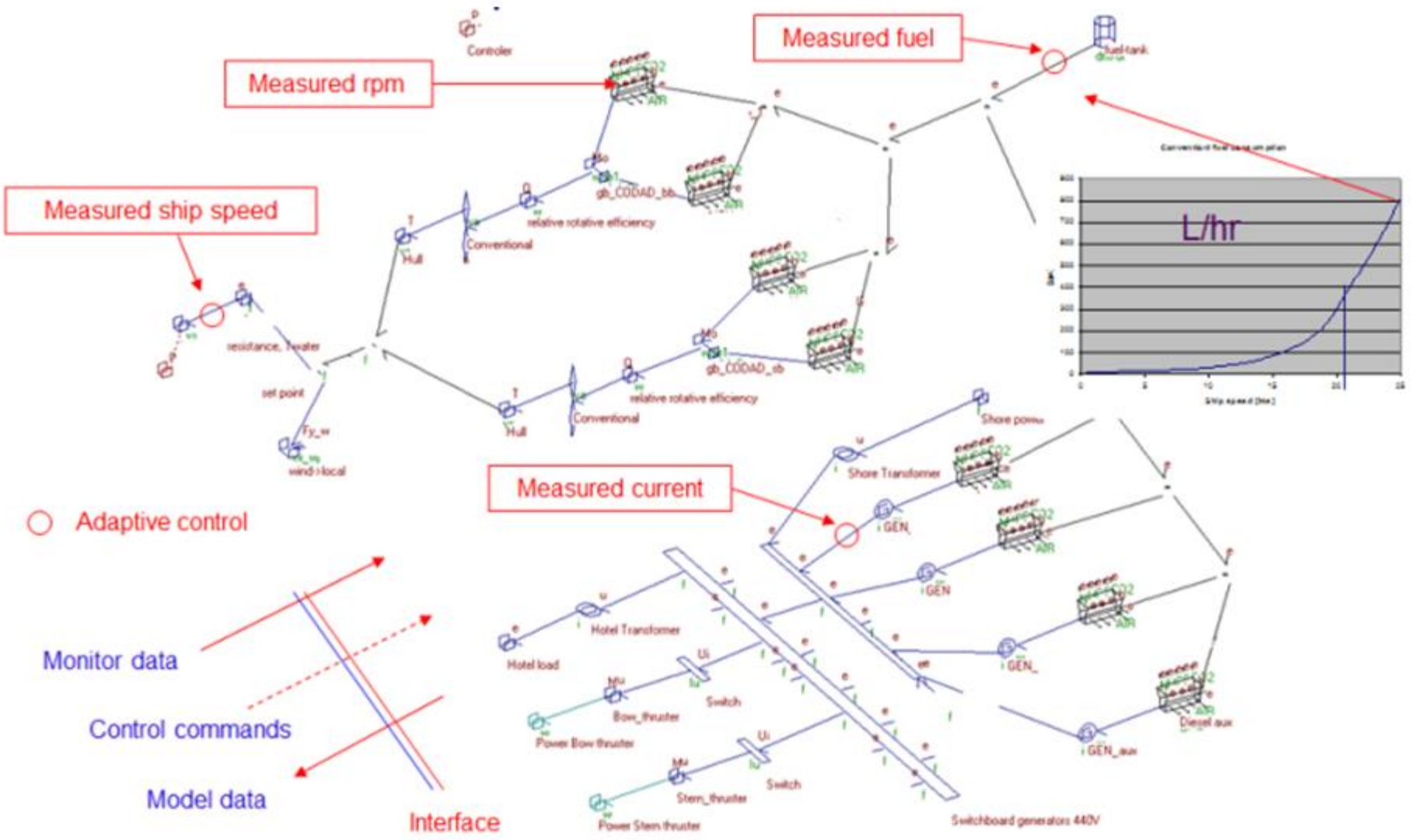


In addition to the LNG propulsion system the vessel will be fitted with a battery bank which an energy storage system (ESS). The vessels will use a 1050VDC, 546kWh ESS consisting of 84 Corvus Energy AT6500 advanced lithium polymer batteries. The ESS will be integrated with the electrical propulsion and distribution system and will be capable of providing power for propulsion for limited periods of time in lieu of the main engines.

Towards zero emission vessels

- Batteries main benefits
  - Power Back Up for critical and high power operations
  - ”Peak Shaving” (reducing load fluctuations seen by engine)
  - Zero-emission operations
  - Improved dynamic response (Gas/Diesel engine with better dynamic performance)
  - ”Spinning” reserve (reducing number of engines online)

Holistic approach for good operational and economical results



The future is at hand : combine existing & new technologies

- Optimisation of existing technologies with a better understanding of efficiency.
- Adoption of zero carbon energy sources.
- Combination of traditionl fuels and sea proven wind energy

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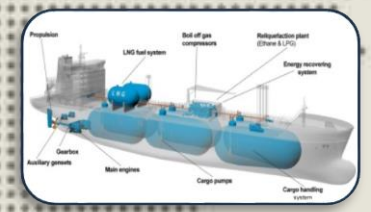


Courtesy Wessels Reederei

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