THE FOURTH REVOLUTION AT SEA

Chapter 2

ZERO CARBON EMISSIONS

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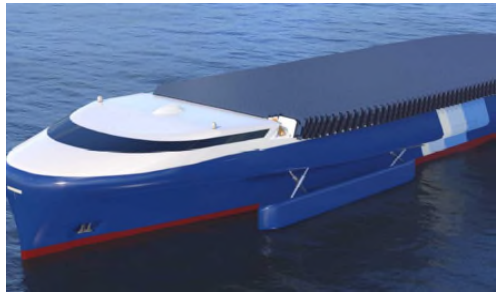
Chapter 2 in a series webinars by Marintec : -
https://www.seatrade-maritime.com/whitepapers-reports

Topics to cover

1. Strategies for cutting CO2 emissions by 2050
2. Innovation scenarios 2020-2050
3. Ship technology
    1. Ship propulsion strategies
    2. Ship electrical systems
    3. Ship function integration & process control.
4. Conclusions



1. Strategies for cutting CO2 emissions by 2050

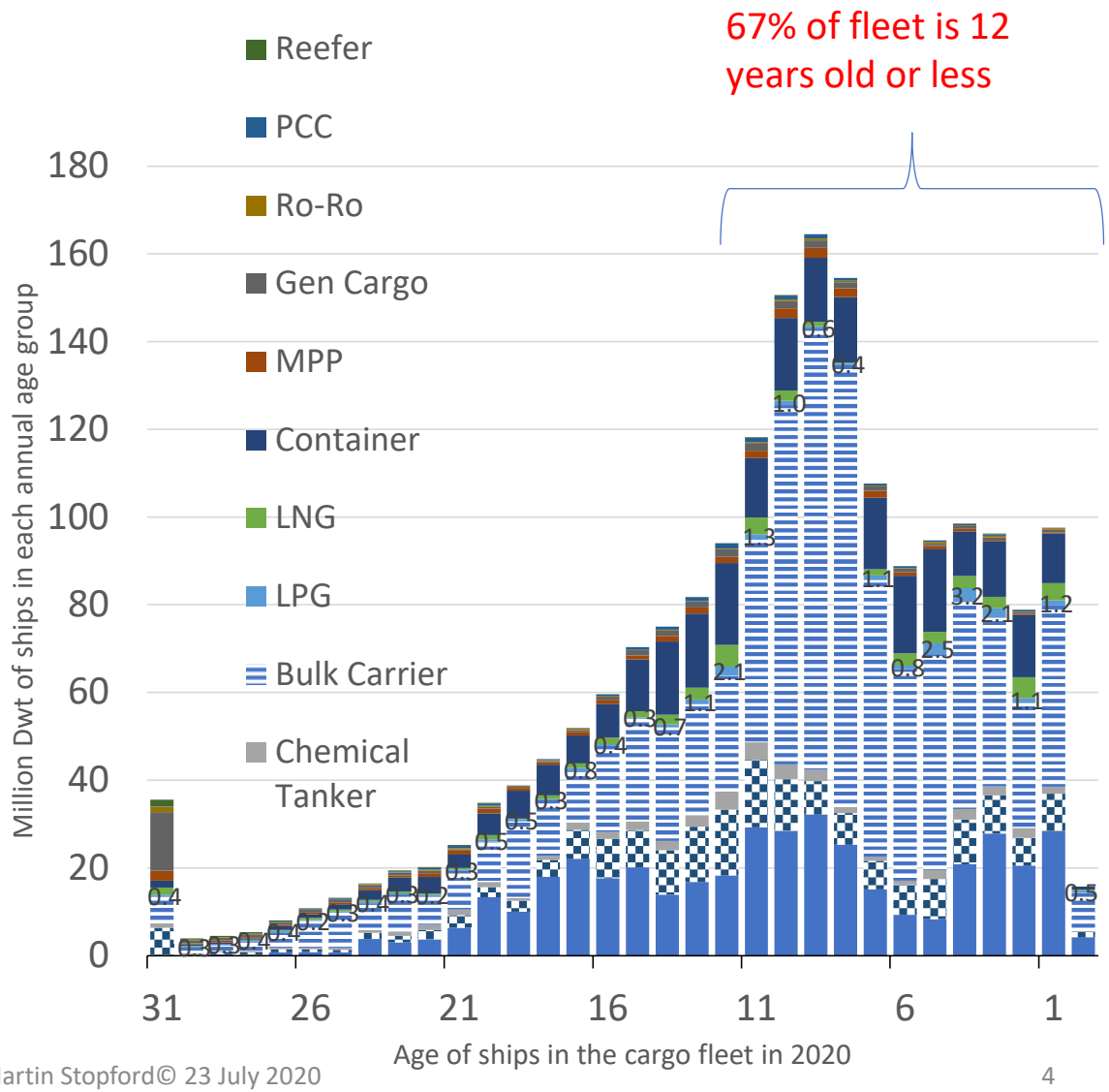
- Step 1: Transport less cargo (monitor carbon emissions, change trading patterns, work with cargo owners, develop ship & company information systems), (40% saving)
- Step 2: make the ships more efficient and operate them for less emissions (better monitoring; lower speed to e.g. 10.5 knots; bigger “small” ships; improved hull surface & on board energy efficiency etc) (40% saving)
- Step 3: Develop zero carbon fuels; new propulsion systems and ships designed to use them efficiently (20% saving)
- Step 4: Finally develop I4 technology to make companies more effective

Minimize emissions of existing fleet

a) This gets quick and quantifiable results for a big slice of cargo transport in the coming decade

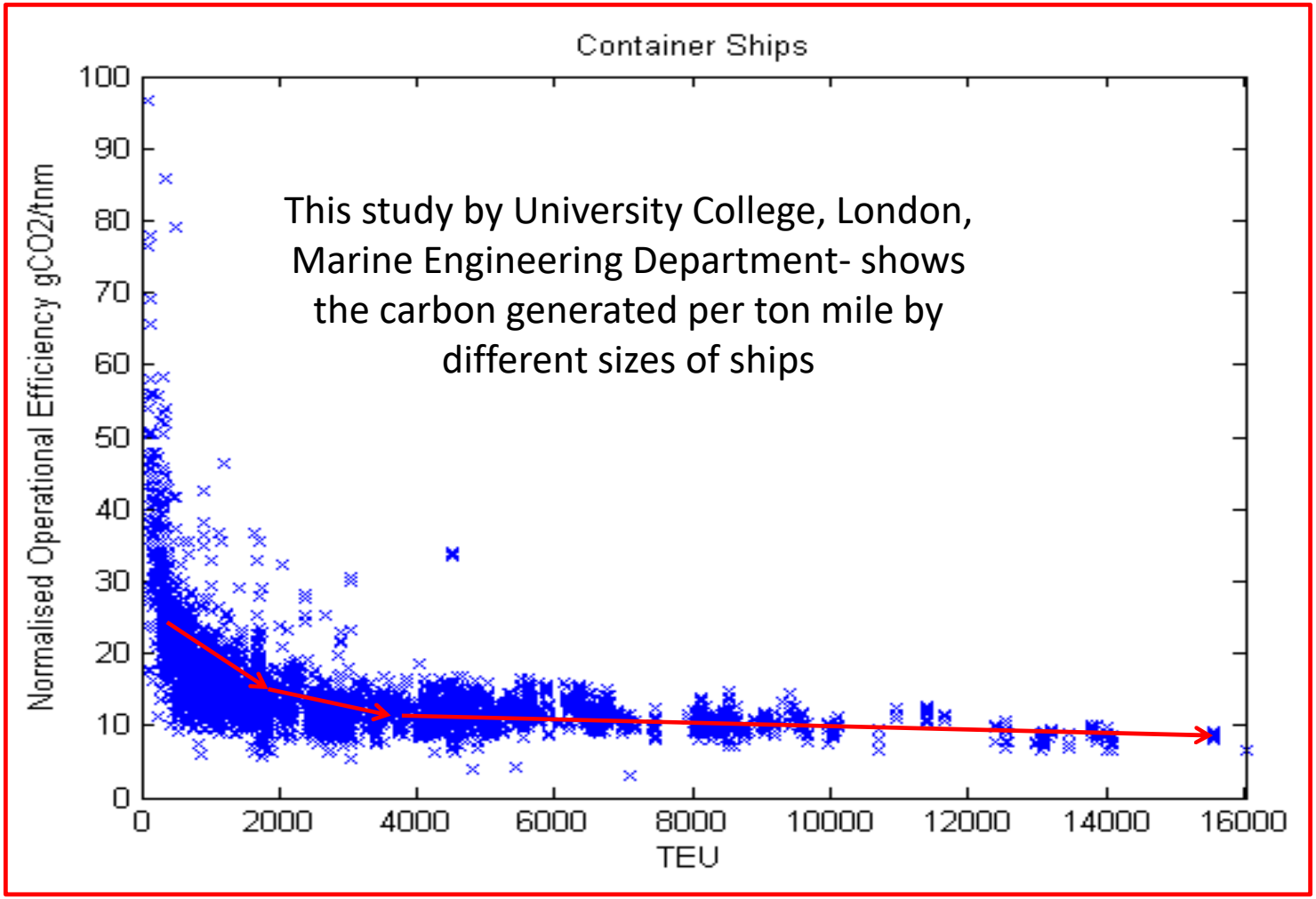
b) 2 billion deadweight fleet (99,031 ships) and 67% of the ships are less than 13 years old.

c) Focus on retrofitting digital and fuel saving technology – good for emissions and costs!

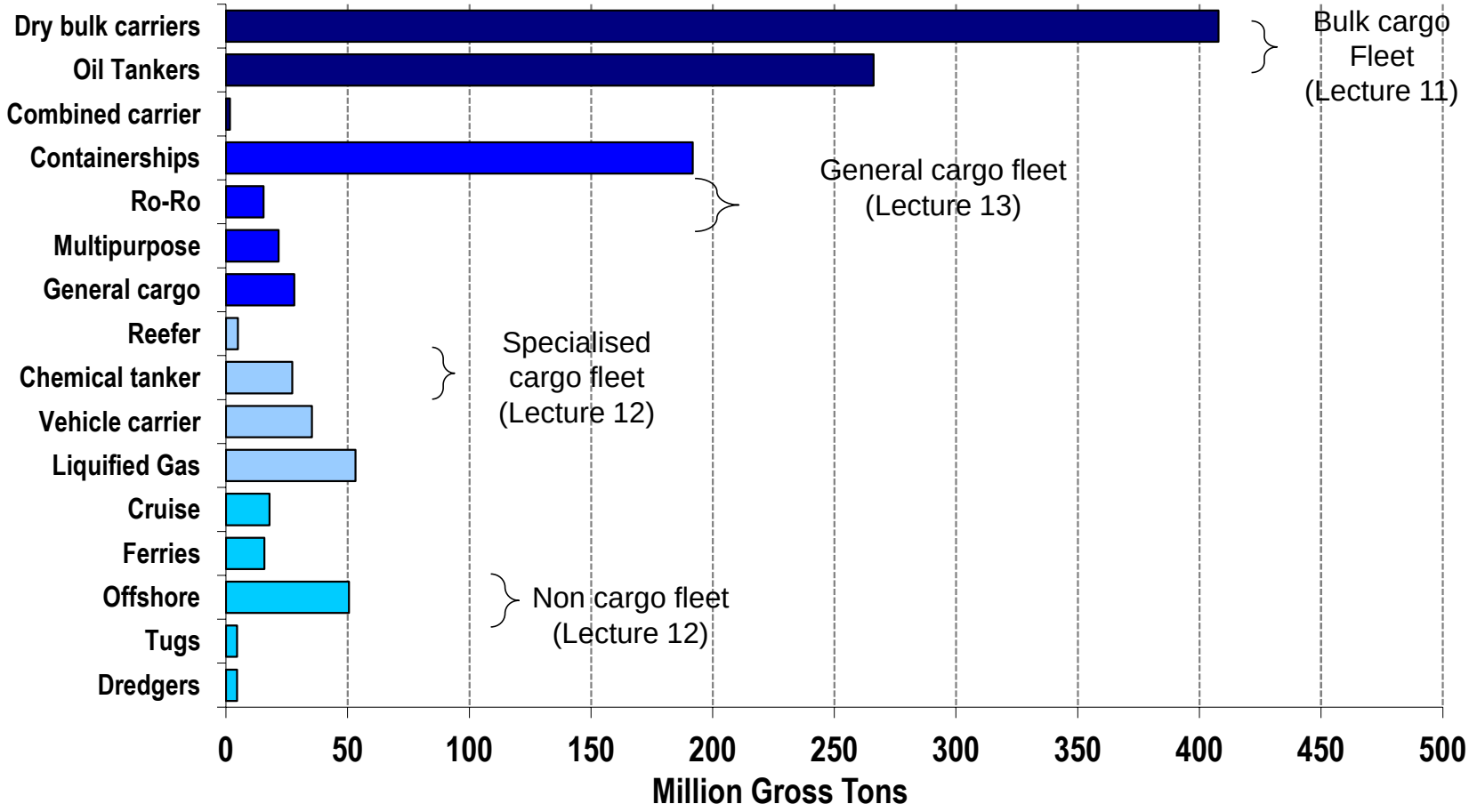


Use bigger small ships

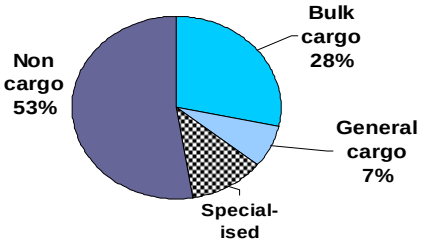
- Bigger ships offer emission savings.
- But the saving diminish as the ships get bigger.
- So the smaller ships are a good place to start. Smaller scontainer ships can call at local ports, cutting out high carbon land transport



Develop a carbon strategy tailored to each market segment's structure



World fleet by type May 14 (numbers of vessels)



Source: Maritime Economics 3rd Ed, Martin Stopford, page 68

2. The Innovation Scenarios

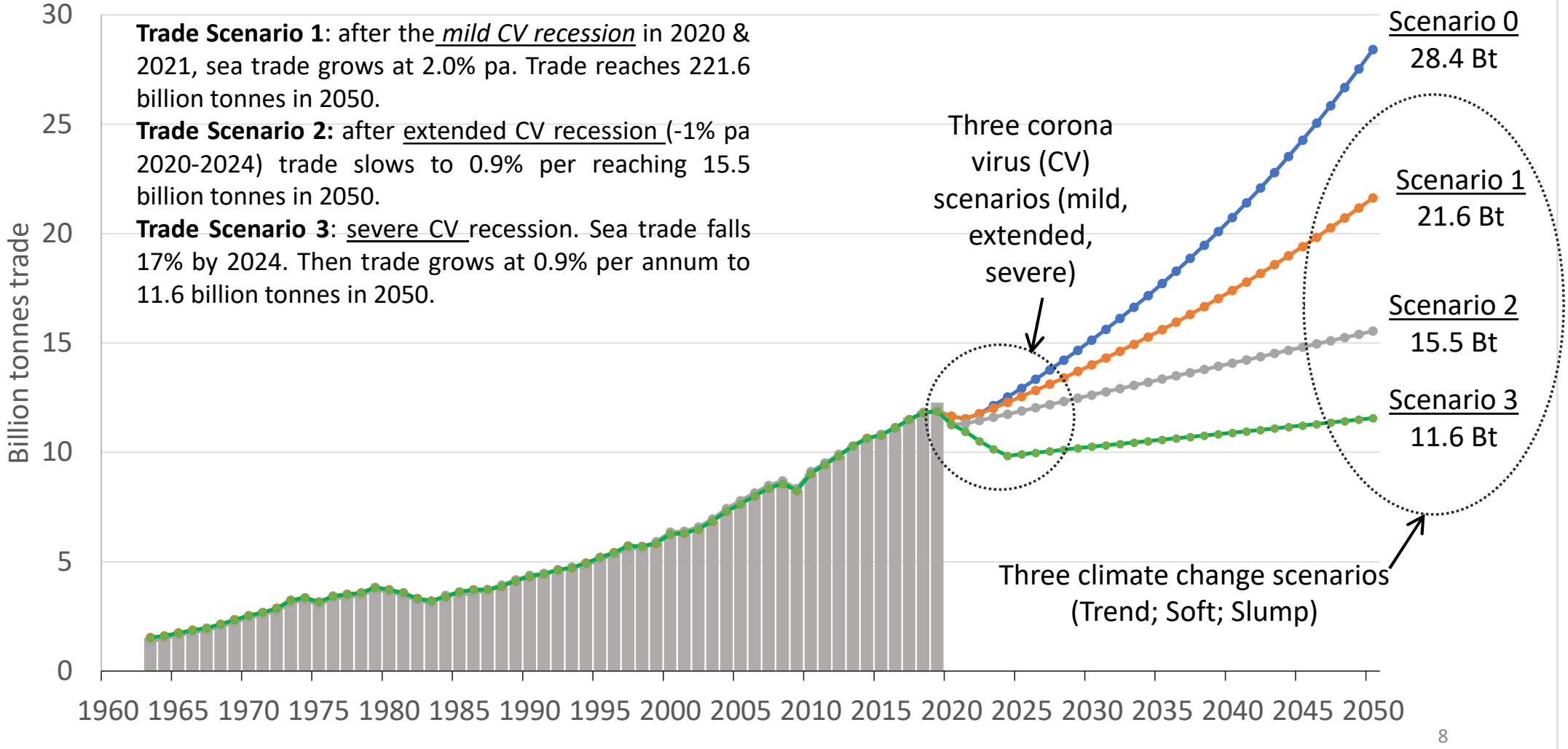
These are based on the three scenarios in my paper “Coronavirus, climate change and smart shipping” published by Seatrade in May. I have updated them. The scenarios cover trade, merchant fleets, shipbuilding demand, and carbon emissions scenarios to 2050

In Scenario 0 trade grows at the past rate of 3.5% pa. This is shown for reference

Trade Scenario 1: after the *mild CV recession* in 2020 & 2021, sea trade grows at 2.0% pa. Trade reaches 221.6 billion tonnes in 2050.

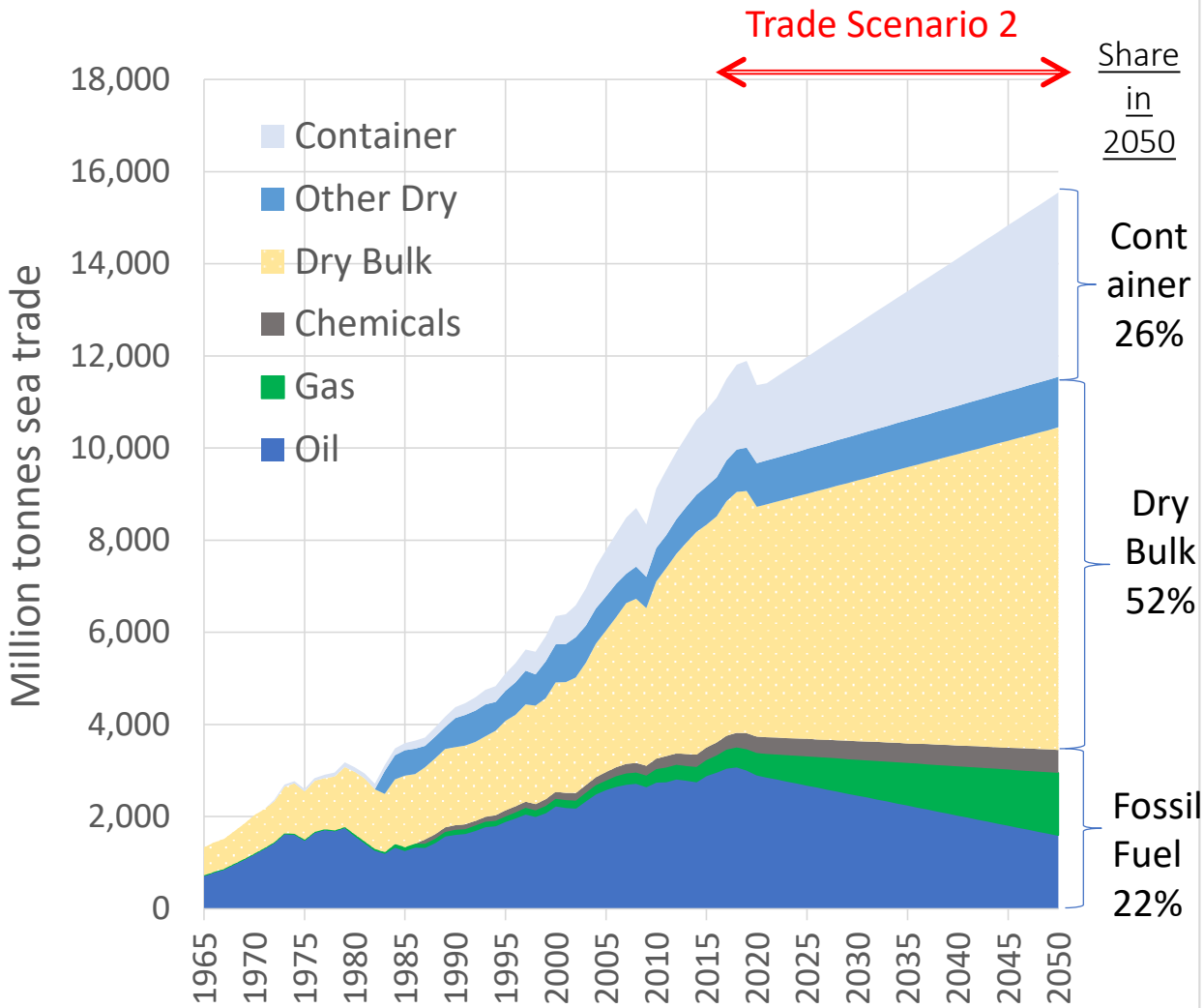
Trade Scenario 2: after extended CV recession (-1% pa 2020-2024) trade slows to 0.9% per reaching 15.5 billion tonnes in 2050.

Trade Scenario 3: severe CV recession. Sea trade falls 17% by 2024. Then trade grows at 0.9% per annum to 11.6 billion tonnes in 2050.

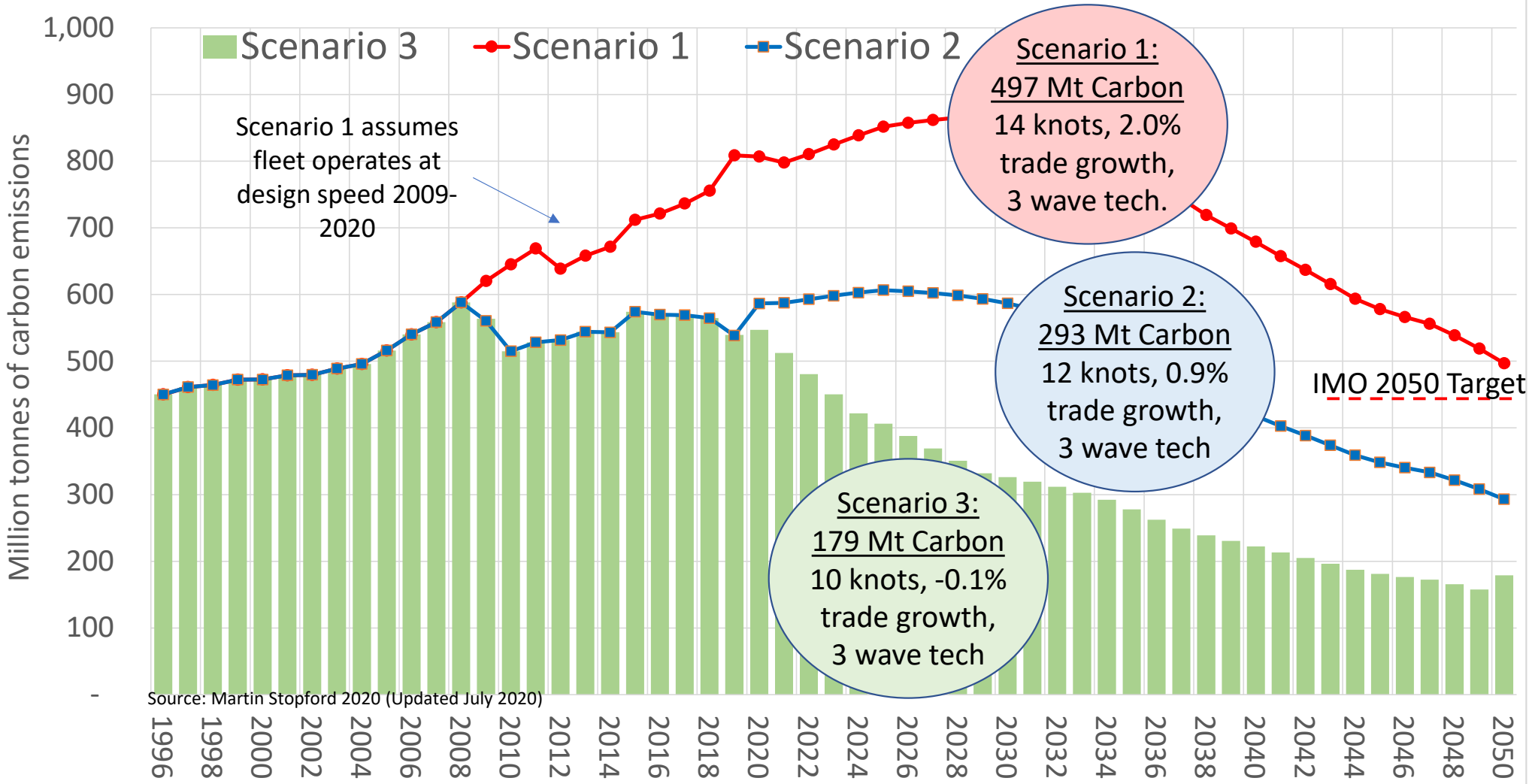


Sea trade will effect how ships are developed – this is Scenario 2 - “Soft Trade”

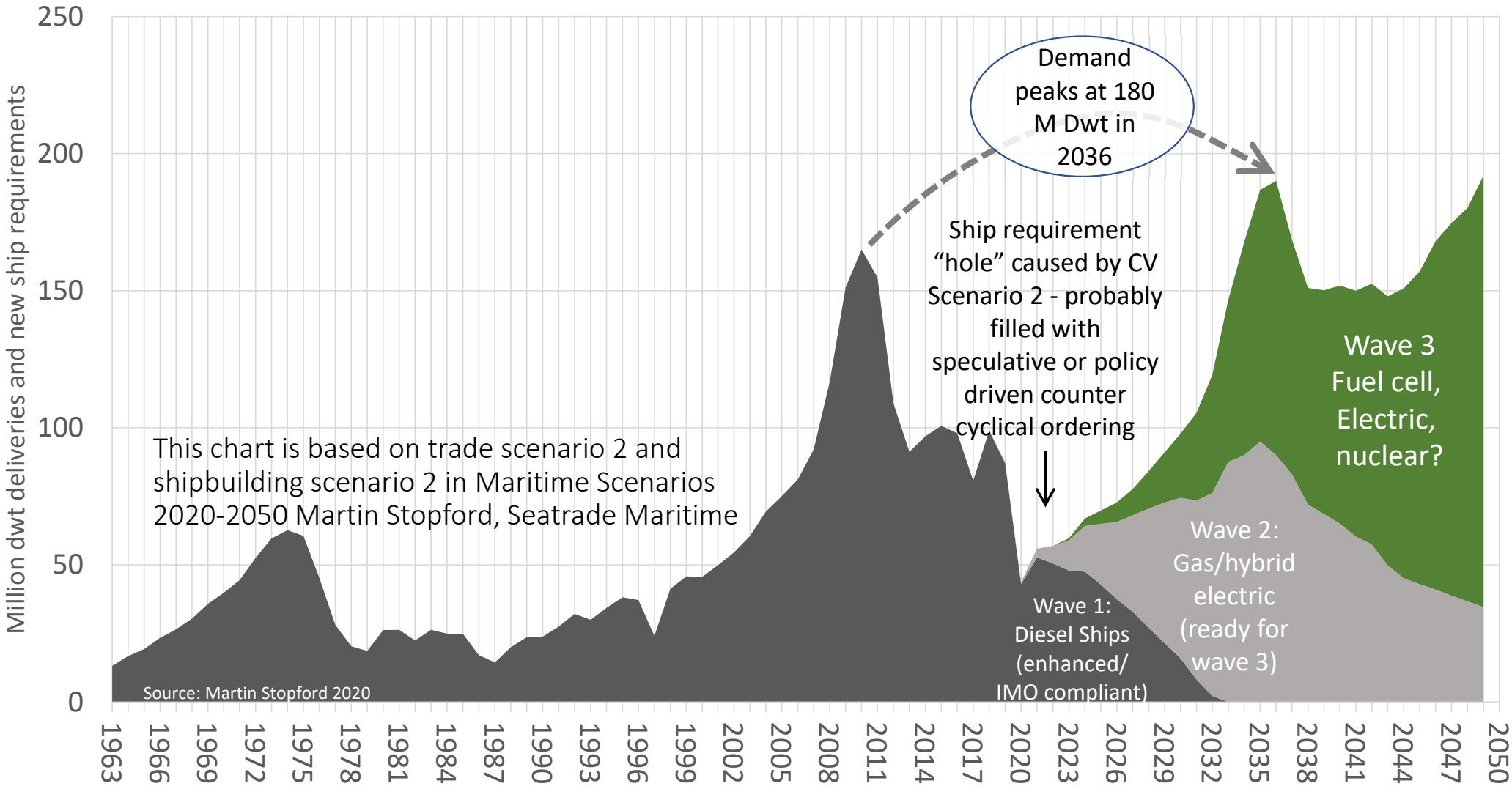
- Scenario 2 shows trade growing at around 1% per annum 2020-2050
- Fossil fuels halve from 40% of the trade in 2020 to 22% in 2050.
- Crude Oil falls by 3% pa, products by 0.8% per annum. But the gas trade grows at 3.2% per annum.
- Dry bulk growth averages 1.0%, with minor bulks growing at 1.8% and the three major bulks declining by .2%.
- Containers grow at 2.5%, doubling their trade share from 13% to 26%. This may reflect more short sea transport.



The 3 emissions scenarios – good progress but not zero carbon



Scenario 2: Soft trade growth and 12.2 knots speed



Please note that this is a scenario to illustrate the way things might develop, not a forecast, it will almost certainly be wrong!

3. Ship propulsion & fuel

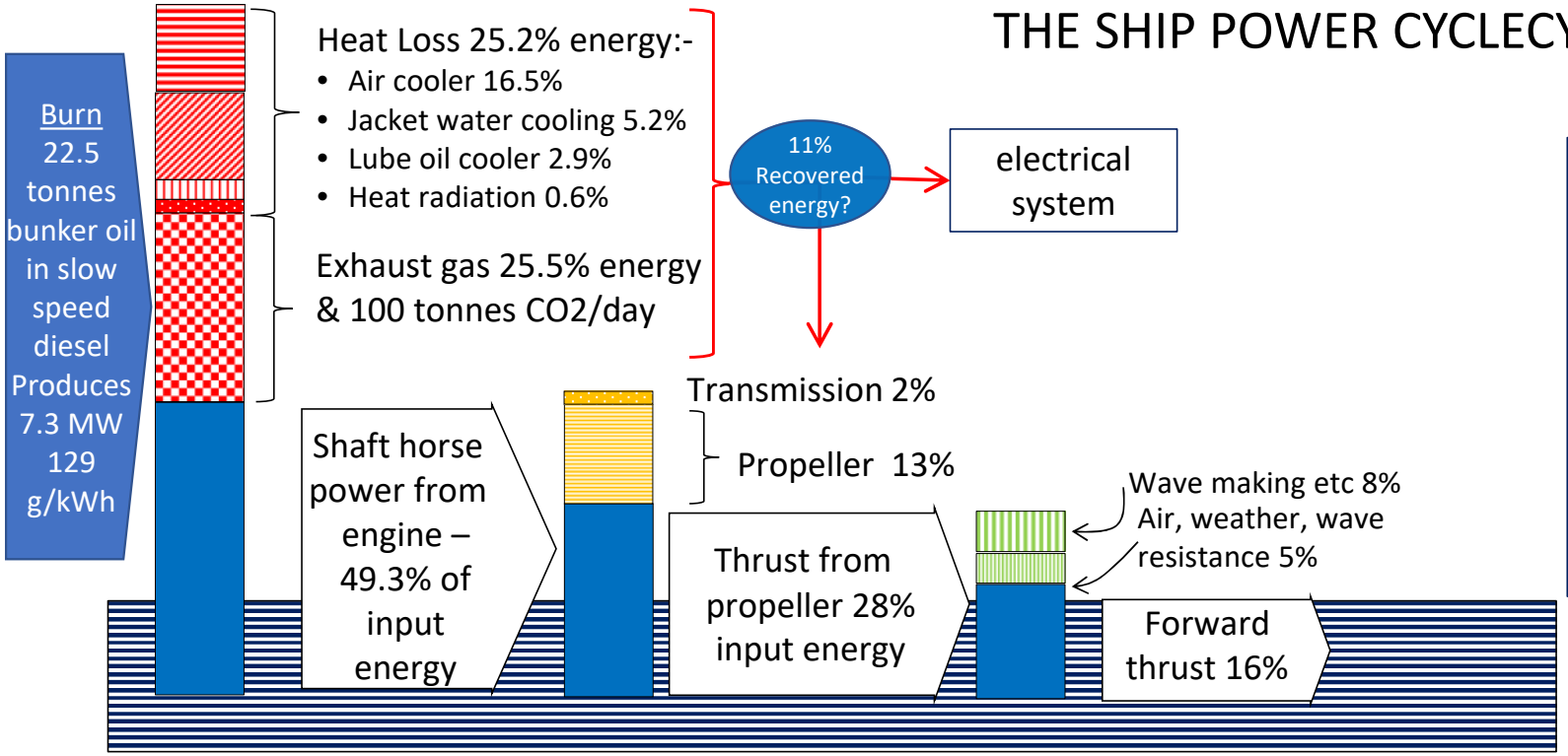
This involves many technologies

1. move towards zero carbon power supply on the ship
2. Reduce the power required by improving the efficiency of the ship.

THE SHIP POWER CYCLECYCLE

1. Fuel options
a) LNG
b) LPG
c) Methanol
d) Ammonia
e) Hydrogen
f) Biofuels

2. Power options
a) Hybrid
b) Battery
c) Fuel Cell
d) Wind power
e) Solar power
f) Wave power
g) Nuclear



6. Operations
a) Voyage plan
b) Just in time
c) Speed
d) Ballast
e) Engine tune
f) Trim
g) Dead freight
h) Electrics
i) Machinery

Improve the performance of the ship in using the energy to transport cargo

% Energy losses in 64,000 dwt bulker, 13.55 knots speed

3. Cut diesel loss of 51%
a) Bigger ships
b) Waste heat recovery
c) Battery hybrid
d) Maintain and tune
e) Power management

4. Cut Propulsion losses of 15%
a) High efficiency propeller
b) Wake equalizer
c) Pre-swirl (e.g. Mewis duct)
d) New propulsor (e.g. flipper)

5. Cut hull energy losses of 16%
a) Slow speed
b) Hull size, form, coating, cleaning
c) Air lubrication
d) Ballast free design
e) Light materials & structure

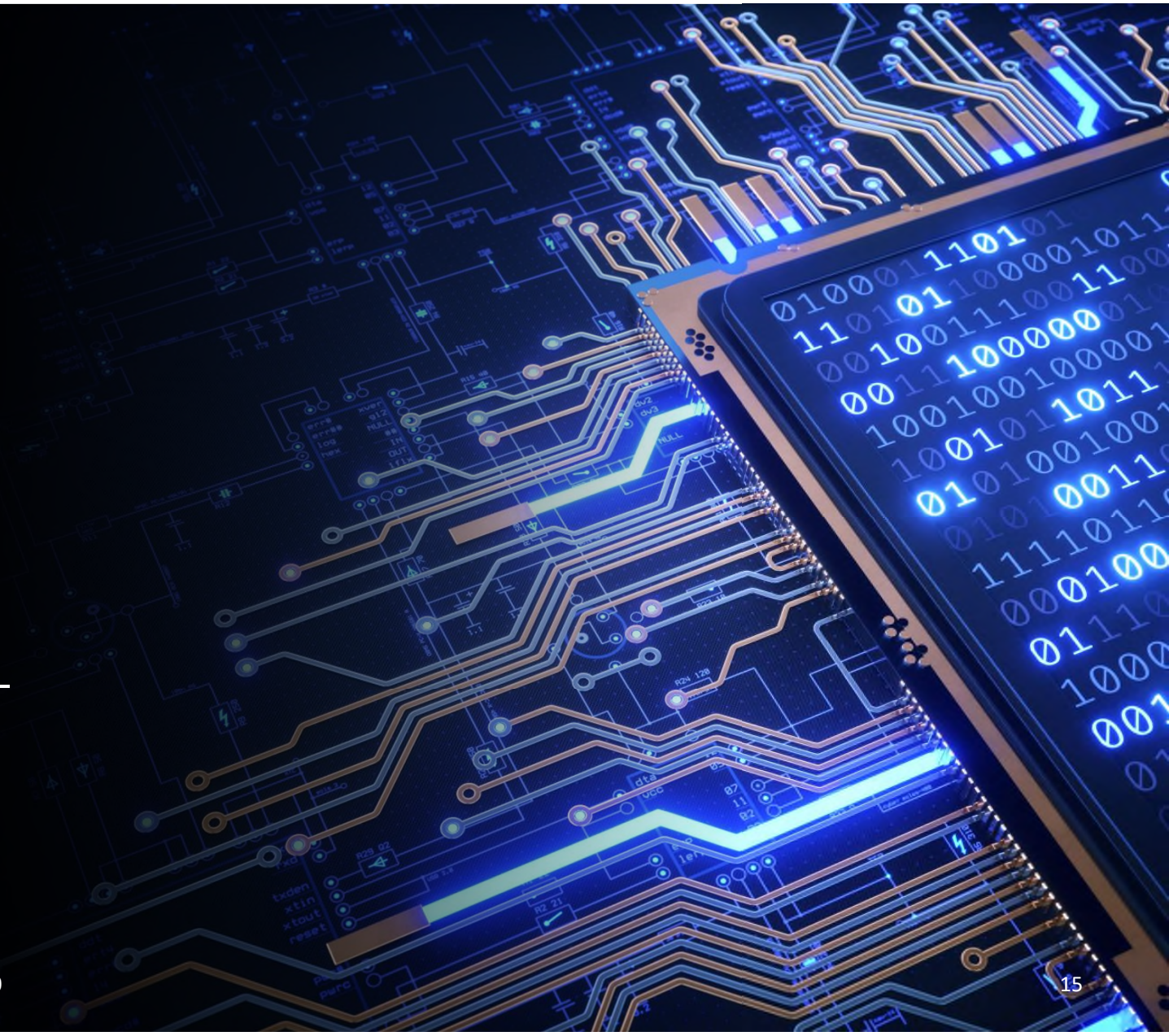
Source: Compiled by Martin Stopford in 1979 from various sources, updated 2020

Liquid fuels which are, or could be, used in merchant ships				*note: all numbers relate to liquid product*			
		HFO	**LNG**	**LPG**	**Methanol**	**Ammonia**	**Hydrogen**
Chemical composition		*Composite*	*CH_4*	*Composite*	*CH_3OH*	*NH_3*	*H_2*
Volume HFO comparison	Ratio to HFO m3/kg*	1	1.9	1.6	2.5	2.6	4.3
Boiling point	˚C 1 bar	150	-166	-26.2	65	-33	-253
Energy density per litre	MJ/lt	41	21.6	24.88	15.7	15.7	9.2
Carbon content	%	0.88	0.75	0.82	0.375	0	0
CO_2 emissions per kWh	kg CO2/kWh	0.245	0.206	0.235	0.249	0	0
Carbon content reduction	Compared to HFO	-	12%	3.30%	56% #	100%	100%
CO_2 compared with HFO	kg CO2/kWh Reduction	-	26%	15.60%	11%	100%	100%
Low flashpoint fuel		Yes	Yes	Yes	Yes	No	Yes
Latent heat vaporisation (LHV)	MJ/kg	41.8	48	46.06	19.9	22.5	120.2
Auto Ignition	Temp ˚C	398	650	428	450	630	535
Flammable range	% vol in air		5-15%	8.9-18.8%	5.5-26%	15-28%	4-74%
* HFO 11.29m3/kg	Source: various sources, including ABS "Low Carbon Shipping" 2019						

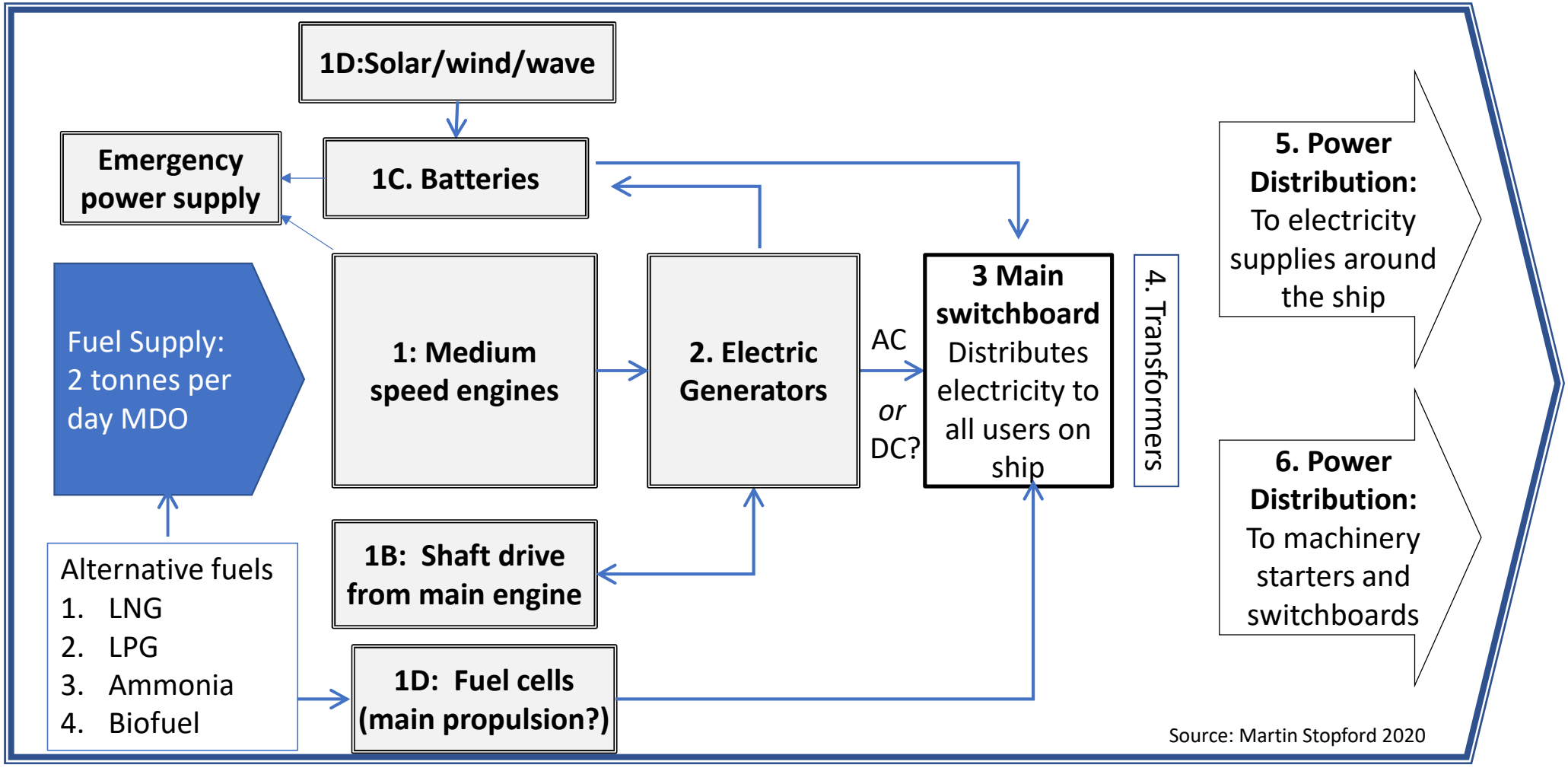
Could be on the low side. Relative to conventional fuels on a well-to-tank (WTT) basis, producers estimate that renewable methanol offers carbon reduction benefits ranging from 65 percent to 95 percent.

4. Ship electrical systems

Optimize the

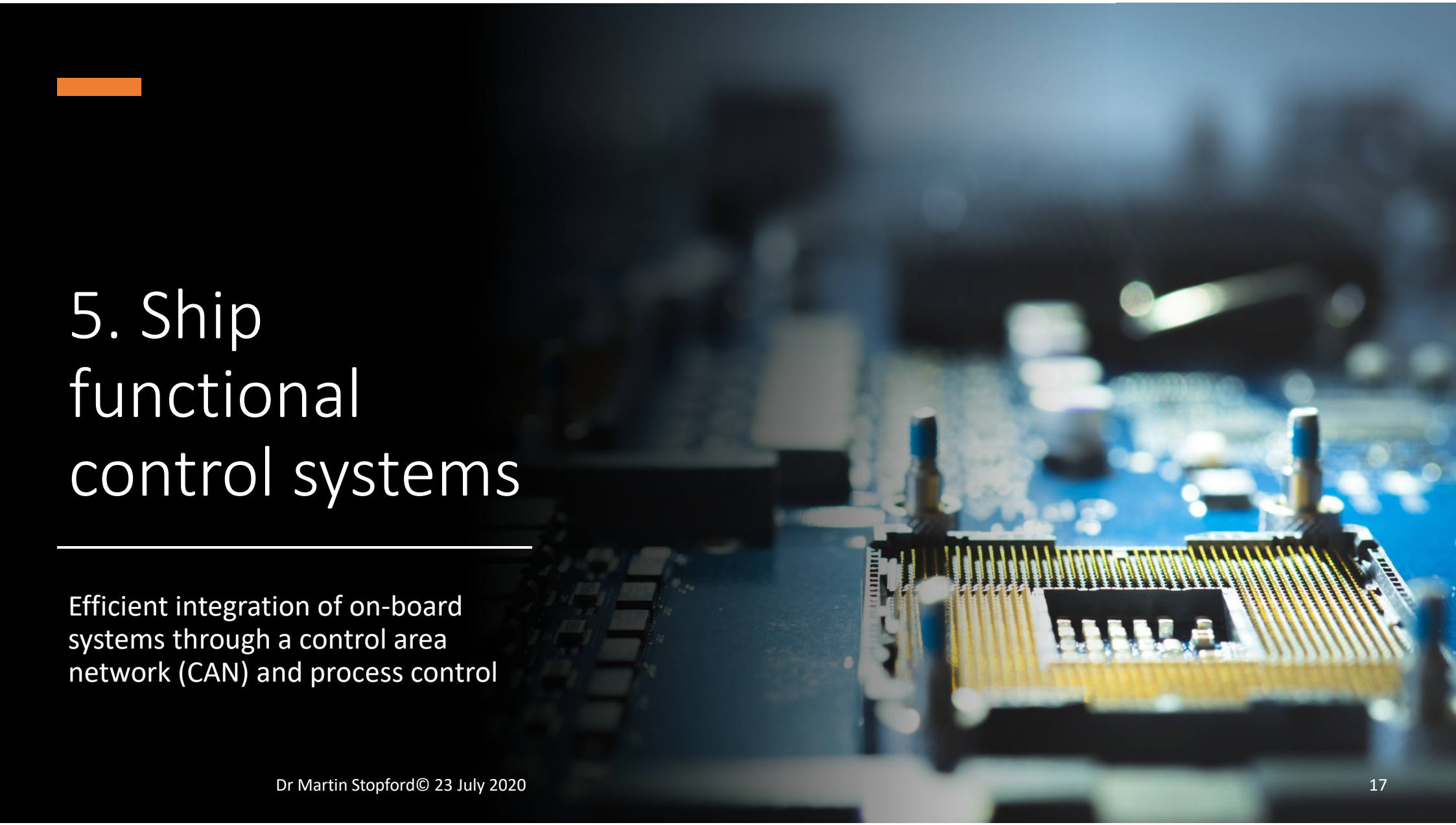


Developing the On board electrical system

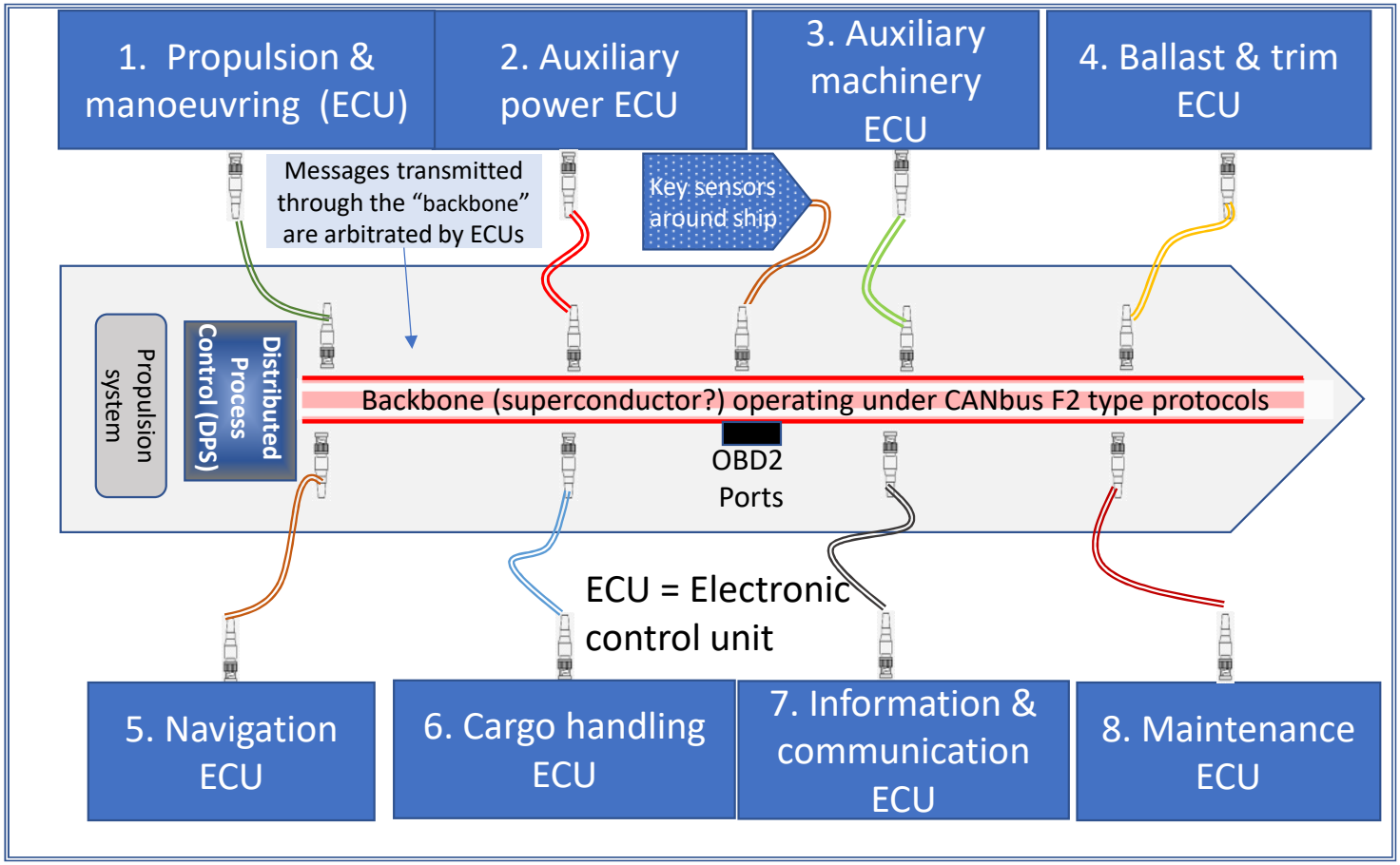


5. Ship functional control systems

Efficient integration of on-board systems through a control area network (CAN) and process control



Restructuring the design of ship-board systems is an essential step



CANbus network for ships – maybe development of NMEA 2000 protocol. Process control could be Modular Type Package (MTP)

CONCLUSIONS

1. Emissions scenarios show IMO 50% emissions target can easily be achieved and surpassed by 2050.
2. Start by systematically retrofitting existing ships.
3. Develop new generation of low emission designs around the diesel engine.
4. Develop wave of gas and hybrid vessels markets where suited and commercially viable.
5. Improve ship performance with Control Area Networks (CAN) and Process Control.
6. Gas and hybrid will be the stepping stone to all-electric ships when zero carbon fuels available.
7. But green fuels need to be produced with green energy and much in demand. Supplies likely to be limited and expensive. Will maritime qualify?
8. So focus on doing the things we know we can do, whilst preparing to do the things we can only do, if we get the fuels to do them!


Thanks for listening