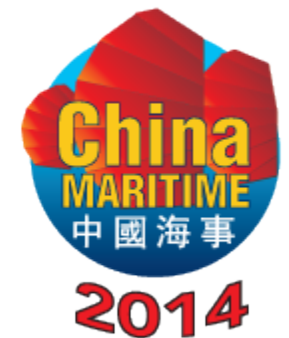


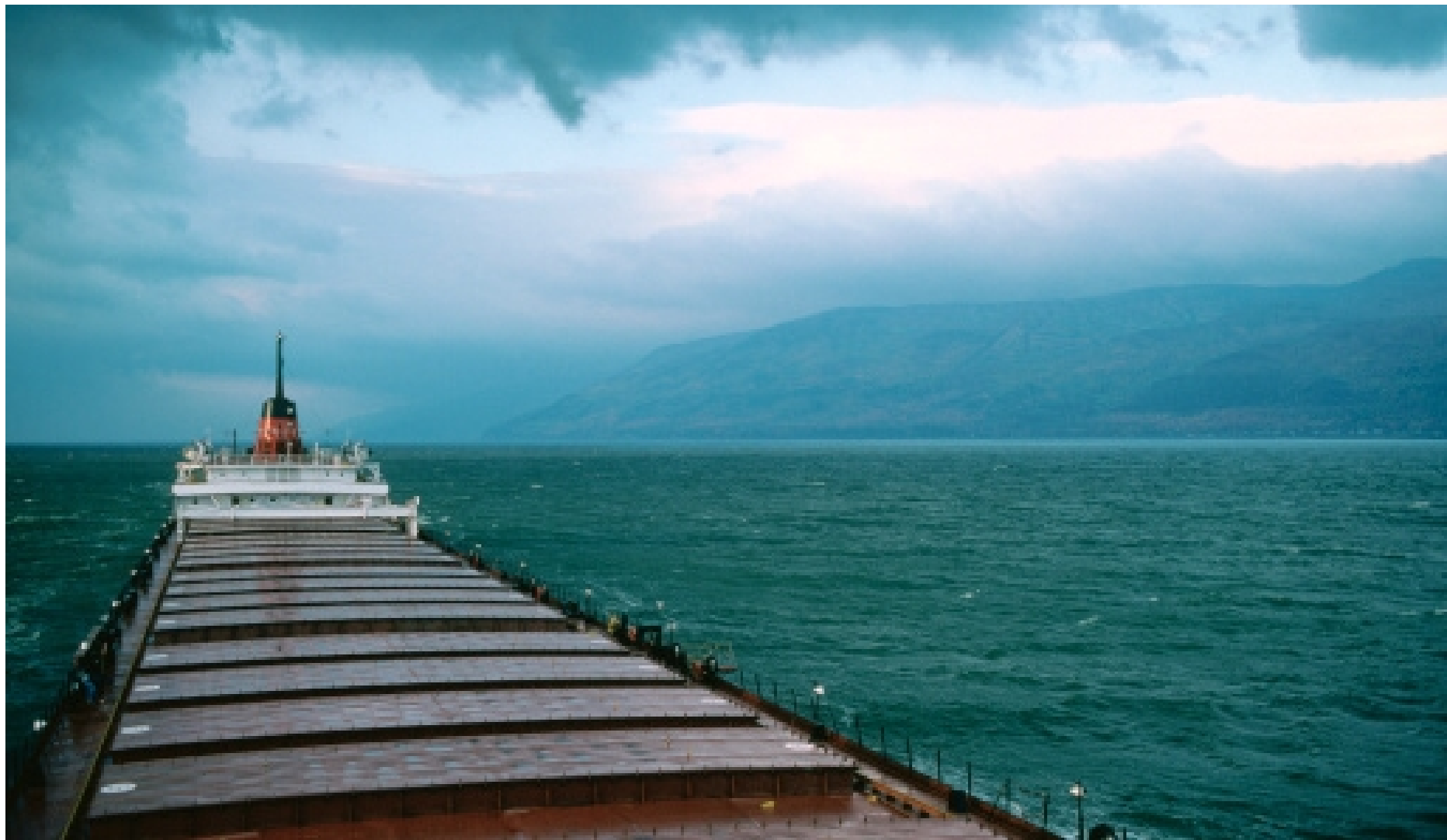
Shipping environmental issues

Key regulations and future outlook

Wei Gao, Technical Support Manager

19 February 2014 @ China Maritime 2014





DRIVERS AND TRENDS

REGULATORY UPDATE

RESPONSE OPTIONS

BEYOND 2020

The world economy and demand for seaborne transport

Development towards 2030

- Uncertain global economic outlook
- Continuous cycles
- Shift in the economic centre of gravity towards Asia



Drivers

- GDP growth
- Global shift in production centres
- High energy prices

Barriers

- Recessions
- Local production

Marine environmental regulations

Development towards 2030

- Stricter regulations on SO_x and NO_x
- GHG emissions - Technical, operational and market-based measures
- Ballast water and recycling conventions
- Regulation on new issues - black carbon, underwater noise, bio-fouling and VOC
- Local marine environmental requirements



Drivers

- Health hazards in populated coastal areas
- Global warming
- Invasion of alien species

Barriers

- Cost of administration and compliance
- Unclear science (black carbon and noise)
- Developing/developed country conflict (GHG)

Stakeholder expectations

Development towards 2030

- Demand for sustainable business practices and transparency
- Disclosure of sustainability information will be a norm
- Performance management systems and documentation of fuel consumption
- Introduction of rating schemes and requirements
- Market premiums for energy efficient ships

Drivers

- Pressure from civil society, charterers, investors, and ports
- High fuel costs
- Charter preference for energy efficient ships



Barriers

- Cost and complexity of reporting
- Reluctance to disclose information
- Crew and shore-based staff competence

Technology developments

Development towards 2030

- Optimisation of main dimensions and hull shape
- Optimisation of propeller and propeller/hull interaction
- Machinery will use various energy sources and hybrid solutions
- Technologies such as scrubber, SCR, EGR and low-pressure LNG engines will mature
- Increased system integration

Drivers

- High fuel costs
- Regulatory compliance
- Increased transport efficiency



Barriers

- Machinery complexity and space limitations
- Cost of implementation and split incentives
- Crew competence

Fuel developments

Development towards 2030

- Decreased demand for heavy fuel oil
- LNG will first penetrate the short sea market and niche markets
- A global LNG distribution network
- Increased uptake of biofuel
- Hydrogen solutions will be piloted in niche segments
- Nuclear power will not be commercially applied in the period towards 2030

Drivers

- Rising energy prices
- Regulatory compliance
- New energy sources



Barriers

- Fuel demand and availability
- Compatibility with machinery
- Public opinion (nuclear)



DRIVERS AND TRENDS

REGULATORY UPDATE

RESPONSE OPTIONS

BEYOND 2020

Ballast water

The IMO Ballast Water Management Convention

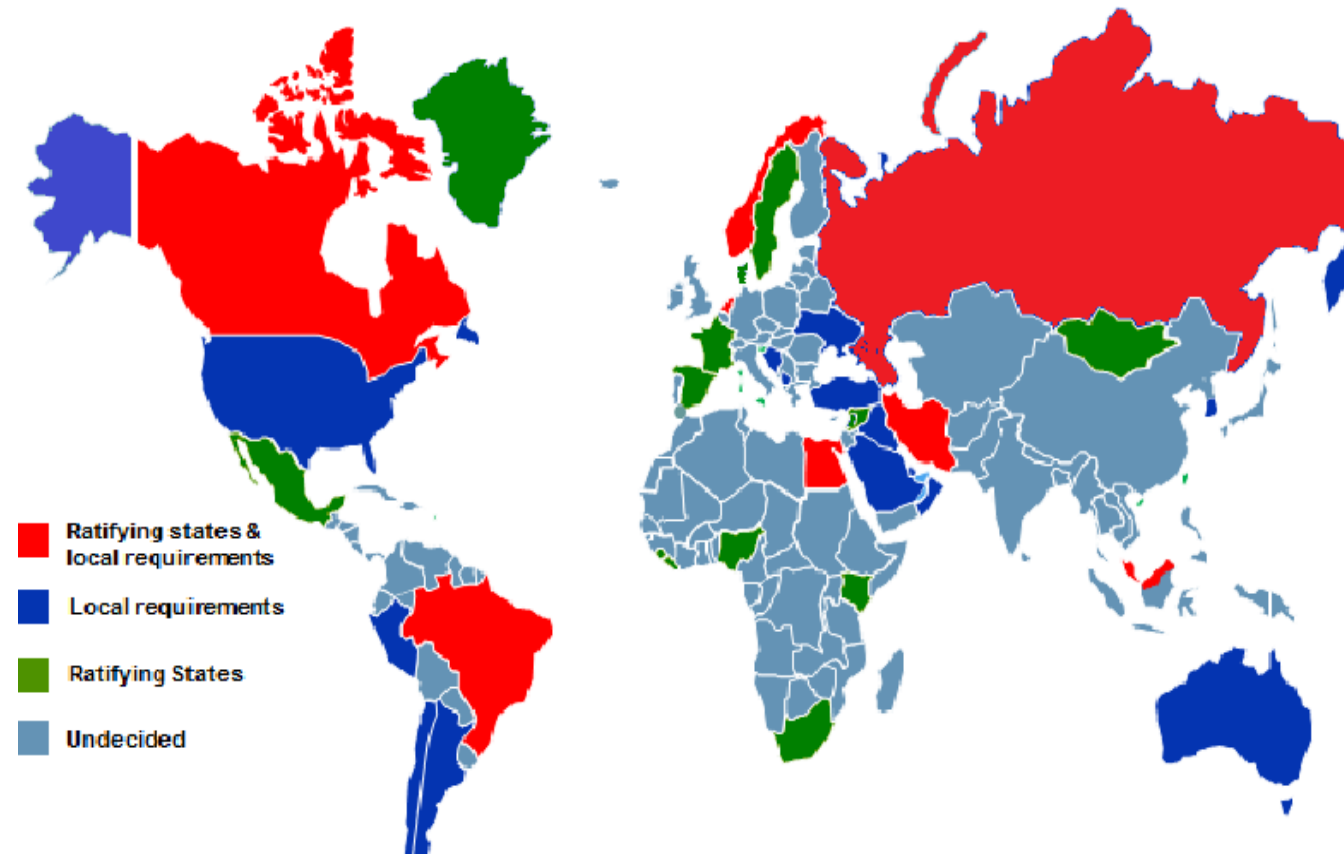
- Aims to minimize
 - transfer of invasive aquatic species between ecosystems
 - transfer of bacteria harmful to human health
- Invasive species do real damage;
 - Great lakes, Canada
 - Zebra Mussels
 - Argentina & Brazil
 - Golden mussels
 - Pandemic outbreak, South America
 - Cholera
- Convention close to ratification



Regulations update - ratification

38 States

30.38%



Country	% GT
Panama	22,95 %
Bahamas	5,57 %
Hong Kong	5,01 %
Singapore	4,89 %
Greece	4,71 %
Malta	4,02 %
China	3,22 %
Cyprus	2,54 %
Italy	1,69 %
Japan	1,56 %
Antigua & Barbuda	1,22 %
India	1,09 %
Finland	0,18 %

Source: IMO, DNV Internal analysis

IMO BWM Convention Implementation Schedule

Constructed year		BW Capacity (m3)	New schedule
Before 2009		Between 1500 and 5000	1 st IOPP renewal survey after entry into force of the Convention
		Less than 1500 or greater than 5000	1 st IOPP renewal survey after the anniversary date of delivery of ship in 2016
2009 or after		Less than 5000	1 st IOPP renewal survey after entry into force of the Convention
	Between 2009 and 2011	5000 or more	1 st IOPP renewal survey after the anniversary date of delivery of ship in 2016
	After 2011	5000 or more	1 st IOPP renewal survey after the day of the entry into force of the Convention

US Ballast Water regulations

- New USCG regulations effective 1 Dec. '13. Applies IMO standard, similar timeline.
- New EPA VGP requirements effective Dec. '13, only partially harmonised with USCG
- Technology availability and type approval issues? AMS? Sampling?
- Enforcement mechanisms and non-compliance consequences?
- States can impose additional requirements; above and beyond IMO / USCG / EPA requirements (e.g. CA, NY)



	Ballast water capacity	Construction date	Compliance date
New ships	All	On or after 2013-12-01	On delivery
Existing ships	Less than 1500 m ³	Before 2013-12-01	First scheduled drydocking after 2016-01-01
	1500 m ³ to 5000 m ³	Before 2013-12-01	First scheduled drydocking after 2014-01-01
	Greater than 5000 m ³	Before 2013-12-01	First scheduled drydocking after 2016-01-01

Market update – systems installed on DNV ships (1/2)

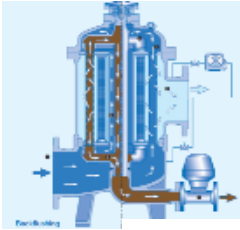
Type	Sub-type	Number
Bulker	Bulk Carrier	23
Container	Container ship	28
Dry Cargo	General cargo	21
	General cargo/container ship	12
	Semi-submersible Heavy Lift	5
Gas carrier	LNG	1
	LPG	9
Miscellaneous	Barge	2
	Seismographic research ships	10
MOU	Ship-shaped drilling unit	2
	Column stabilized unit	5
Sub-total		118

Market update – systems installed on DNV ships (2/2)

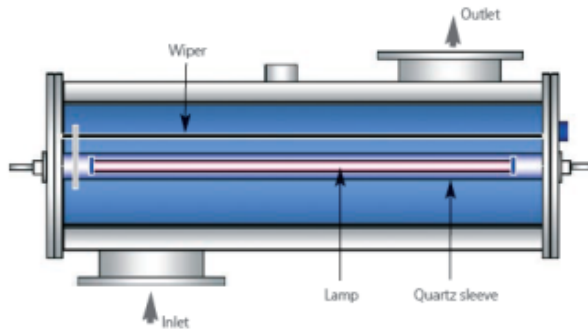
Type	Sub-type	Number
OSV	Supply vessel	16
	Supply vessel anchor handling	1
	Supply vessel/tug	4
	Multi-purpose offshore vessel	8
	Pipe-layer	1
Passenger/ferry	Passenger ship	3
Roro	Roll-on/Roll-off carrier	2
	Vehicle carrier	14
Tanker	Tanker for Oil	11
	Tanker for Oil Products	3
	Tanker for Oil and Chemicals	5
	Tanker for Asphalt	2
Total		188

Technology options

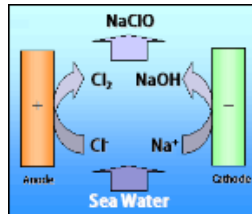
- Filters



- UV treatment



- Electrolysis / chlorine



- Ozone



- Biocide



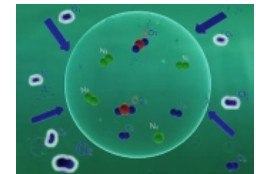
- Cavitation / pressure drop



- Pasteurization



- De-oxygenation



Approvals as of October 2013

IMO Ballast water convention

- 32 systems type approved
- 15 in the pipeline – more applications forthcoming

US AMS approval – 12 February 2014

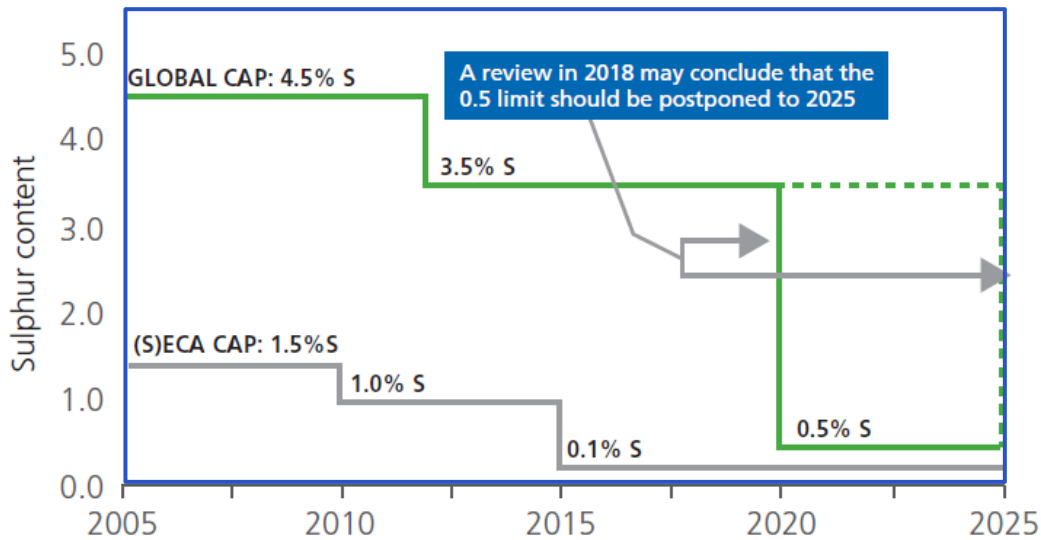
- 34 systems approved

- Details available upon request

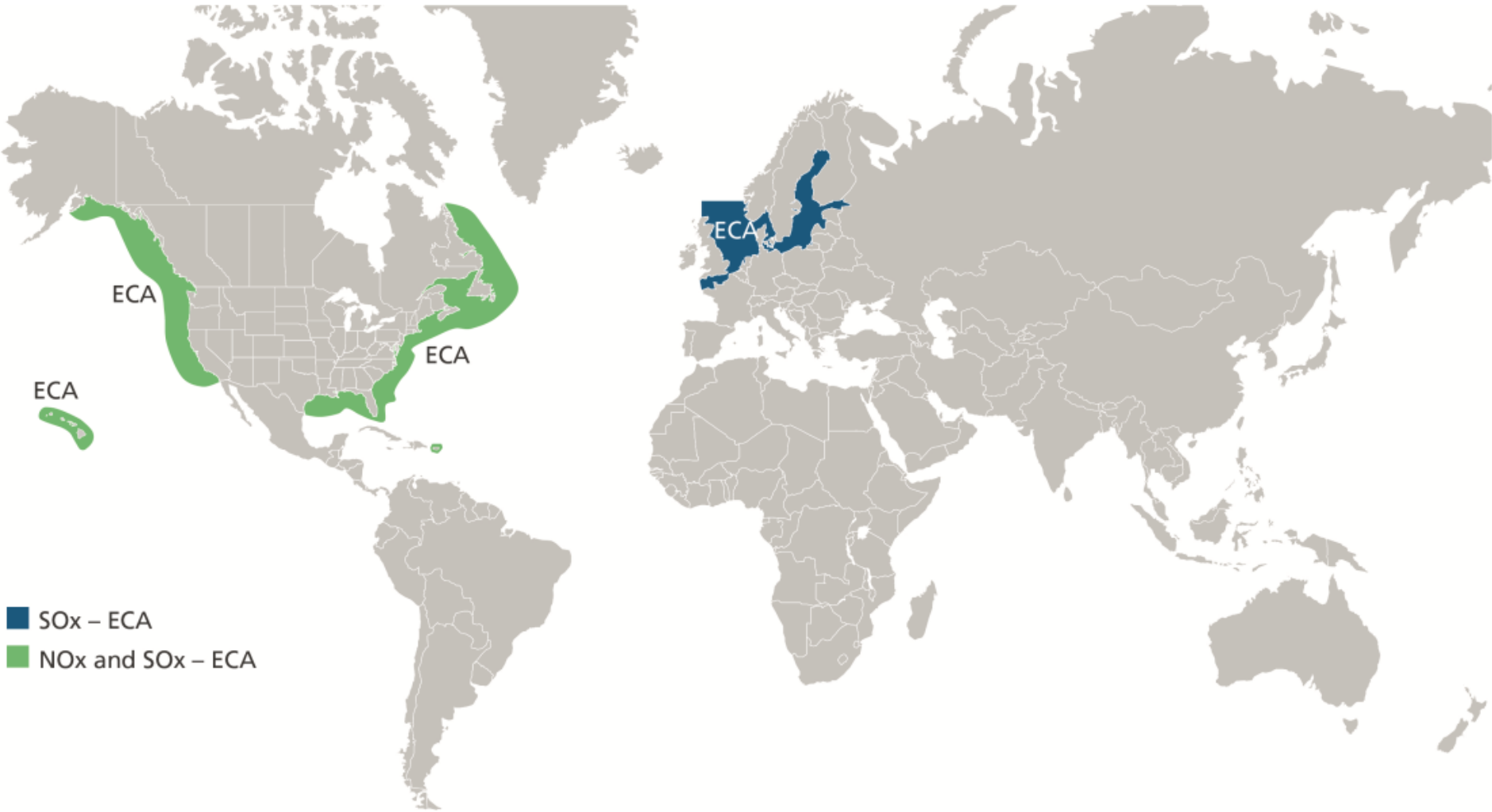
SOx

Tightening sulphur emission requirements

Global sulphur	ECA sulphur	EU sulphur
Requirement 2020 / 2025*; Sulphur < 0.50% * Date TBD pending 2018 review	Requirement 2010; Sulphur < 1.0% 2015; Sulphur < 0.1%	Requirement 2012; updated ECA reqs. in EU law 2020*; Sulphur < 0.50% * All EU waters; 200NM

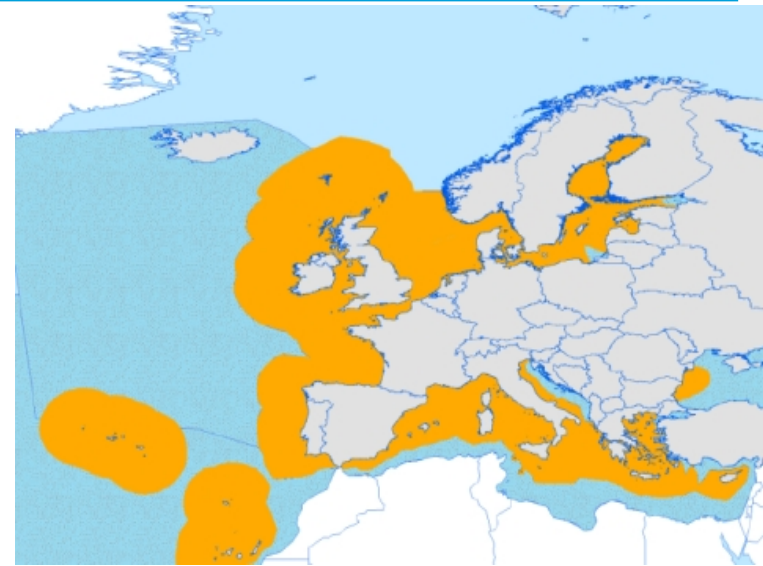


Existing Emission Control Areas



EU sulphur Directive - revision highlights

- Revised Directive agreed by EU;
 - Alignment with MARPOL Annex VI
 - **Agreement on 0.5% in EU waters in 2020**
 - PAX vessel requirements at 1,5% in all non-ECA EU waters until 2020 (200 NM)
 - State aid for technology investments (scrubbers, LNG, infrastructure)
- Future actions and consequences
 - Additional support measures may be forthcoming
 - Mediterranean ECA? Political climate and 0.5% in 2020 renders this unlikely
 - Will shipping lanes shift in 2020?



Local issues - California Sulphur Regulations



Fuel Requirement	Effective Date	Percent Sulfur Content Limit
Phase I	July 1, 2009 ¹	Marine gas oil (DMA) at or below 1.5% sulfur; or Marine diesel oil (DMB) at or below 0.5% sulfur
	August 1, 2012 ²	Marine gas oil (DMA) at or below 1.0% sulfur; or Marine diesel oil (DMB) at or below 0.5% sulfur
Phase II	January 1, 2014 ³	Marine gas oil (DMA) or marine diesel oil (DMB) at or below 0.1% sulfur

1 No change from the existing requirements.

2 Marine gas oil sulfur limit reduced from 1.5% to 1%. No change in marine diesel oil limit.

3 Implementation delayed from 2012 to 2014.

- Non-compliance fee
 - \$45,500 for 1st visit, increasing to \$182,000 for 5th
- Scrubbers will not be allowed as substitute
 - Waiver if system accepted as R&D project
- CARB regulation will be superseded by MARPOL Annex VI in 2015
 - IMO regulations allow for use of scrubbers

NOx

NOx emissions – MARPOL Annex VI

NOx

Requirement

2011: NOx Tier 2, -20%
 2016: NOx Tier 3, -80%*

* New builds, only in NECA, EIf
 2021?

NECA - Baltic

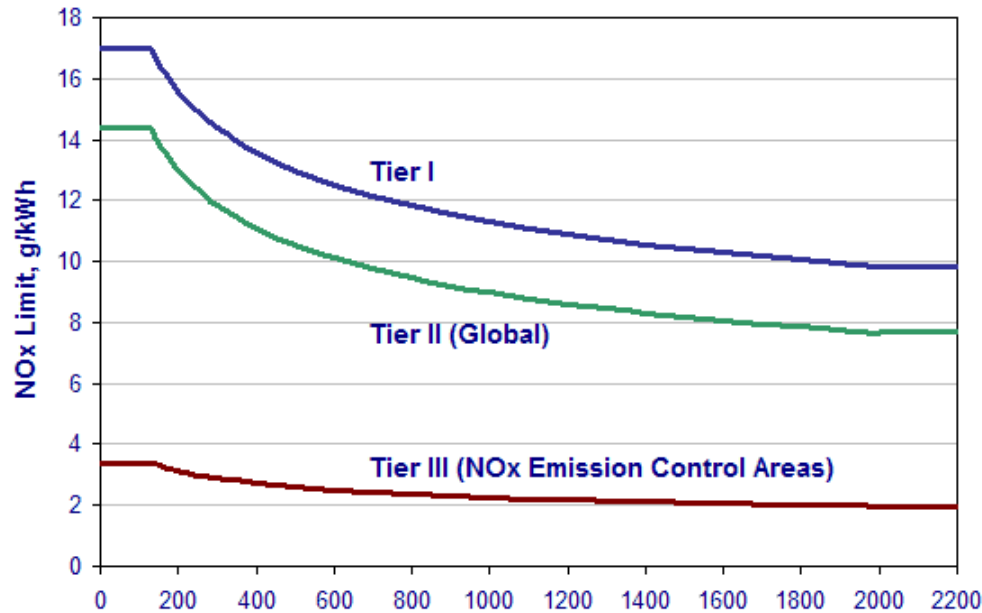
HELCOM working on issue.
 EC and EU Council pushing,
 member states split

Submission to MEPC67?

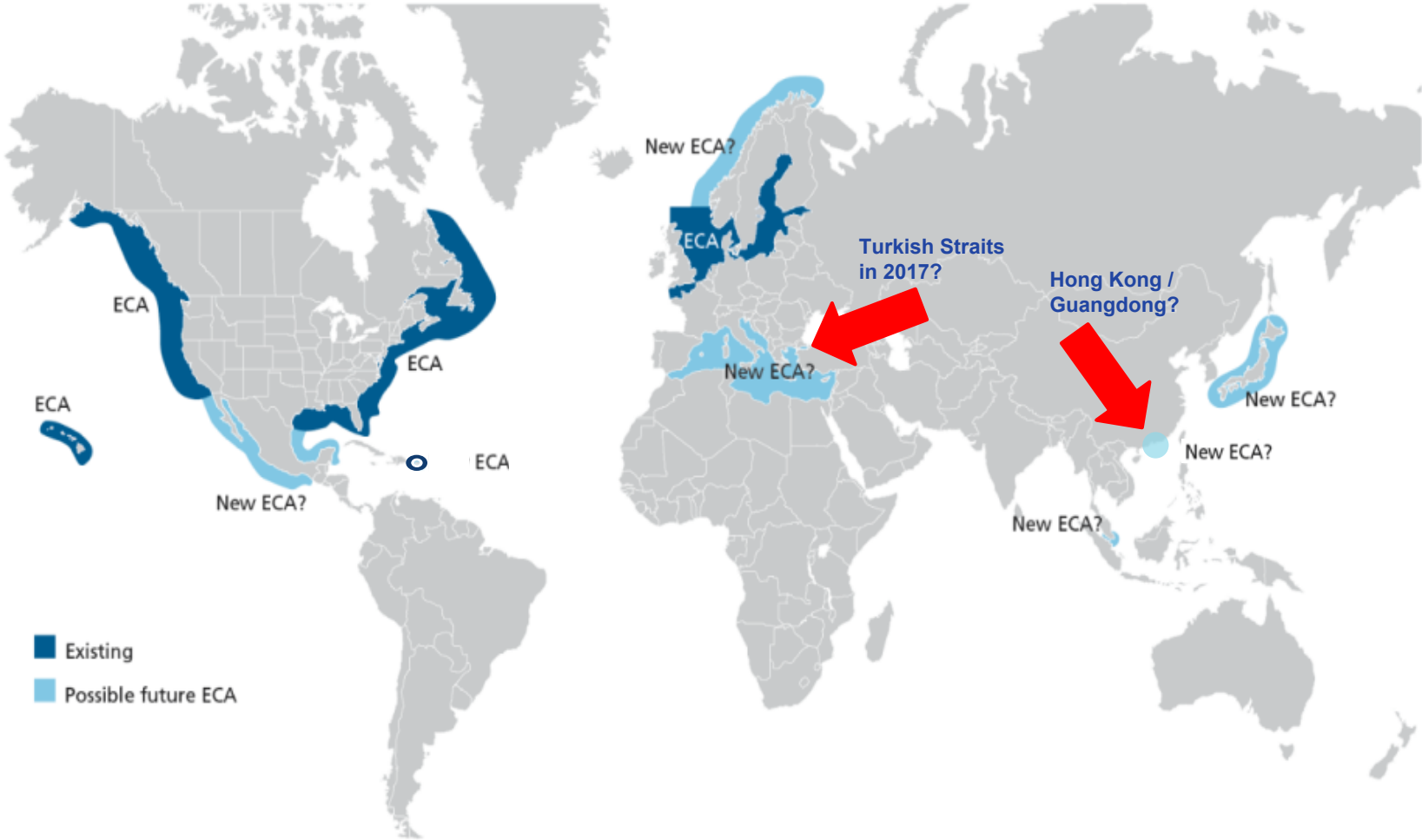
NECA – North Sea

Consultations on-going but
 slow moving – must be seen
 in conjunction with Baltic
 NECA activities

Submission date uncertain



New ECAs – fact or fiction?



CO₂

GHG policy status

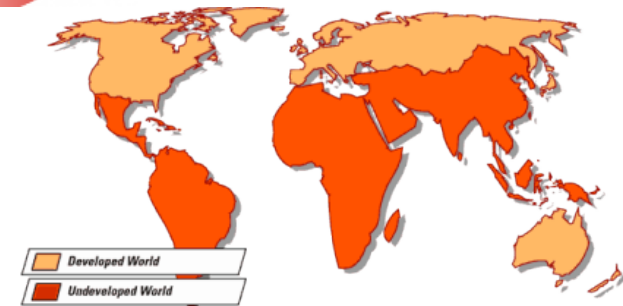
IMO - EEDI and SEEMP key instruments while MBM is dead in the water. Increasing activity on emission Monitoring, Reporting and Verification (MRV)

US - Work on efficiency standards expected to remain key US focus area; MRV key component

EU - Focus shifted from regional MBM to regional MRV; regulation in the pipeline

UNFCCC – Working on global climate deal by 2015 with 2020 as effective target date; outcome remains uncertain

Developing countries - Expected to remain opposed to MRV, but positions may be softening. UNFCCC principles remain a key concern





EU Monitoring, Reporting and Verification scheme

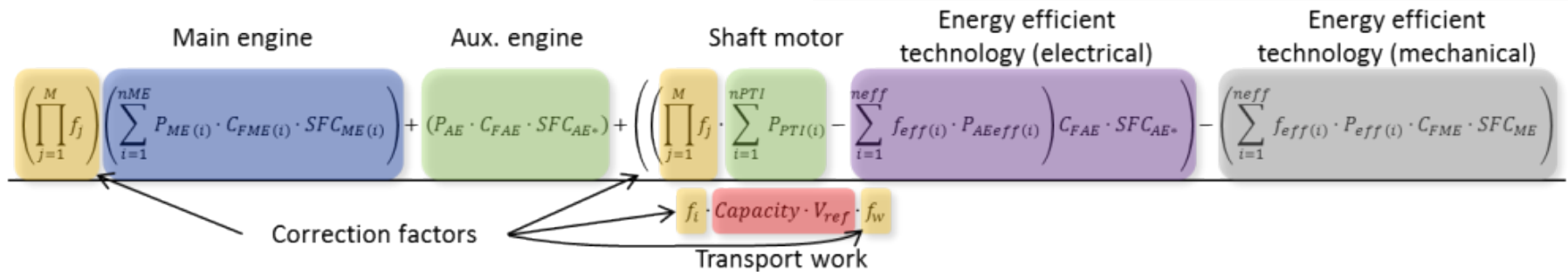
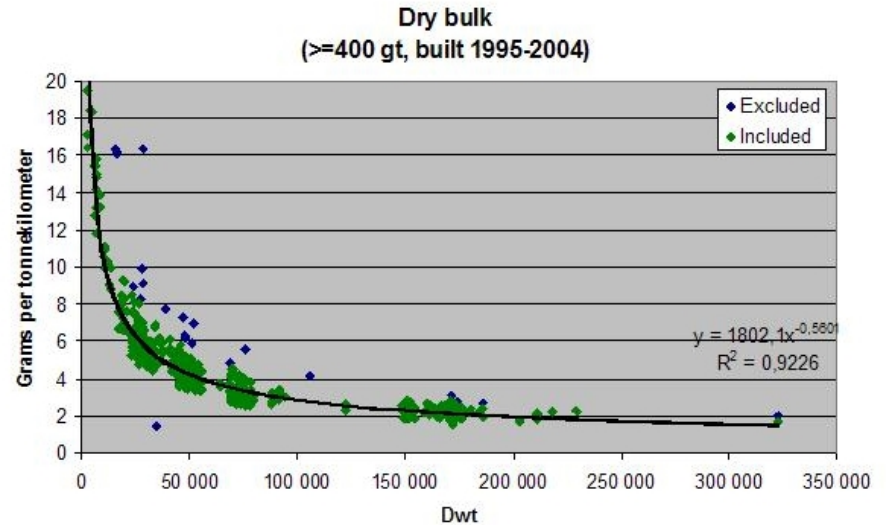
- Ships above 5000 GT (all flags) have to report CO2 emission on voyages to, from and between EU ports
- Regulation expected in effect January 1 2018
- Four methods
 - a. Bunker Fuel Delivery Note (BDN) and periodic stocktakes of fuel tanks;
 - b. Bunker fuel tank monitoring on board;
 - c. Flow meters for applicable combustion processes;
 - d. Direct emissions measurements
- Has to be negotiated and approved with EU Council and Parliament (2014 likely)
- EU sees this as a step toward a global system and further reduction requirements for shipping



The Energy Efficiency Design Index (EEDI)

- An international “mileage standard” for ships – similar to cars...

$$\text{Attained design } CO_2 \text{ index} = \frac{\text{Environmental cost}}{\text{Benefit for society}}$$



- Entered into force Jan 1 2013, further development on-going
- Industry focused on implementation

EEDI – new phases driving ship design changes

Reduction factors (in percentage) for the EEDI relative to the reference line for each ship type.

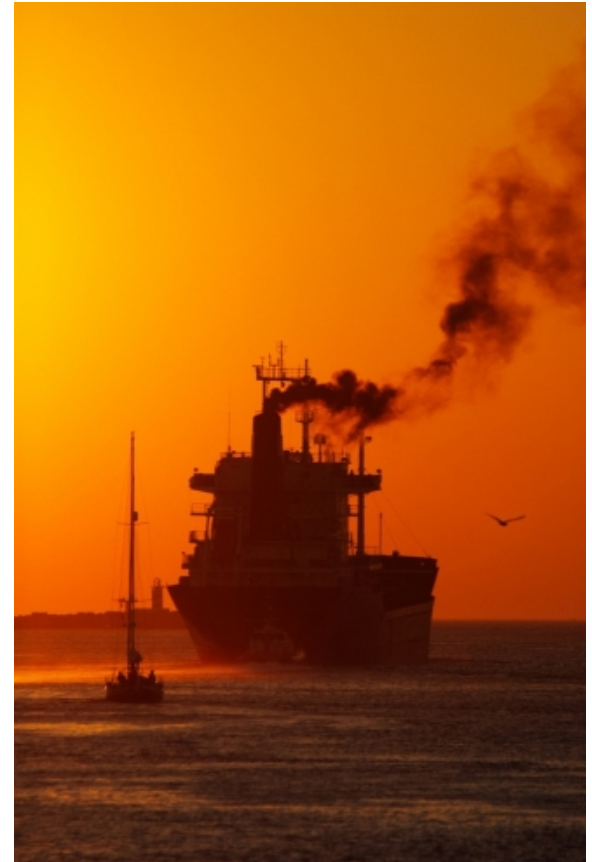
	Size	Phase 0 1 Jan 2013 – 31 Dec 2014	Phase 1 1 Jan 2015 – 31 Dec 2019	Phase 2 1 Jan 2020 – 31 Dec 2024	Phase 3 1 Jan 2025 onwards
Bulk Carriers	>20,000 Dwt	0%	10%	20%	30%
	10-20,000 Dwt	n/a	0-10%*	0-20%*	0-30%*
Gas tankers	>10,000 Dwt	0%	10%	20%	30%
	2-10,000 Dwt	n/a	0-10%*	0-20%*	0-30%*
Tanker and combination carriers	>20,000 Dwt	0%	10%	20%	30%
	4-20,000 Dwt	n/a	0-10%*	0-20%*	0-30%*
Container ships	>15,000 Dwt	0%	10%	20%	30%
	10-15,000 Dwt	n/a	0-10%*	0-20%*	0-30%*
General Cargo ships	>15,000 Dwt	0%	10%	15%	30%
	3-15,000 Dwt	n/a	0-10%*	0-15%*	0-30%*
Refrigerated cargo carriers	>5,000 Dwt	0%	10%	15%	30%
	3-5,000 Dwt	n/a	0-10%*	0-15%*	0-30%*

* The reduction factor is to be linearly interpolated between the two values depending on the vessel size. The lower value of the reduction factor is to be applied to the smaller ship size.

- Schedule and/or levels may change subject to IMO reviews in 2015 and 2022

Regulations summary – air emissions

1. SO_x ECA requirements will remain unchanged though global 0.5% likely delayed until 2025 – but note EU waters in 2020
2. Limited near-term spread of new ECAs, prime candidates are Bosphorus / Marmara & Hong Kong / Guangdong
3. NO_x ECA requirements may be postponed until 2021, but more likely that 2016 date will be retained for the North America ECA
4. NO_x NECA expansion to include North Sea and Baltic Sea likely this decade
5. CO₂ MRV for the EU likely this decade, may possibly be superseded by IMO MRV
6. CO₂ pricing in the 2020's at the earliest





DRIVERS AND TRENDS

REGULATORY UPDATE

RESPONSE OPTIONS

BEYOND 2020

SOx: 3 options on the table

1 LNG as fuel



2 HFO + Scrubbers for exhaust gas cleaning

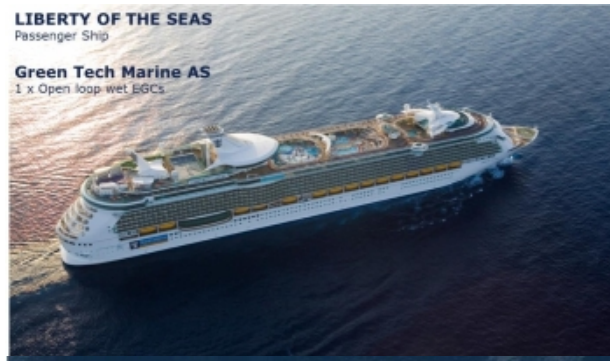
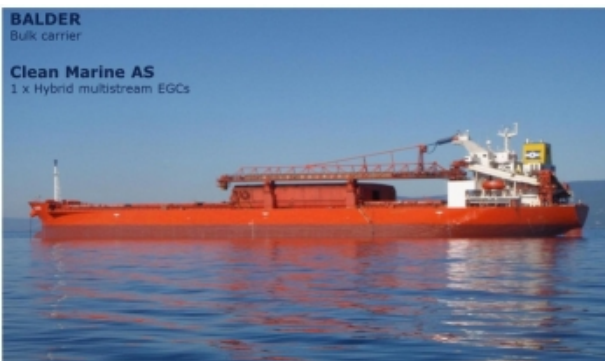


3 HFO + change over to low-sulphur fuel in ECA



Scrubber systems – maturing and scaling

>44 SOx Exhaust Gas Cleaning systems on 20 DNV classed ships and NB projects



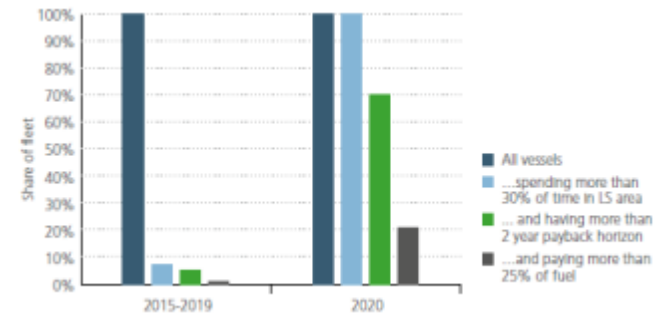
Shipping 2020 on scrubbers...



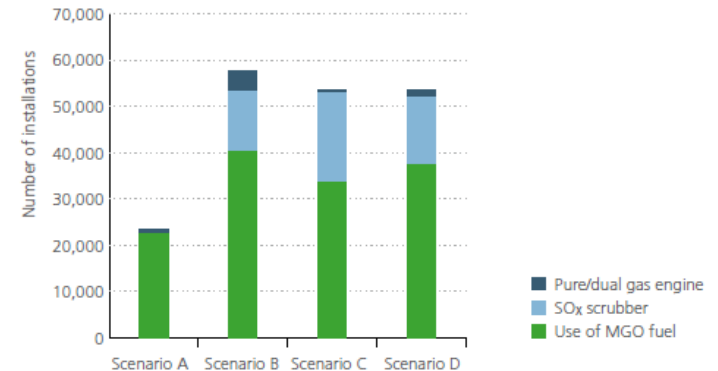
Scrubbers are a globally significant option after 2020

- Ships need to spend more than the 30% of their time in an ECA to justify a scrubber before 2020
- In 2020, assuming a global sulphur requirements, scrubbers become a globally significant solution
 - Scrubbers can be retrofitted and can take 25% of the market, 15-20,000 ship
 - Still, 70% of ships will run on distillates
 - In the short term LNG can only take a small part of the market
- Uncertainty about the 2020 limit will slow technology development and uptake

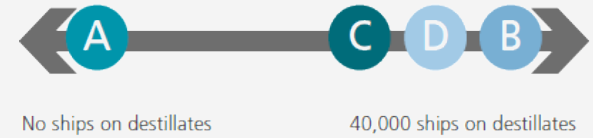
Ship owner investment profile



SOx reduction options in 2020

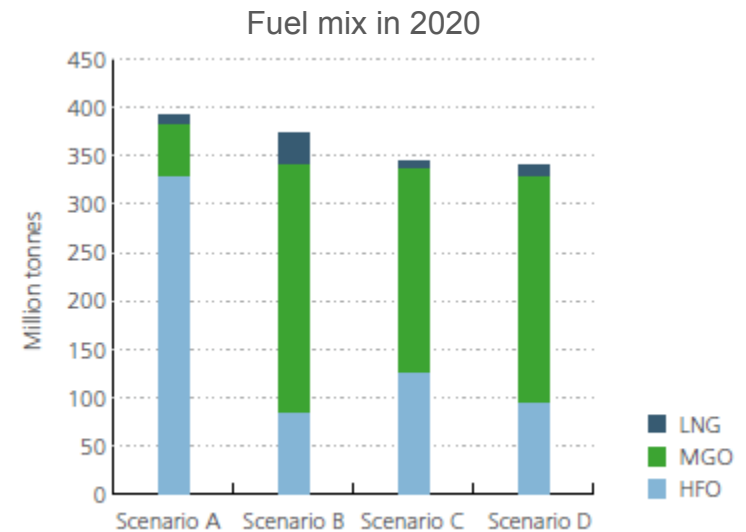


Shipping 2020 on fuel availability



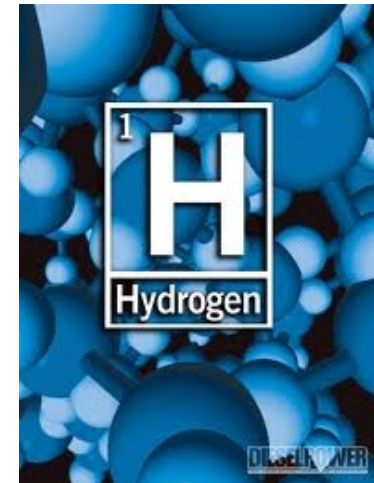
In 2020, the demand for marine distillates could be as high as 200-250 million tonnes annually

- A 0.1% limit in ECAs (2015) is expected to increase the demand to 45 million tonnes from the current 30 million tonnes
- With a global 0.5% sulphur limit HFO demand may drop from 300-350 million tonnes to only 80-110 million tonnes in 2020
 - Depends on the number of scrubbers in use
 - The use of LNG will not significantly impact the demand of other fuels
 - Energy efficiency measure will only slow the fuel demand in the short term



Fuel options?

- Heavy Fuel Oil (with exhaust cleaning)
- Distillate fuel oils
- LNG
- CNG
- LPG
- GTL
- Methanol
- Biofuels / biogas and alcohols
- Hydrogen (as energy carrier)
- Batteries (as energy carrier)
- Nuclear

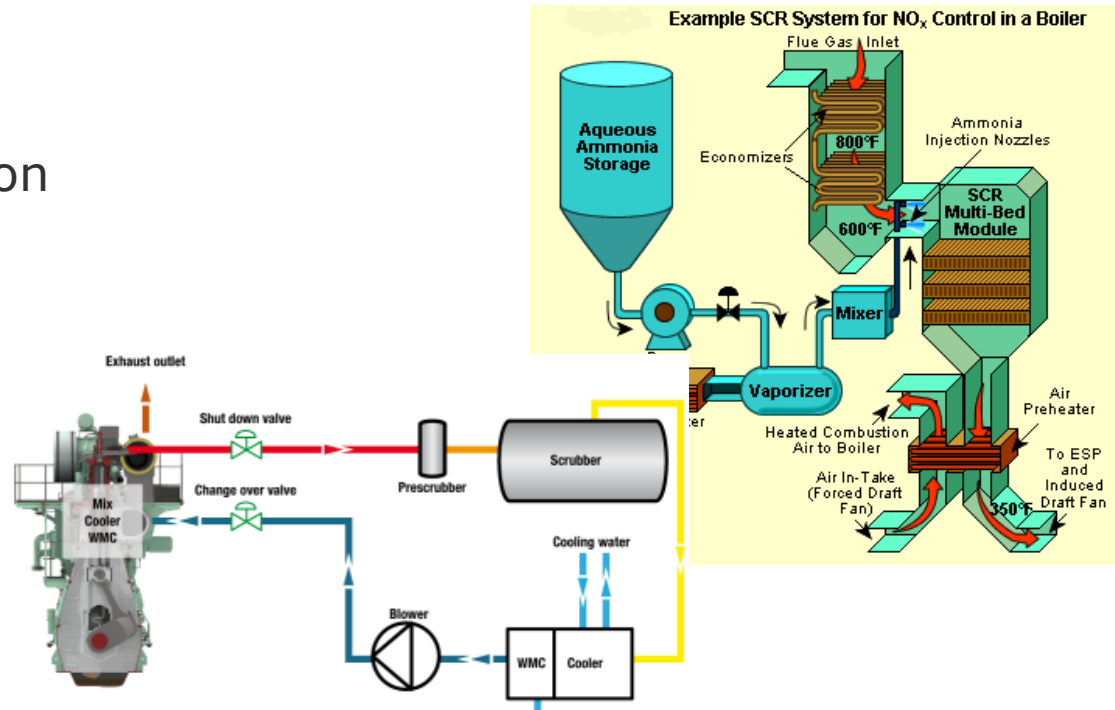


And don't forget the NO_x decision...

1 Selective catalytic reduction

2 Exhaust gas recirculation

3 LNG as fuel





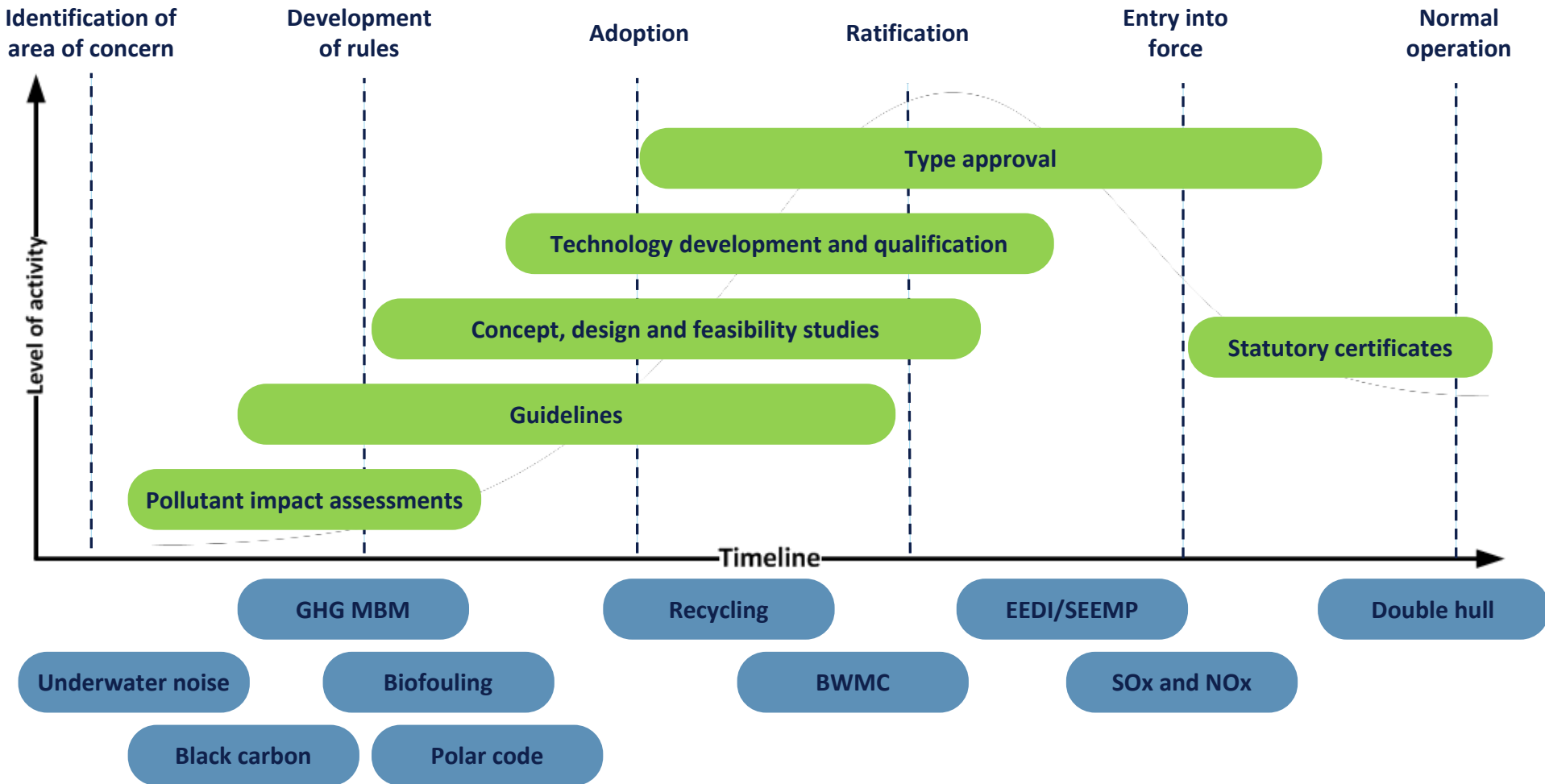
DRIVERS AND TRENDS

REGULATORY UPDATE

RESPONSE OPTIONS

BEYOND 2020

Typical development of regulation



Biofouling

- Research indicates that biofouling continues to be a significant mechanism for species transfer by vessels
- The anti-fouling Convention and the BWM Convention do not directly address the problem
- Draft guidelines for the control and management of ships' biofouling agreed by BLG in 2011
 - Evaluation of guidelines on-going in BLG
- Biofouling addressed in USCG rule on ballast water, also in EPA VGP
- EU working on invasive species regulation
- IMO regulation likely towards end of decade, in force some years later



Black carbon

- Black carbon (soot) is *"a strongly light-absorbing carbonaceous aerosol produced by incomplete combustion of fuel oil"*
 - Latest studies show larger global warming potential than previously thought
 - In Arctic, BC also accelerates ice melting
- IMO BLG working on definition of black carbon, measurement methods, and appropriate control measures in the Arctic
 - US-led correspondence group submitted report for BLG and PPR (Feb. '13 & Feb. '14)
 - Little consensus, discussion will continue
- IMO regulation possibly in place towards end of decade, in force some years later



Underwater noise

- The USA raised the issue in MEPC58 in 2008:
 - *"The introduction of human-produced noise into the marine environment and its potential adverse impacts on marine life is a matter of increasing concern."*
 - Propeller cavitation and machinery are the primary sources of noise from ships
- The US has a 10 knot speed limit in certain areas
- IMO has put the issue on the agenda
 - US-led DE correspondence group established
 - Draft guidelines submitted for DE57 (March '13)
- IMO regulatory proposals towards end of decade at earliest, in force some years later



Regulations on the horizon

- Hull bio-fouling
- **Particles, “Black Carbon”**
- Underwater noise

- And if considering Arctic operations keep an eye on IMO Polar Code developments...



