Market based measures (MBMs) for greenhouse gases (GHGs)

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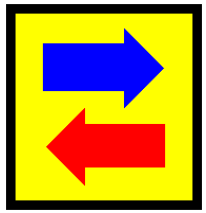


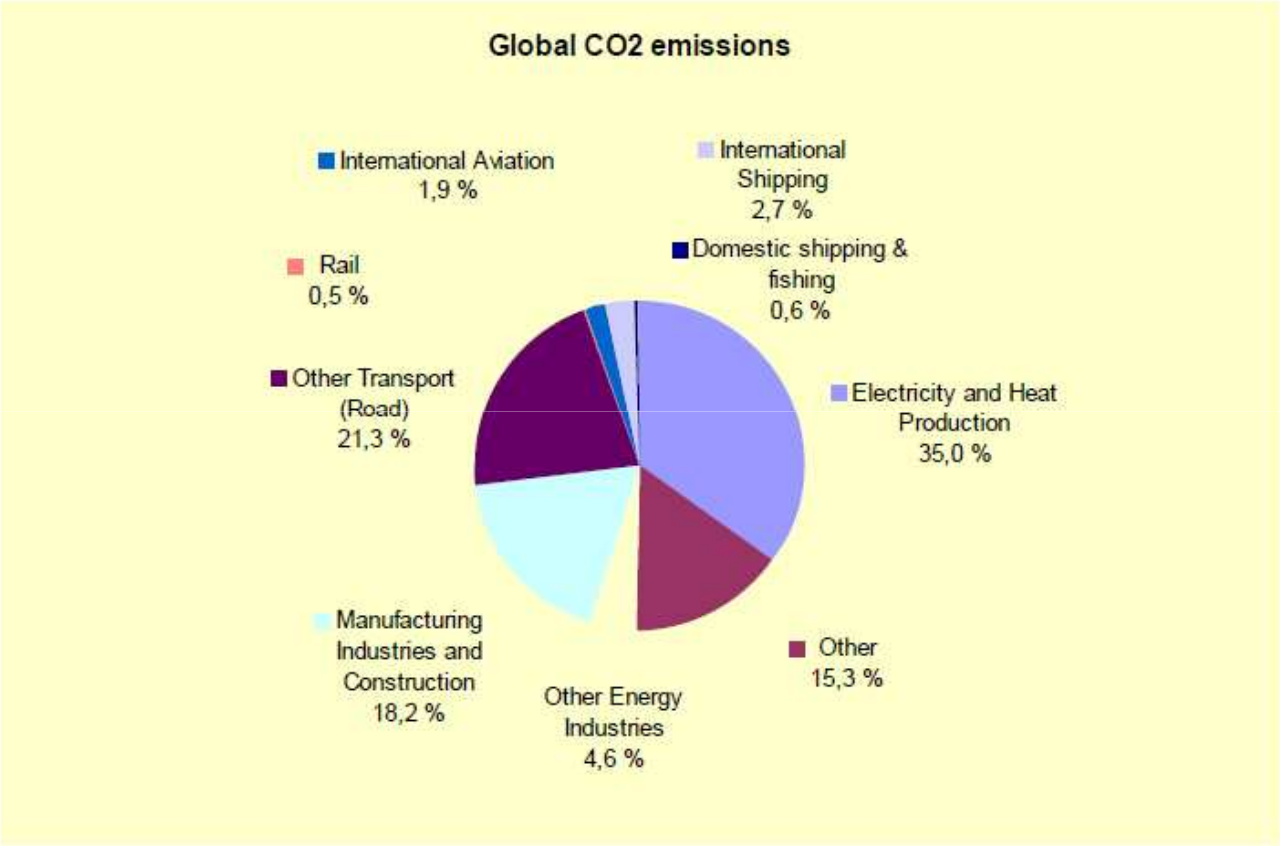
Outline

- Some background
- Proposals to IMO on MBMs
- Discussion

Types of emissions

- Green House Gases-GHGs (mainly CO_2, but also CH_4 , N_2O and others)
- Non-GHG (mainly SO_2, but also NO_x and others)
- P.M., etc

Share of global CO_2 emissions



Emissions of CO_2 from shipping compared with global total emissions for 2007 (Source: Second IMO GHG Study 2009)

Comparison among modes

(source: IMO GHG study 2009)

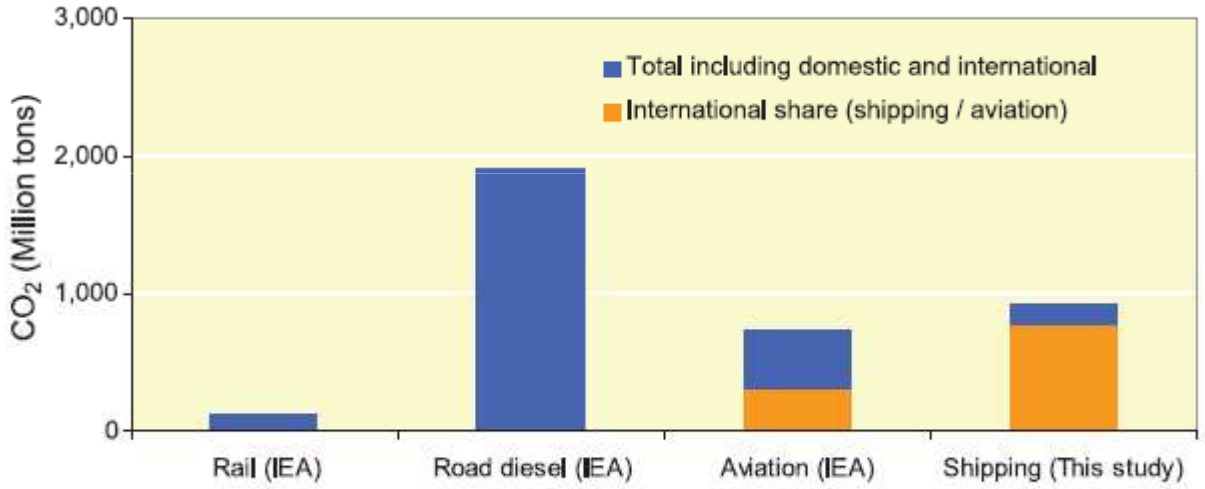


Figure 9.6 *Emissions of CO_2 in 2005 from shipping compared to other transport modes*

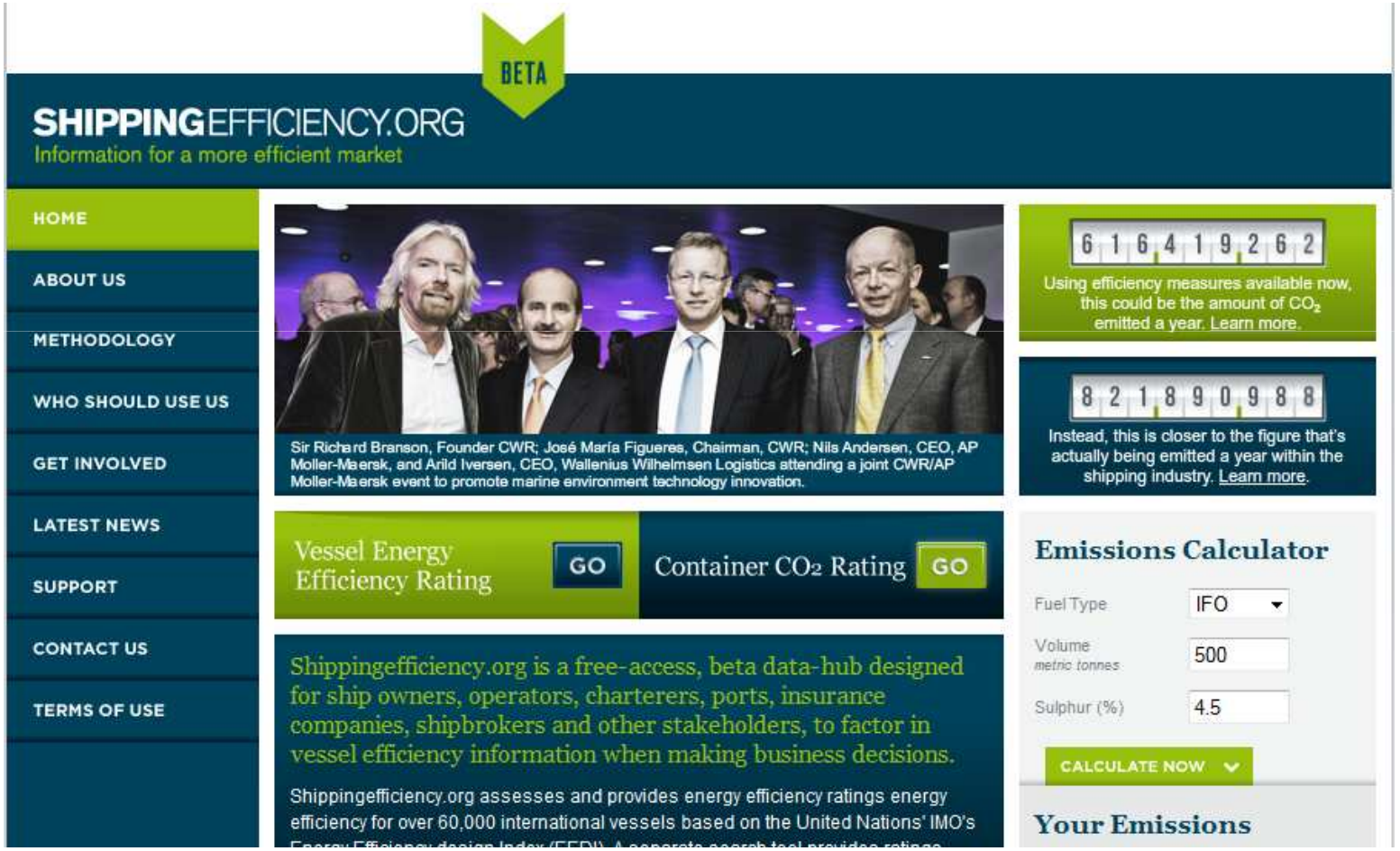
Kyoto Protocol

- United Nations Framework Convention on Climate Change -UNFCCC (1997)
- COP-15 Copenhagen 2009 (a big failure)
- COP-16 Cancun 2010 (??)
- Urgent measures to reduce CO_2 emissions are necessary to curb the projected growth of GHGs worldwide
- Shipping thus far escaped being included in the Kyoto global emissions reduction target for CO_2 and other GHGs
- Road: Fleet average reduction targets (CO_2/km)
- Aviation: EU ETS
- Shipping: so far regulation only for SO_2, NOx

Era of GHG non-regulation in shipping:

- Rapidly approaching its end!
- Measures to curb future CO2 growth are being sought with a high sense of urgency.
- As CO2 is the most prevalent of these GHGs, any set of measures to reduce the latter should primarily focus on CO2.

Shipping under pressure



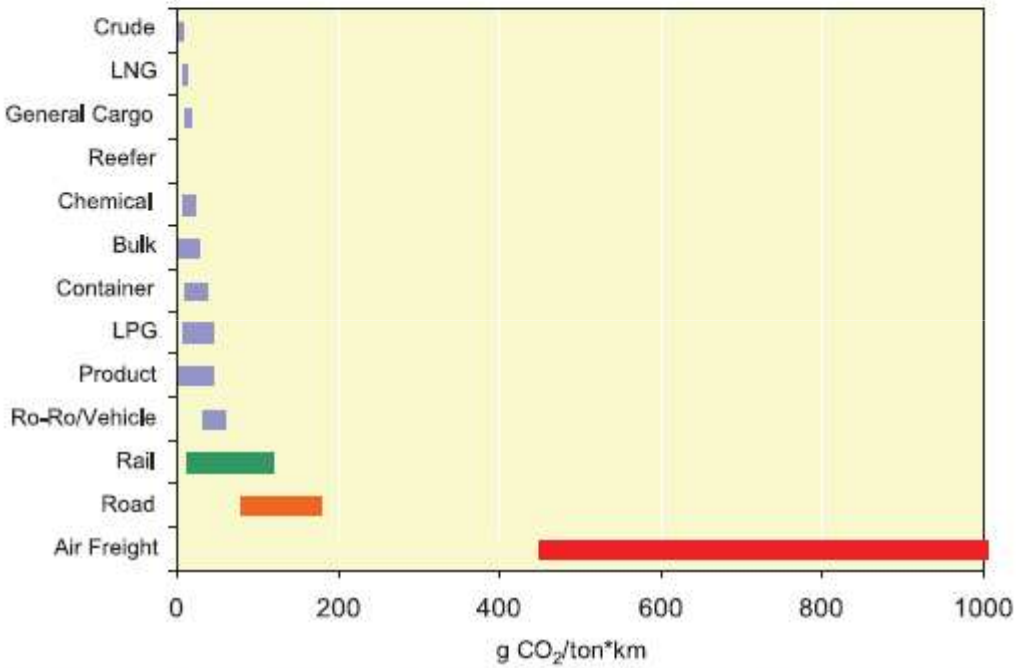


Figure 9.3 *Typical range of ship CO_2 efficiencies compared to rail, road and air freight*

Measures contemplated

- Technological
  - More efficient (energy-saving) engines
  - More efficient ship designs
  - More efficient propellers
  - Cleaner fuels (low sulphur content)
  - Alternative fuels (fuel cells, biofuels, etc)
  - Devices to trap exhaust emissions (scrubbers, etc)
  - Energy recuperation devices
  - “Cold ironing” in ports
- Logistics-based (operational)
  - Speed reduction
  - Optimized routing
  - Several others
- Market-based
  - Emissions Trading Scheme (ETS)
  - Carbon Tax/Levy on Fuel
  - Several others


SkySails

What an MBM can do

- May induce ship owners to adopt measures that will reduce CO2 emissions
- May also collect money to be used to reduce CO2 emissions outside the marine sector
- May use part of the money to support LDCs and R&D

Example

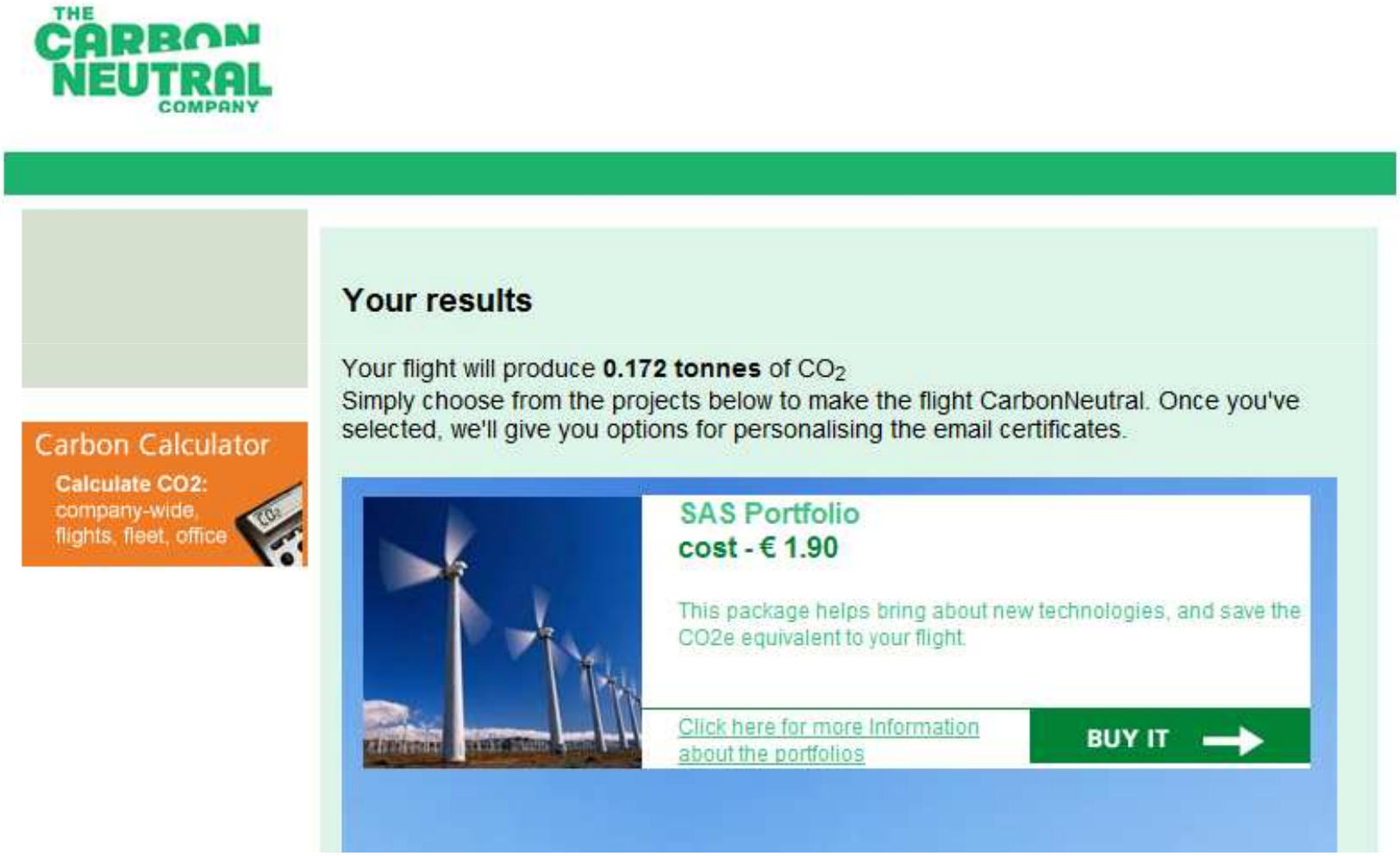
- Impose a levy (or tax) on bunkers
- May induce shipowners to slow steam
- CO2 is a non-linear function of speed
- Slow steaming would reduce CO2 emissions, even if ships are added to replace reduced throughput capacity

Example #2

- MBM may induce shipowners to purchase ships that are more energy efficient (better engines, propellers, hulls, etc)
- They would invest in these technologies that would save CO2, rather than pay for the MBM

  (equivalent: buying a hybrid car)

Example #3: offsetting



Laboratory for Maritime Transport | SHIP EMISSIONS - LABORATORY F...

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LABORATORY FOR MARITIME TRANSPORT

Ship Emissions Calculator

VESSEL DETAILS

SELECT SHIP TYPE	Dry Bulk Carrier	SELECT SHIP SIZE	Handysize BC	Slow Speed Eni	
ROUTE	Tubarao-Rotterdam	TRIP DISTANCE	4974 nm	9232 km	
PAYLOAD (tonnes)	25000	DWT (tonnes)	27000		

OPERATIONAL DETAILS

STATE	TIME (days)	SPEED (knots)	FUEL OIL S %	FUEL OIL Consumption (tonnes/day)	DIESEL OIL S %	DIESEL OIL Consumption (tonnes/day)
SEA LADEN	15.94	13	3.5	24	1.5	0
SEA BALLAST	15.94	13	3.5	24	1.5	0
PORT (loading,discharging)	4		3.5	4.5	1.5	0

EMISSIONS

	CO2	SO2	NOx
ROUNDTRIP EMISSIONS KG PER tonne TRANSPORTED	99.31	2.19	2.73
ROUNDTRIP EMISSIONS GRAMS PER LADEN tonne-MILE	19.97	0.44	0.55
ROUNDTRIP EMISSIONS GRAMS PER LADEN tonne-KM	10.76	0.24	0.30

SHOW/HIDE DETAILED RESULTS | CALCULATE | HELP | ABOUT

DETAILED RESULTS

TOTAL BALLAST-LADEN DISTANCE		nm	9,948.00				
LADEN tonne-MILES		tonne*nm	124,350,000.00				
TIME IN PORT		days	4.00				
TRIP DURATION	SEA-LADEN	days	15.94	EMISSIONS			
TRIP DURATION	SEA-BALLAST	days	15.94	CO2	SO2	NOx	
TOTAL RTRIP DURATION		days	35.88	tonnes	tonnes	tonnes	
CONSUMPTION FO	SEA LADEN	tonnes	382.62	1,212.89	26.78	33.29	
CONSUMPTION DO		tonnes	0.00	0.00	0.00	0.00	

Emissions 101

- Q: If we burn a ton of fossil fuel (Heavy fuel oil, diesel, or other), how much CO2 is generated?

- A: Between 3.02 and 3.11 tons, depending on the fuel

Emissions 101b: how much CO2 is produced by international shipping?

- Problem: Even estimates of past marine fuel sales are impossible to make
- Most global emissions estimates are based on **modelling** (even of past emissions)

GHG marine emissions estimates

- IMO latest update of GHG study (2009)

Table 1.1 *Summary of GHG emissions from shipping* during 2007*

	International shipping (million tonnes)	Total shipping	
		million tonnes	CO_2 equivalent
CO_2	870	1050	1050
CH_4	Not determined*	0.24	6
N_2O	0.02	0.03	9
HFC	Not determined*	0.0004	≤6

* A split into domestic and international emissions is not possible.

IMO GHG study 2009

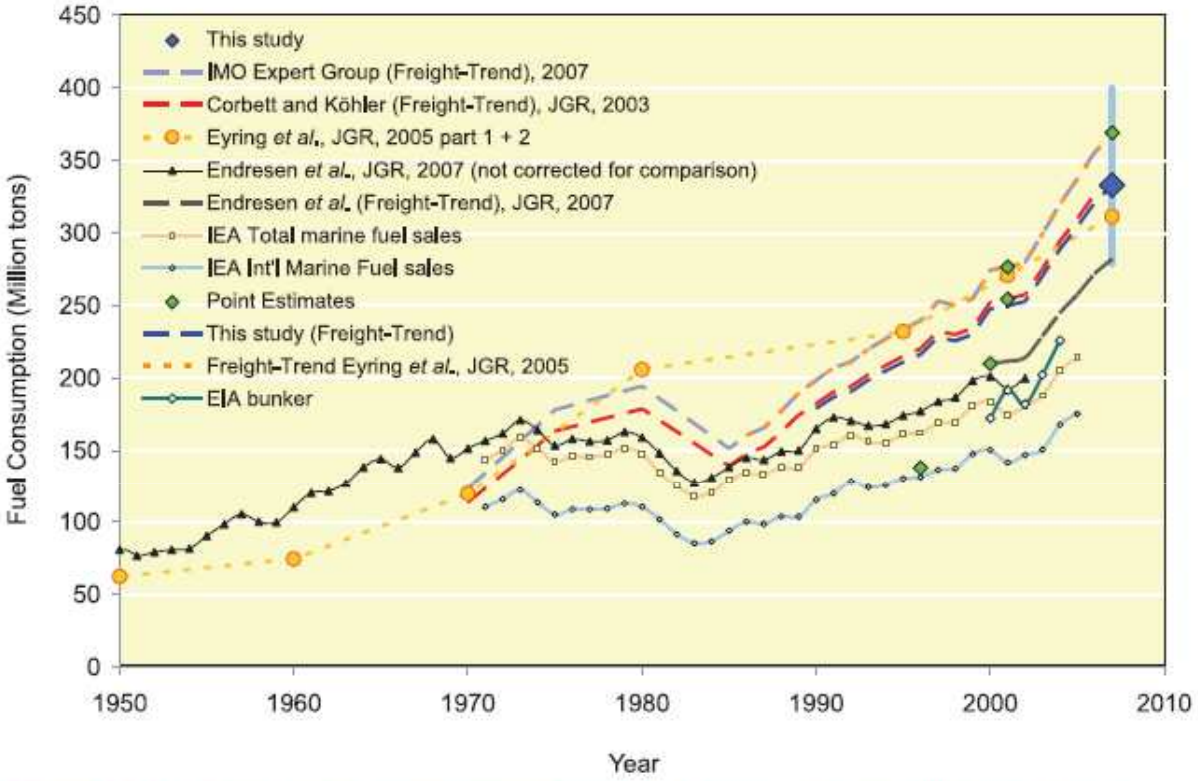


Figure A1.4 *World fleet fuel consumption (except naval vessels) from different activity-based estimates and statistics. Symbols indicate the original estimates for individual years and the solid lines show the original estimates of trend. Dashed lines show the backcast and forecast, calculated from the time evolution of freight tonne-miles with the point estimates. The blue square shows the activity-based estimate from this study and the blue range bar indicates the high and low bound estimates*

Future projections

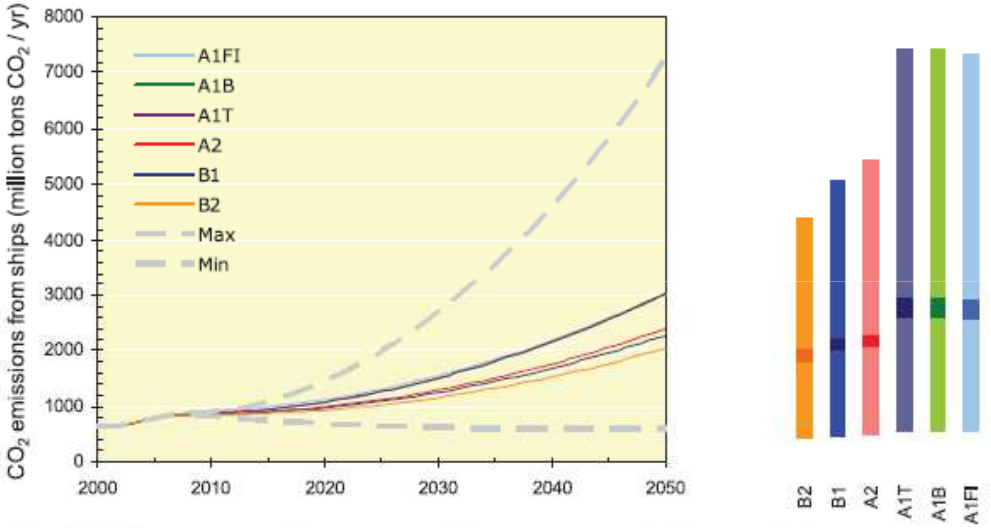
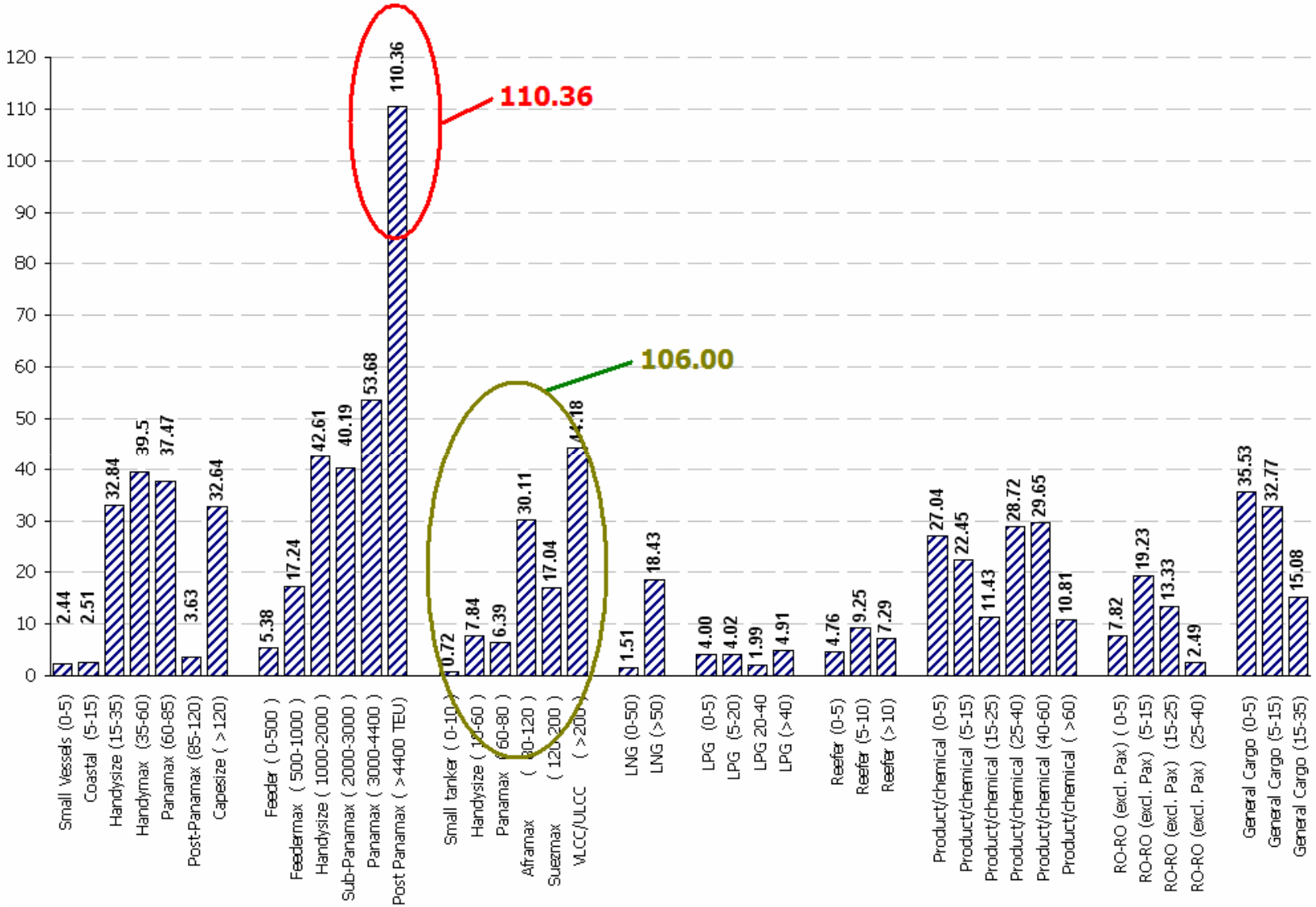


Figure 1.2 *Trajectories of the emissions from international shipping. Columns on the right-hand side indicate the range of results for the scenarios within individual families of scenario.*

- A scale of 10:1 between worst case and best case!

CO2 emissions per vessel category (million tonnes)



Energy Efficiency Design Index (EEDI): NOT an MBM!

- Defined as

$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}*\right) + \left(\left(\prod_{j=1}^{M} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}\right)}{f_i \cdot Capacity \cdot V_{ref} \cdot f_w}$$

- Ratio of installed power divided by (capacity* speed) [gr CO2/ton-mile]

EEDI contd

- Mandatory for newbuildings
- Will have to have: EEDI ≤ EEDI ref. line
- Ref. line = f (ship type, DWT)
- Ref. line more stringent in future years

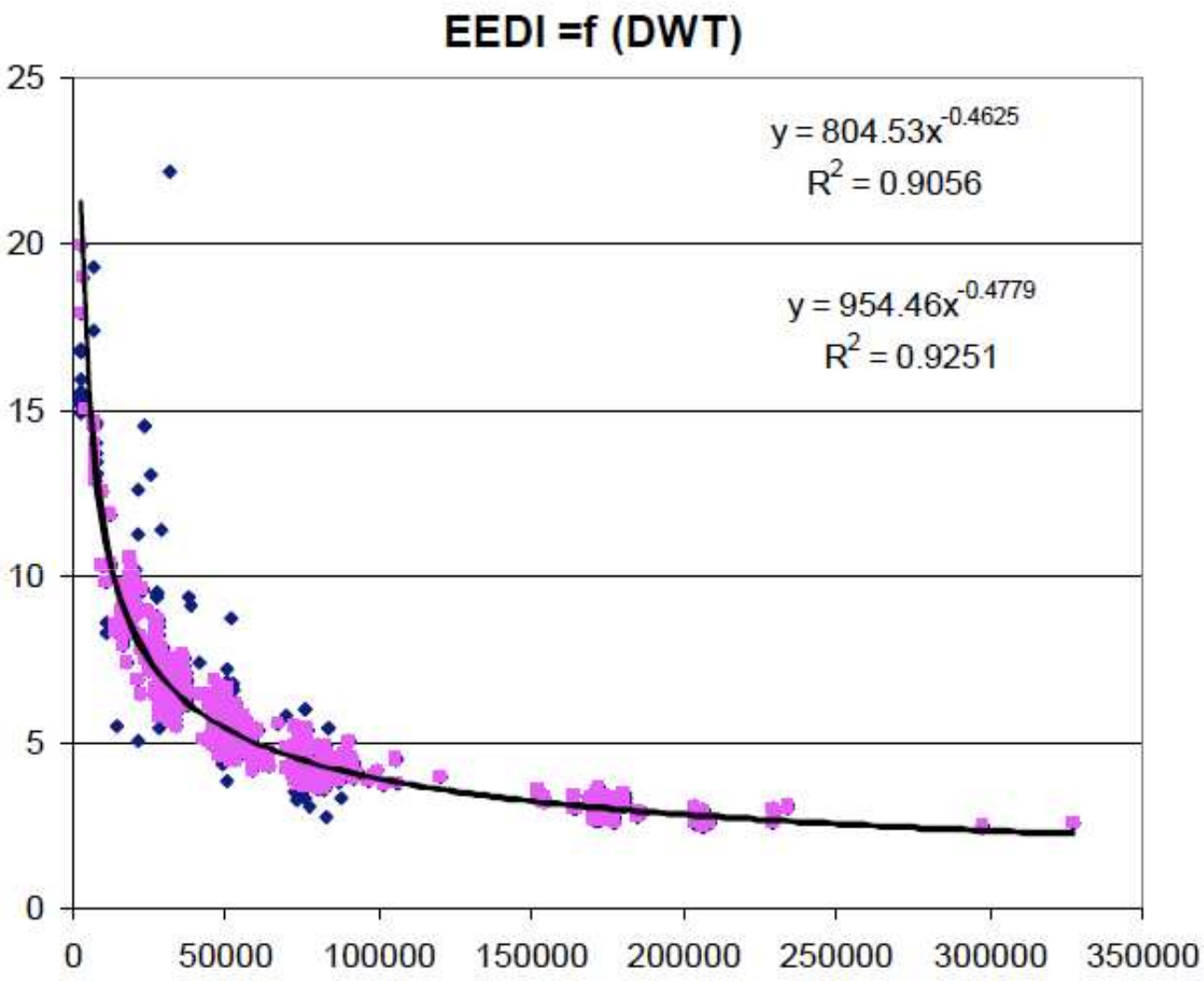


Figure 1: Dry bulk carriers
All data: 2,259 ships. Without outliers (shown in blue ◆): 2,218 ships

Concerns

- To reach required EEDI would mandate reducing design speed
- This would lead to underpowered ships, with negative implications on safety
- Market effects & fuel price neglected
- CO2 reductions marginal or even negative
- It could also lead to modal shifts

MEPC 61: status

- Big division among developing and developed countries
- Developing countries: EEDI should not be mandatory for them
- Draft regulations circulated, for adoption at MEPC 62 (July 2011)
- Not even consensus to circulate!

Market Based Measures

- 11 MBM proposals at MEPC 60 (March 2010)
- Expert Group formed by Sec. General
- Feasibility study
- Work: May- August 2010
- Report presented at MEPC 61 (Sep. 2010)

Spot the speaker

?

9 Criteria for evaluation

.1 Environmental effectiveness

.2 Cost-effectiveness and potential impact on trade and sustainable development

.3 The potential to provide incentives to technological change and innovation

.4 Practical feasibility of implementing MBM

.5 The need for technology transfer to and capacity building within developing countries, in particular the least developed countries (LDCs) and the small island development states (SIDS)

9 criteria cont'd

.6 The relation with other relevant conventions (UNFCCC, Kyoto Protocol and WTO) and the compatibility with customary international law

.7 The potential additional administrative burden and the legal aspects for National Administrations to implement and enforce MBM

.8 The potential additional workload, economic burden and operational impact for individual ships, the shipping industry and the maritime sector as a whole, of implementing MBM

.9 The compatibility with the existing enforcement and control provisions under the IMO legal framework.

MBM proposal groups

- International GHG Fund (Denmark et al) (LEVY)
- Emissions Trading Schemes (Norway, UK, France, Germany)
- Various hybrids, based on EEDI (Japan, USA, WSC)
- Port-based (Jamaica)
- Rebate mechanism (IUCN)
- Bahamas proposal

The 11 → 10 MBM proposals

- An International Fund for Greenhouse Gas emissions from ships (GHG Fund) proposed by **Cyprus, Denmark, the Marshall Islands, Nigeria and IPTA** (MEPC 60/4/8)
- Leveraged Incentive Scheme (LIS) to improve the energy efficiency of ships based on the International GHG Fund proposed by **Japan** (MEPC 60/4/37)
- Achieving reduction in greenhouse gas emissions from ships through port-State arrangements utilizing the ship traffic, energy and environment model, STEEM (PSL) proposed by **Jamaica** (MEPC 60/4/40)

MBM proposals cont'd

- The **United States** proposal to reduce greenhouse gas emissions from international shipping, the Ship Efficiency Credit Trading(SECT) (MEPC 60/4/12)
- Vessel Efficiency System (VES) proposed by **World Shipping Council** (MEPC 60/4/39)
- The Global Emission Trading System (ETS) for international shipping proposed by **Norway** (MEPC 60/4/22)
- Global Emissions Trading System (ETS) for international shipping proposed by the **United Kingdom** (MEPC 60/4/26)

MBM proposals cont'd

- Further elements for the development of an Emissions Trading System (ETS) for international shipping proposed by **France** (MEPC 60/4/41)
- Market-based Instruments: a penalty on trade and development proposed by **Bahamas** (MEPC 60/4/10)
- A Rebate Mechanism (RM) for a market-based instrument for international shipping proposed by **IUCN** (MEPC 60/4/55)

In-sector vs out-of-sector

- All proposals describe programs that would target GHG reductions through:
  - **In-sector** emissions reductions from shipping; or
  - **Out-of-sector** reductions through the collection of funds to be used for mitigation activities in other sectors that would contribute towards global reduction of GHG emissions

Bahamas' proposal

- (basically) do nothing
- Q: will do-nothing reduce emissions?
- A: YES!

Critical parameter: fuel price

- Much of the CO2 reduction will come because of measures that become cost-effective as fuel prices go up
- It is very likely that fuel prices will be much higher in the future
- Ship owners would implement these measures without being forced to do so

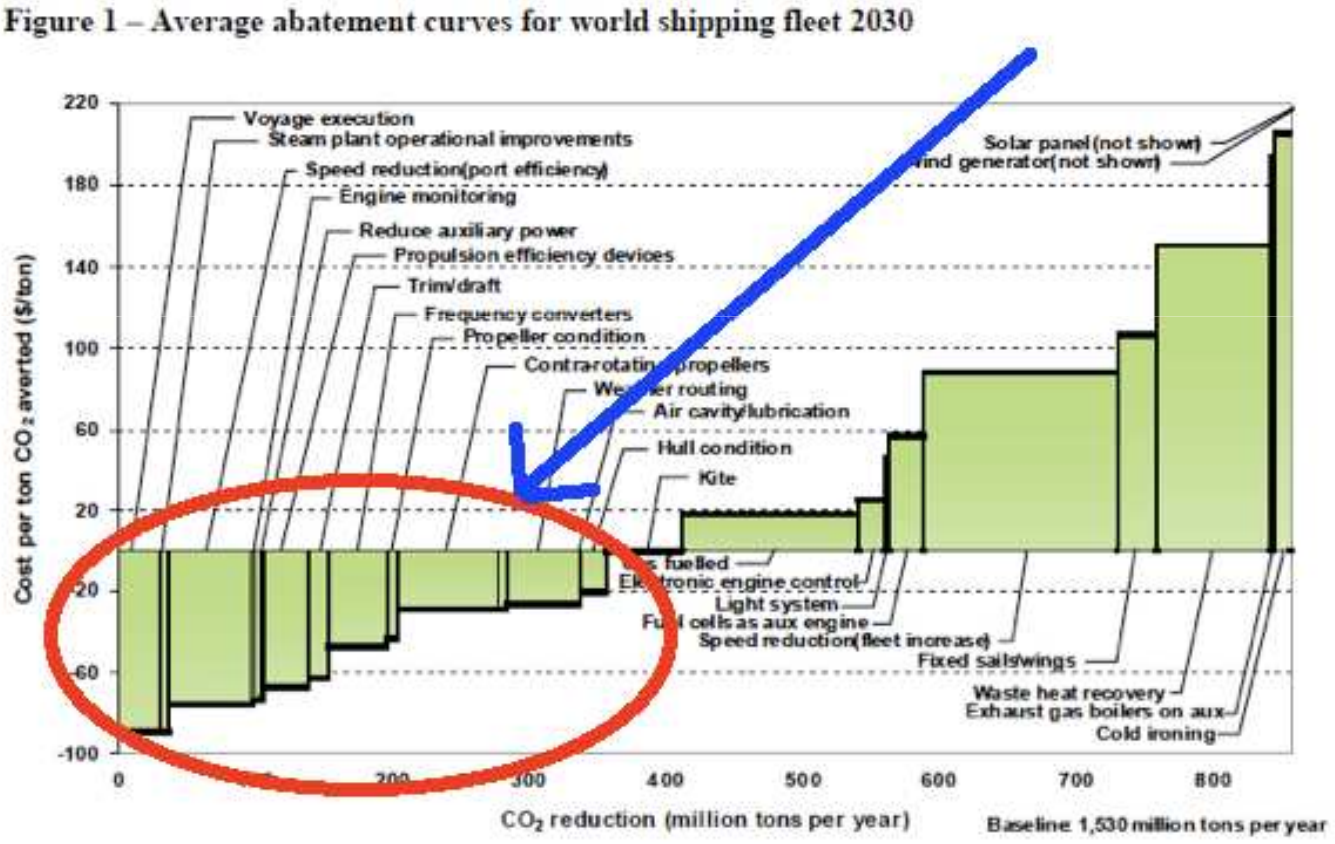
Marginal Abatement Cost (MAC): dollars per ton of CO2 averted

Let A be a CO2 abatement measure

- MAC(A) = ΔNCOST(A)/ΔCO2(A), where
  - ΔNCOST(A) = Net cost differential in implementing A
  - ΔCO2(A) = tons of CO2 averted by A
- ΔNCOST(A) = ΔGCOST(A)- ΔFUEL(A)*PFUEL, where
  - ΔGCOST(A) = Gross cost differential in implementing A
  - ΔFUEL(A) = Fuel consumption averted by implementing A
  - PFUEL = fuel price
- **MAC(A) = ΔGCOST(A)/ΔCO2(A) – PFUEL/F**
  - F = CO2 coef (between 3.02 and 3.11)

DNV's MAC curves

- MAC<0



Denmark's GHG Fund proposal

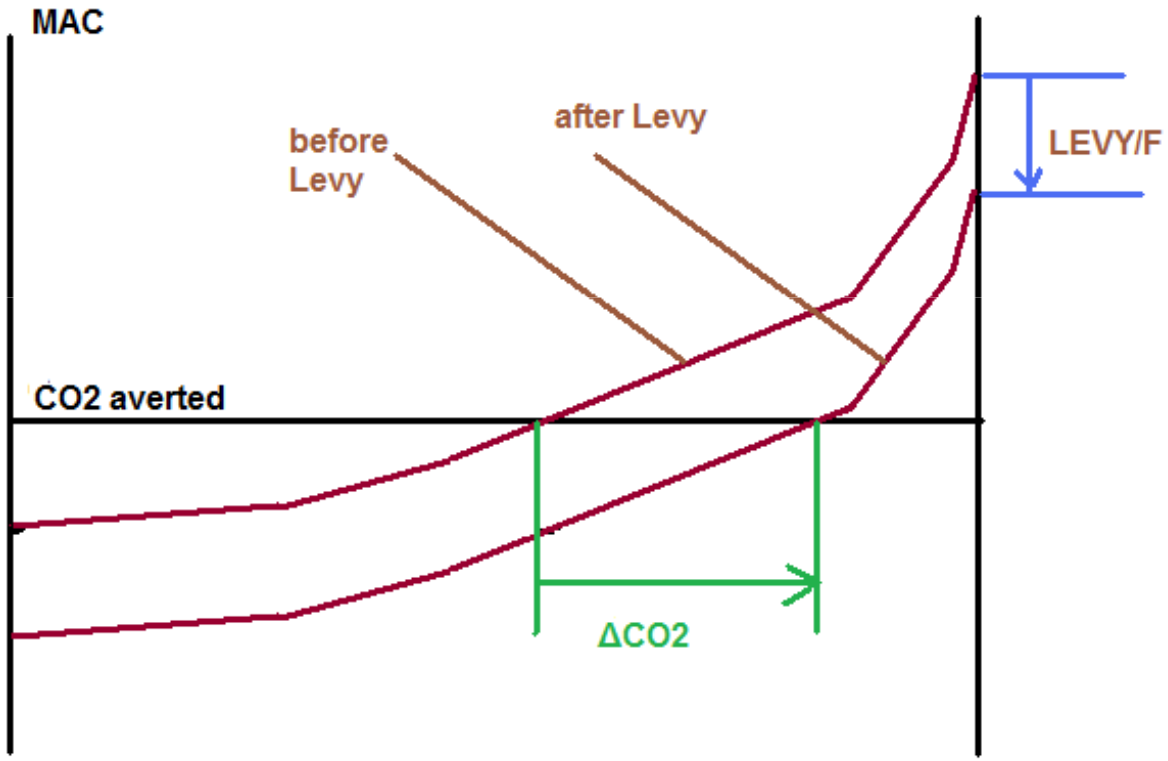
(+Cyprus, Nigeria, Marshall Islands & IPTA)

- Impose a Levy (or Tax) on bunker fuel (DK calls it "contribution")
- 2 options:
  - Option 1: collect by Bunker Supplier
  - Option 2: collect by Shipowner
- According to US CBO study, Levy is most efficient way to reduce emissions

Discussion

- Cost certainty: Investors respond better to a known price
- Administrative burden: lower than all other schemes (except Bahamas)
- Practical feasibility: reasonable (can be modeled after IOPCF)
- Can handle slow steaming automatically

Effect of Levy using MAC curves



Japan's LIS proposal

- Like GHG Fund, plus:
- Give some of the collected money to ships that have good EEDI or EEOI

Discussion

- Enjoys some of the good features of GHG Fund, but:
- Higher administrative costs than those of GHG Fund
- Carries with it all problems of EEDI
- Likely to benefit developed countries (like Japan) more

Problem with all “hybrid” schemes (MBM based on EEDI)

Two different but parallel mechanisms:

- New ships will be impacted in **two ways**, one direct (according to whatever provisions will be adopted as a result of the EEDI deliberations) and one indirect (via the provisions of the hybrid MBM proposal).
- Existing ships will be impacted in **one way**, indirectly, only via the provisions of the hybrid MBM proposal.

More..

- The deliberations to conclude EEDI (still ongoing) have no “reverse feedback” from the possible introduction of an MBM based on EEDI

IUCN's Rebate Mechanism proposal

- "Piggy back" concept
- Use any of the MBM proposals as basis*
- Give a rebate to developing countries according to their imports

*GHG Fund used as an example

Discussion

- Carries all the features of the MBM on which it relates
- Some benefits for developing countries
- Higher admin. costs

Norway's ETS proposal

(+UK, France, Germany)

- Cap-and-trade system
- Put a cap on emissions
- Auction and sell permits

- EU ETS: largest ETS market
- Claim: "100% reduction certainty"
- Full legal text available

Claim:100% Reduction certainty

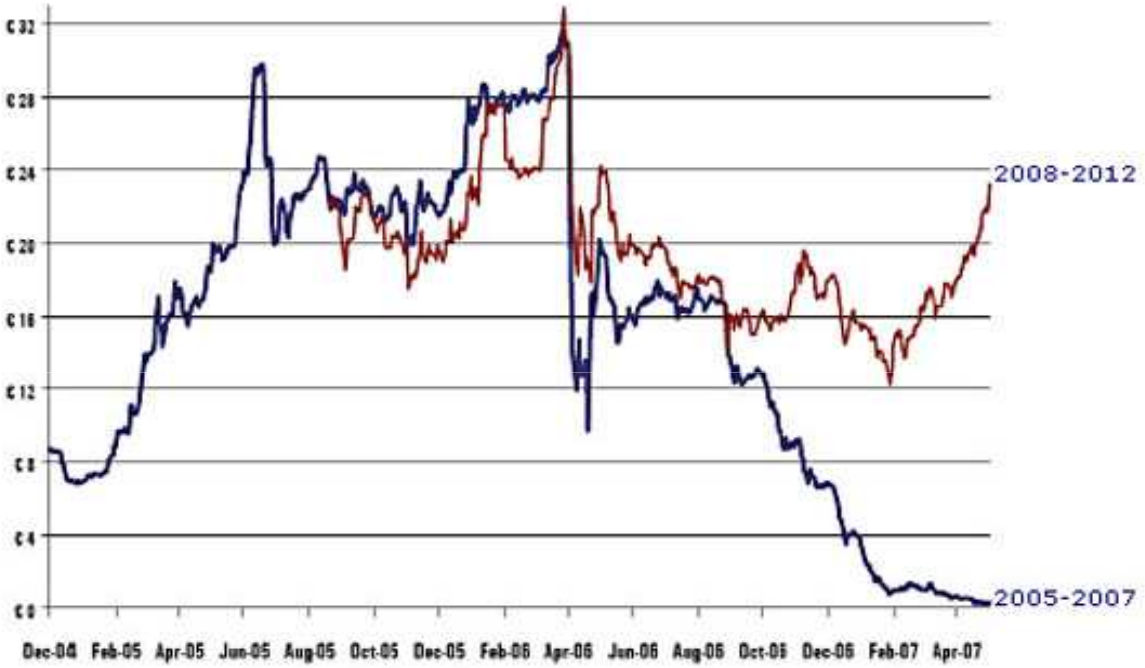
- Set a cap
- Only auction permits within that cap, no more

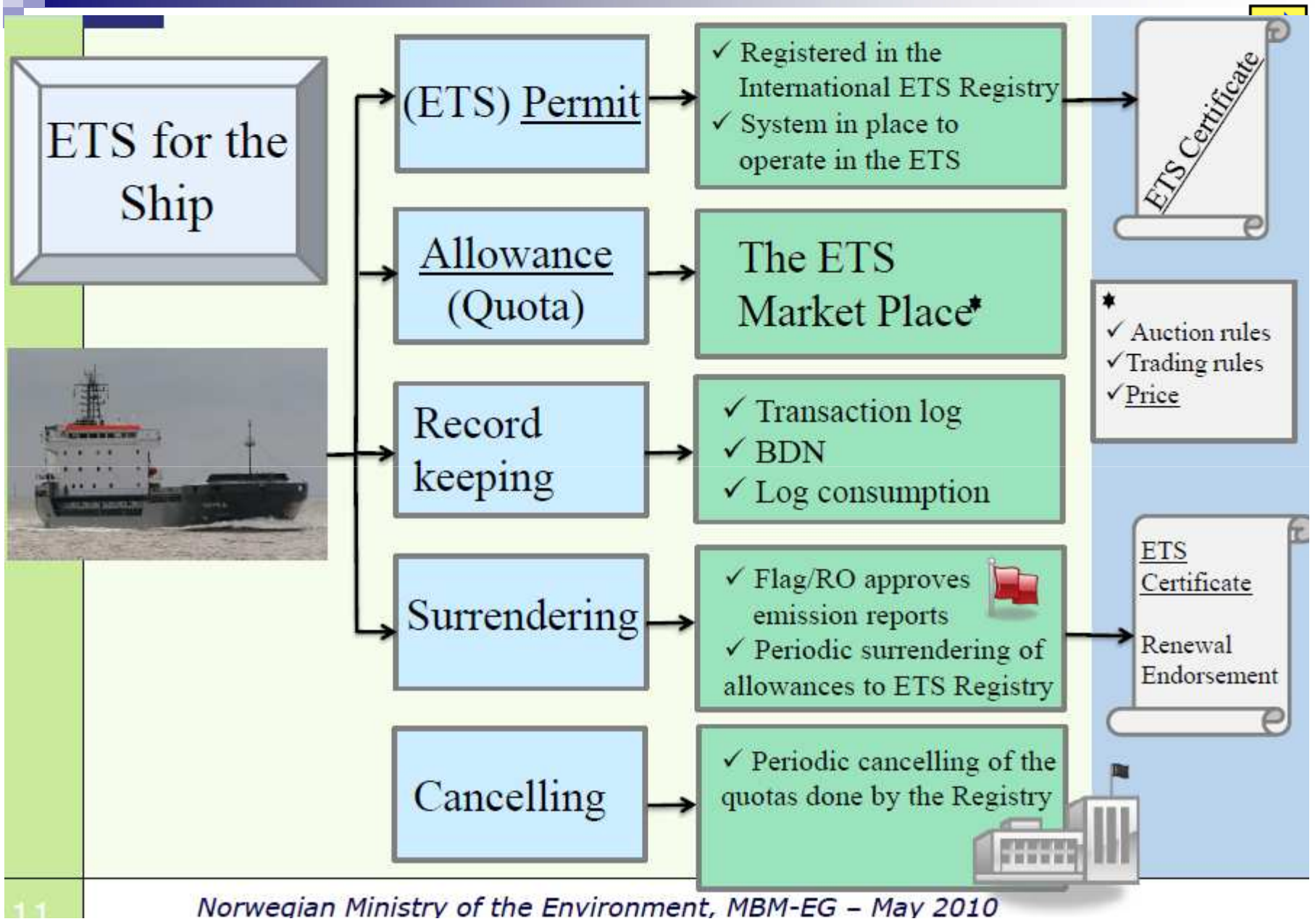
- Possible problem: at what price?

EU ETS carbon price

carbon price volatility

Not a very good incentive for investors




ETS for the Ship
(ETS) Permit
✓ Registered in the International ETS Registry
✓ System in place to operate in the ETS
ETS Certificate
Allowance (Quota)
The ETS Market Place*
* ✓ Auction rules ✓ Trading rules ✓ Price
Record keeping
✓ Transaction log
✓ BDN
✓ Log consumption
Surrendering
✓ Flag/RO approves emission reports
✓ Periodic surrendering of allowances to ETS Registry
ETS Certificate
Renewal Endorsement
Cancelling
✓ Periodic cancelling of the quotas done by the Registry
11
Norwegian Ministry of the Environment, MBM-EG – May 2010

Administrative burden

- Higher than GHG-Fund
- May exempt ships > certain DWT
- May exempt traffic thru island states
- Exemptions may induce carbon leakage and be impossible to monitor

USA's SECT proposal

- Compute a ship's EEDI
- Allow trade on EEDI: a ship with a good EEDI can trade EEDI credits to a ship with a poor EEDI

Discussion

- Funds stay in sector
- High admin. cost (worse than ETS)
- Carries all problems of EEDI
- Applies EEDI also to existing ships

WSC's VES proposal

- Also EEDI based
- Ships with EEDI above standard pay a fuel charge
- Charge proportional to deviation above standard
- Also proportional to how much vessel is operated

Discussion

- Carries all problems of EEDI (not as bad as SECT)
- High admin. cost (lower than SECT)

Jamaica's PSL proposal

- Port state– based
- All vessels calling at a port pay a charge based on amount of fuel consumed by the vessel on its voyage
- Aim: internalize external costs
- STEEM system of monitoring

Discussion

- Very difficult/impossible to monitor
- Very difficult to eliminate evasion
- Port states with poor monitoring may evolve into mega hubs
- Possible distortion of trade flows

Modelling scenarios

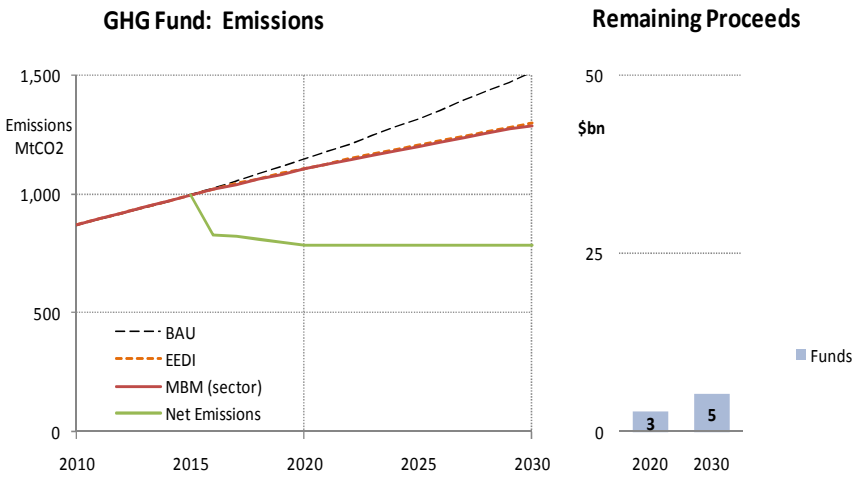
- two growth rates (1.65% and 2.8%)
- three targets lines /caps for GHG Fund and ETS (0%, 10% and 20% below 2007 level)
- 28% revenue used for mitigation for Rebate Mechanism and 25%, 50%, and 75% revenue refunded for LIS
- low, medium and high stringency standards for VES and SECT
- two carbon price scenarios (medium and high) and two fuel price scenarios (reference and high)

Emission reductions in 2030

Modelled emission reductions across various scenarios

	SECT	VES	Bahamas	GHG Fund	LIS	PSL	ETS (Norway France)	ETS (UK)	RM
Mandatory EEDI (Mt)	123-299	123-299	123-299*						
MBM In sector (Mt)	106-142	14-45		1-31	32-153	29-119	27-114	27-114	29-68
MBM Out of Sector (Mt)				152-584			190-539	190-539	124-345
Total reductions (% BAU)	19-31%	13-23%	10-20%	13-40%	3-10%	2-8%	13-40%	13-40%	13-28%
Potential supplementary reductions (Mt)		45-454		104-143	232-919	917-1232	696-870		187-517

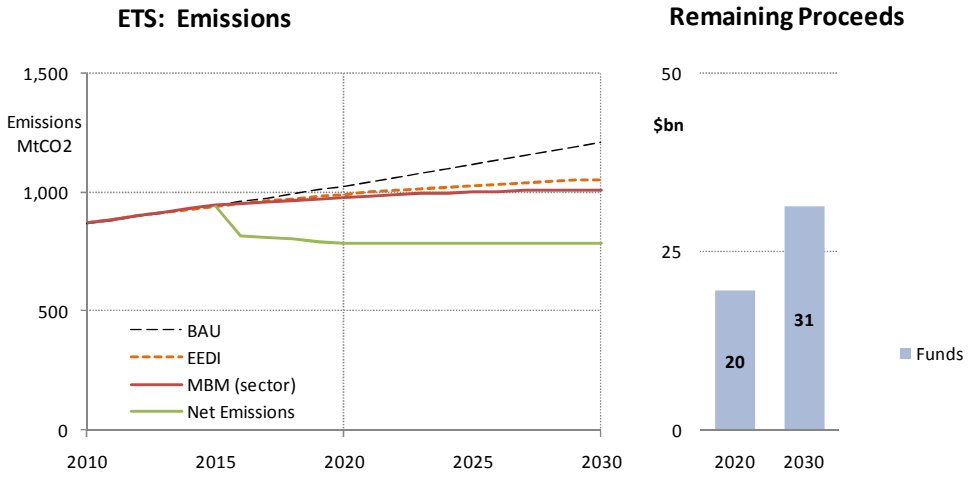
* Included if the mandatory EEDI is adopted by the committee



Assumptions,

assumptions,

- assumptions,
  assumptions,
  & more assumptions!



MEPC 61: status

- EG Report: > 300 pages
- Extensive modelling (many assumptions)
- Some “black boxes”
- No comparative assessment
- No winner or loser

Dissenting view

- Reservations on some points
  - Modelling effort
  - Basis of comparison
  - Black boxes
- Comparative assessment of proposals
- NOT included in EG report!

TABLE A: HORIZONTAL ASSESSMENT OF ALL MBM PROPOSALS

PART I

Main criterion	GHG Fund (Denmark)	Leverage Incentive Scheme (Japan)	ETS (Norway, UK, France)	SECT (USA)
1. Environmental effectiveness (how certain is MBM to achieve a specific reduction target)	There may be less certainty of CO_2 reductions than ETS, but MAC curves of DNV can give an estimate. If price is same, CO_2 reductions are same with ETS. Offsets can contribute meeting a cap. See also criterion 2 below.	Lower than GHG Fund, but may have side-effects due to possible distortions induced by misuse of EEDI (eg, an underpowered ship has a low EEDI but may emit more CO_2).	There may be higher certainty of CO_2 reduction, but reduction target is arbitrary (or very difficult to determine). Plus, enforcing the cap can be difficult and carbon price may skyrocket if we are close to the cap. Significant carbon leakage risks exist (eg, if not all ships are covered, some countries like LDCs excluded, etc).	Low. CO_2 reduction certainty does not exist, as scheme trades on EEDI. No attempt to compute CO_2 directly. Variant to use actual fuel burned instead of EEDI has merit.

Main criterion	GHG Fund (Denmark)	Leverage Incentive Scheme (Japan)	ETS (Norway, UK, France)	SECT (USA)
2. Cost effectiveness	High. Costs are known as price is known. Simplest scheme (except Bahamas). Option 2 is probably better than Option 1. According to US CBO study, Levy is most efficient way to reduce emissions[2].	High, but lower than GHG Fund, due to costs of tracking EEDI.	Low. High administrative costs, very unpredictable carbon prices.	Low. Combines problems of ETS with EEDI distortions and other problems.
3. Incentives to technological change	High. Investors will respond to known price.	High, but lower than GHG Fund, due to possible mixed EEDI signals (eg, invest in underpowered ships).	Low. Investors will not know what future prices they will encounter and will pay high administrative costs.	Same as above. May provide the wrong signals in favour of low-EEDI ships than may emit more CO_2.
4. Practical feasibility	Reasonable. Can be modelled from IOPCF.	Lower than GHG Fund, due to tracking of EEDI for existing ships.	Low. All GHG Fund (option 2) processes, plus auction permits, monitor allowance market, enforce compliance, indentify fraud, etc.	Worse than ETS. Combines problems of ETS with tracking EEDI for existing ships and estimating activity levels.

Main criterion	GHG Fund (Denmark)	Leverage Incentive Scheme (Japan)	ETS (Norway, UK, France)	SECT (USA)
OTHER CRITERIA				
Impact on safety	Neutral.	Problem if under-powered ships are advocated due to low EEDI.	Neutral.	Problem if under-powered ships are advocated due to low EEDI
Risk of fraud	Average.	Average.	High- documented cases in EU ETS and elsewhere.	Higher than GHG Fund
Money collected	Limited to in-sector contributions. Depends on level of Levy.	Same as GHG Fund minus difference in admin. costs- some of the proceeds go to ships of low EEDI.	If GHG Fund Levy and ETS carbon price are same, amount of money collected for ETS is same as GHG Fund minus difference in admin. costs.	Depends on price of EEDI traded.

To see both reports

- Go to http://www.martrans.org/lemis.htm

(LMT's page on emissions)

- MBM EG report under No. 15
- HNP's report under No. 16

- (or send an email to hnpsar@mail.ntua.gr)

Cancun outcome

- No binding decision
- But maybe a way ahead
- Global fund ($100B/yr)
- Many issues unresolved (eg, how fund will be collected, distributed, etc)
- Shipping and aviation are (still) off the hook
- IMO, ICAO still entrusted
- Long way to go

$100 billion a year!

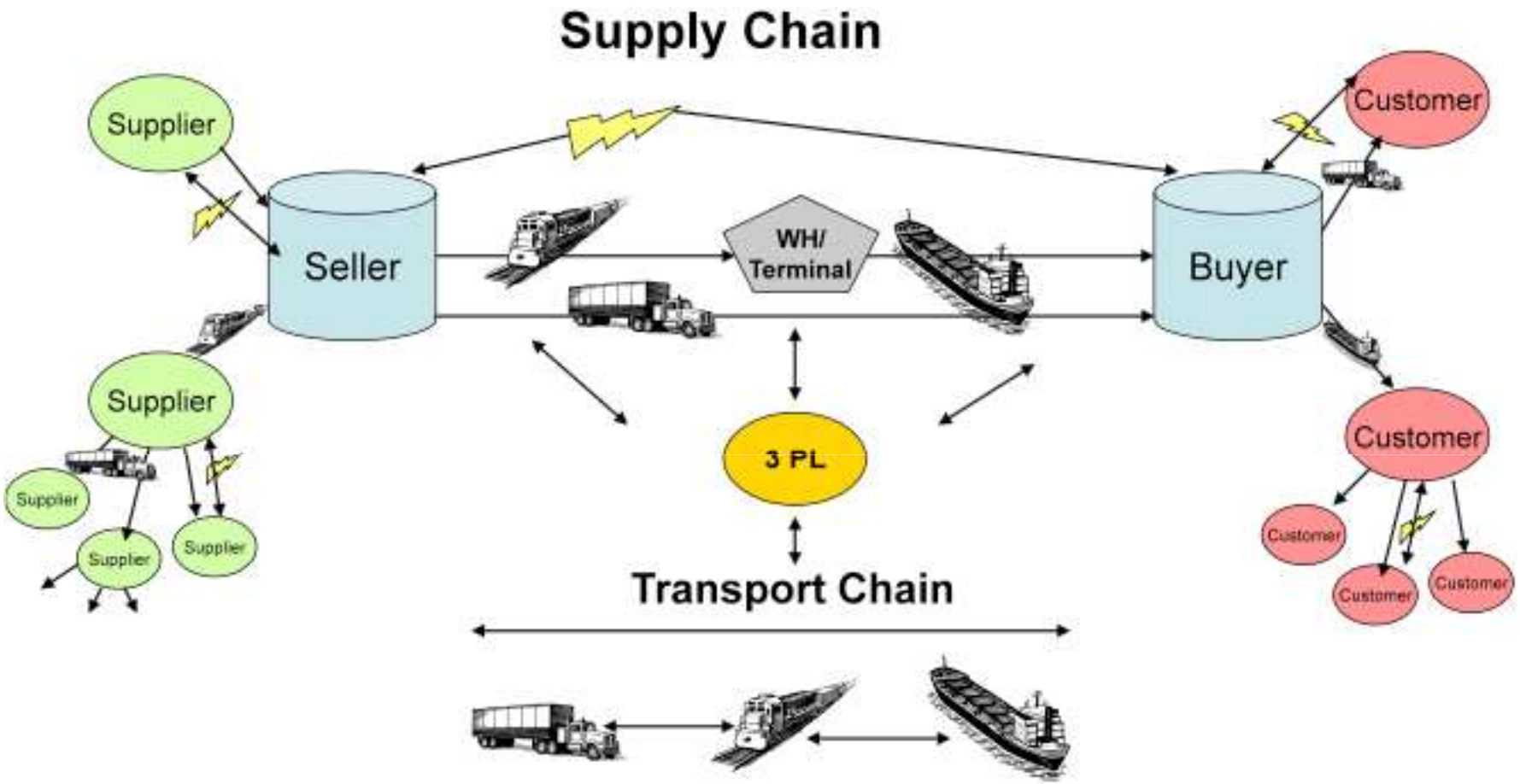
- Not clear how it will be collected
- Not clear how it will be distributed
- If proportionality is kept (2.7%), $2.7b from int'l shipping
- Divide by ~270m tons of bunkers (2007):
- Equivalent to a LEVY of ~$10/ton of fuel

Further IMO work on MBMs

- Working Group, March-April 2011
- MEPC 62, July 2011

GHG-WG 3 terms of reference

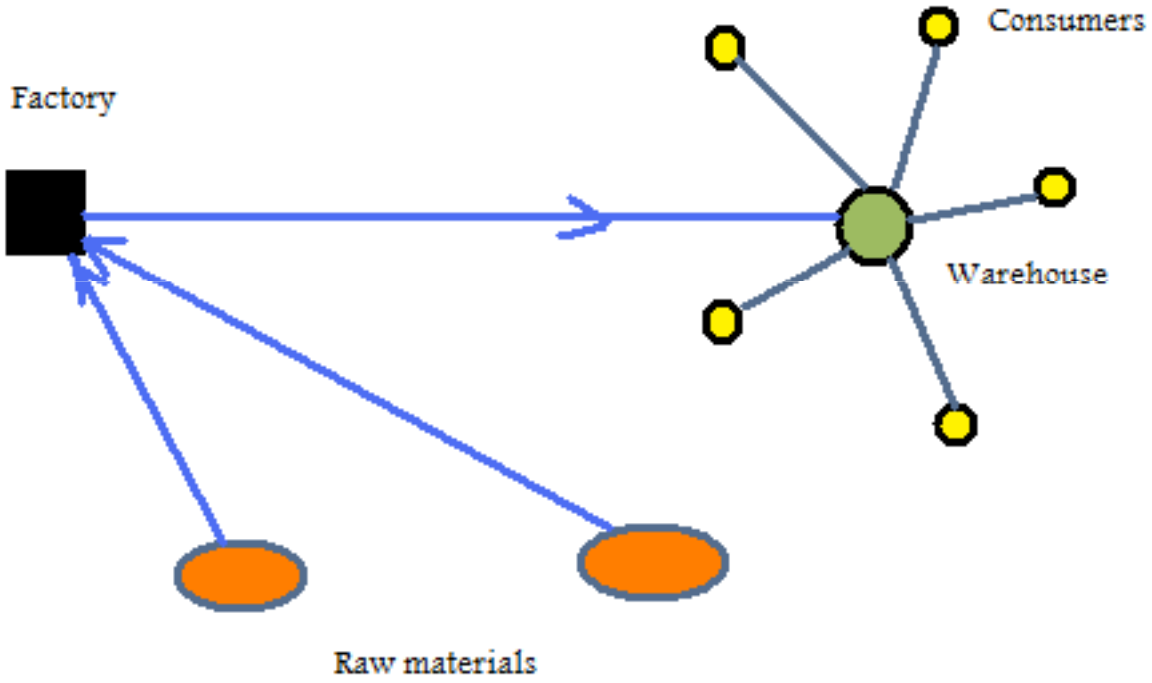
1. examine and provide the Groups' **opinion on the compelling need and purpose** of Market-based Measures (MBM) as a possible mechanism to reduce greenhouse gas emissions from international shipping;
2. **group the proposed MBMs** in accordance with the reduction mechanism they use (e.g., in-sector/out-of-sector, etc.) and other relevant features; and identify and list strengths and weaknesses for each of the MBM groups;
3. examine the MBM proposals relation to the principles and provisions of relevant conventions such as the **UNFCCC and its Kyoto Protocol**, as well as their compatibility with the WTO Rules and customary international law, as depicted in UNCLOS;
4. having in mind the discussion in paragraph 3 and building on the work of the Expert Group on Feasibility Study and Impact Assessment of Possible Market-Based Measures (MBM-EG), **further assess** each of the MBM groups mentioned above against the same criteria as used by the MBM-EG (paragraph 5 of annex 8 to MEPC 60/22, reproduced at appendix), using the analyses already undertaken by the MBM-EG to avoid duplication, for a more clear input to the Committee in relation to the policy issues;
5. **continue the analysis** of the MBM-EG Study (MEPC 61/INF.2), evaluate the impact of the proposed MBMs on international trade, and the maritime sector of developing countries, least developed countries (LDCs) and small island developing states (SIDS), and the corresponding environmental benefits; and
6. submit a written report to MEPC 62.



Part loads/Groupage: Line traffic - > terminals, consolidation, 3PL

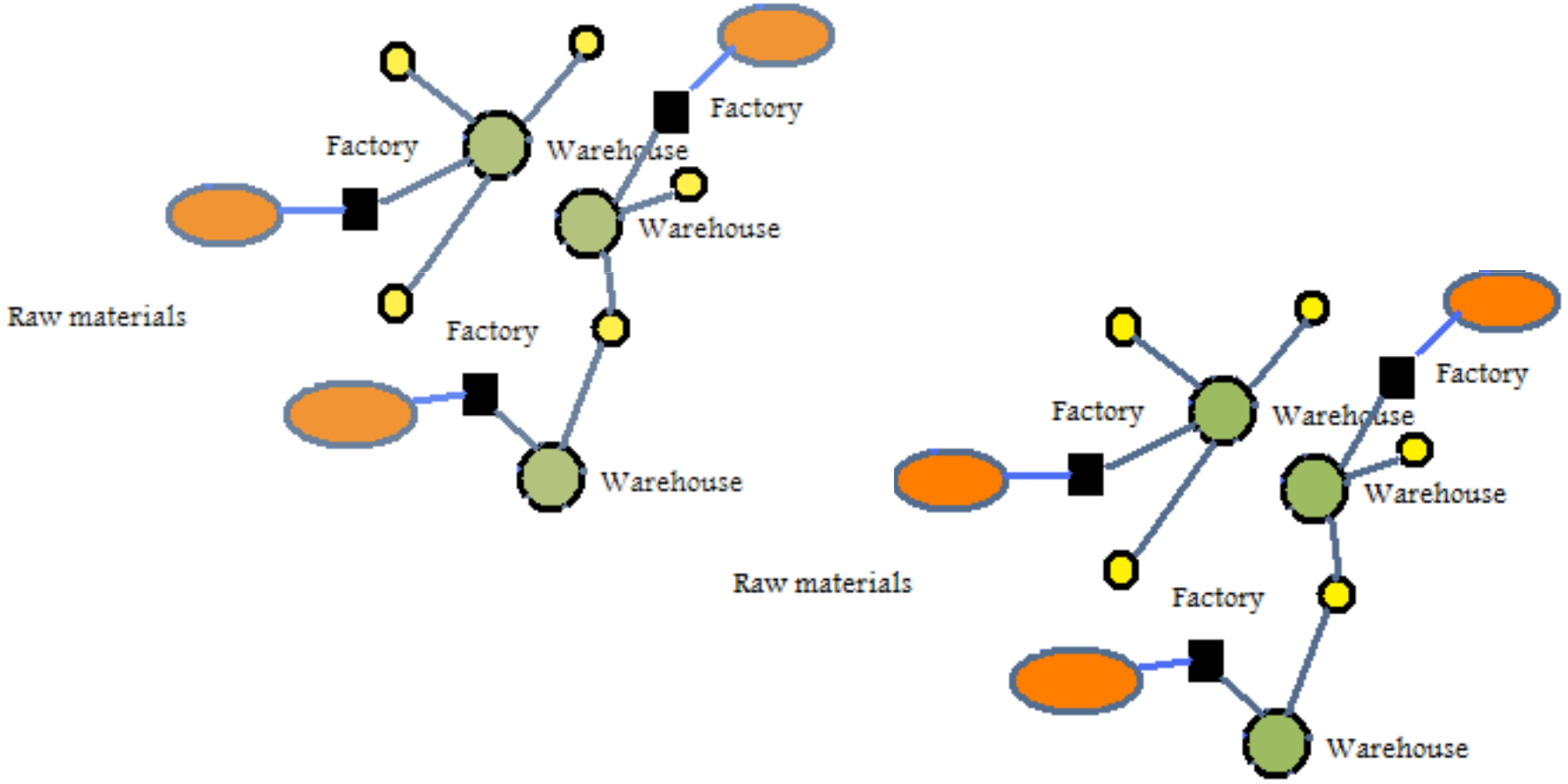
Full loads/ FTL,FCL: Bulk, Tramp Traffic, Contracted containers/tankers/rail cars

Which model?



- Long haul

Short haul (if price of emissions is high enough)



Is this green enough?

- Globally, ruminant livestock produce about 80 million metric tons of CH4 annually, accounting for about 28% of global CH4 emissions from human-related activities

(source: US EPA)

Thank you very much!

- www.martrans.org