

# **Mid-Atlantic and Northeast Collaboratives**

## **The Impact of Marine Emission Legislation on the Bunker Industry A European Perspective**

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Marine and Energy Consulting Limited**

**Conference Call  
18 April 2007**

## **Introduction**

- **The regulations are upon us and doing nothing is no longer an option**
- **Future regulations are becoming even more uncertain**
- **More countries will legislate and with increasing stringency**
- **Demand for LSBF is increasing as is the sulphur price premium**
- **Buyers and suppliers operations will become more complex and costly**
- **The ship owner pays hoping to pass on the costs to his customers**

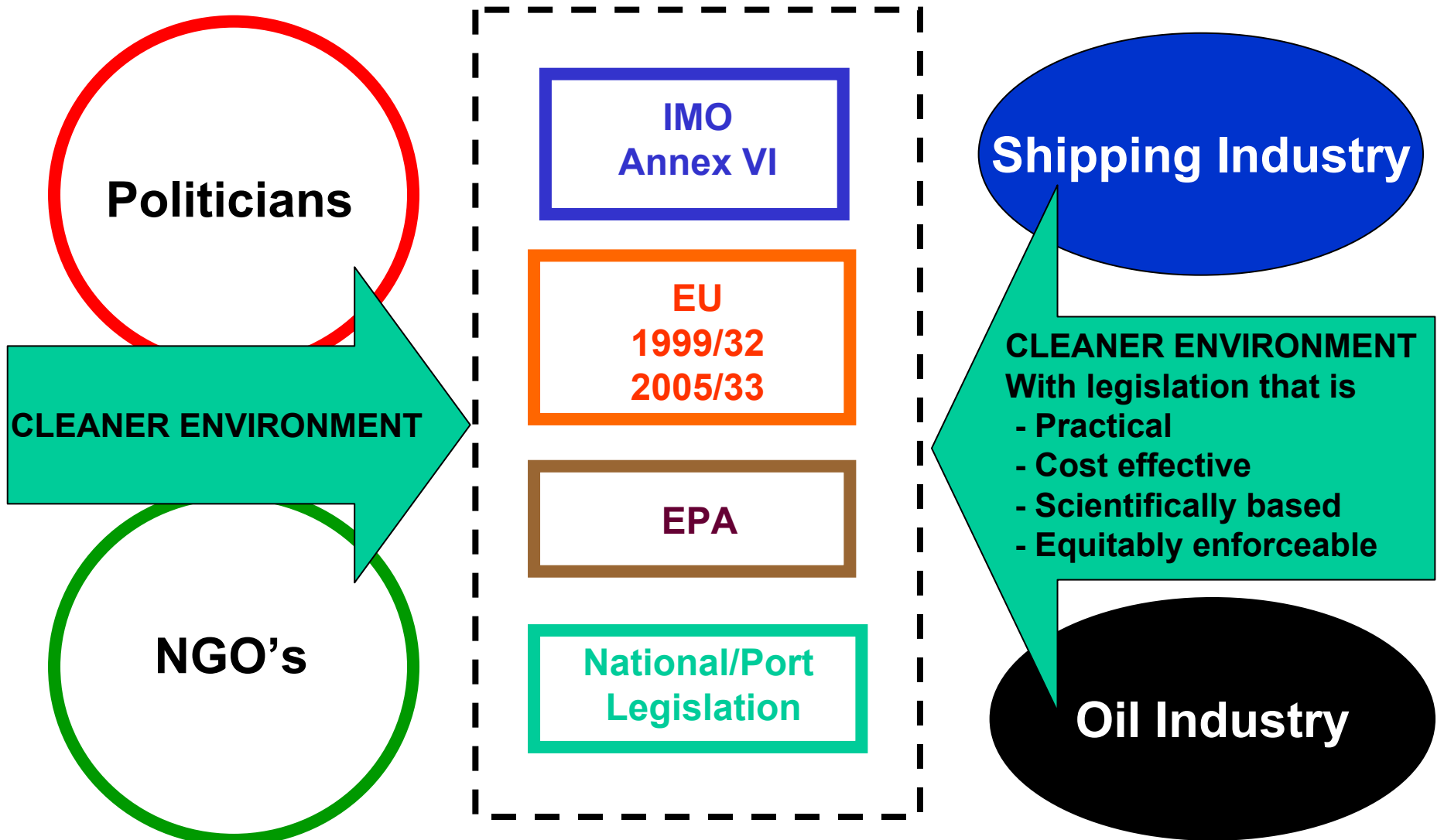
## **Impact**

- **The Bunker Consumer will seek the lowest cost solution**
  - That usually complies with the regulations
  - While improving our environment
  
- **The Supplier will react to market forces to maximise profits while**
  - Minimising the impact on the environment
  
- **The Legislators will attempt to implement regulations that improve the environment and hopefully**
  - Are cost effective
  - Are based on scientific analysis
  - Consider all aspects of the environment
  - Provide a basis for planning

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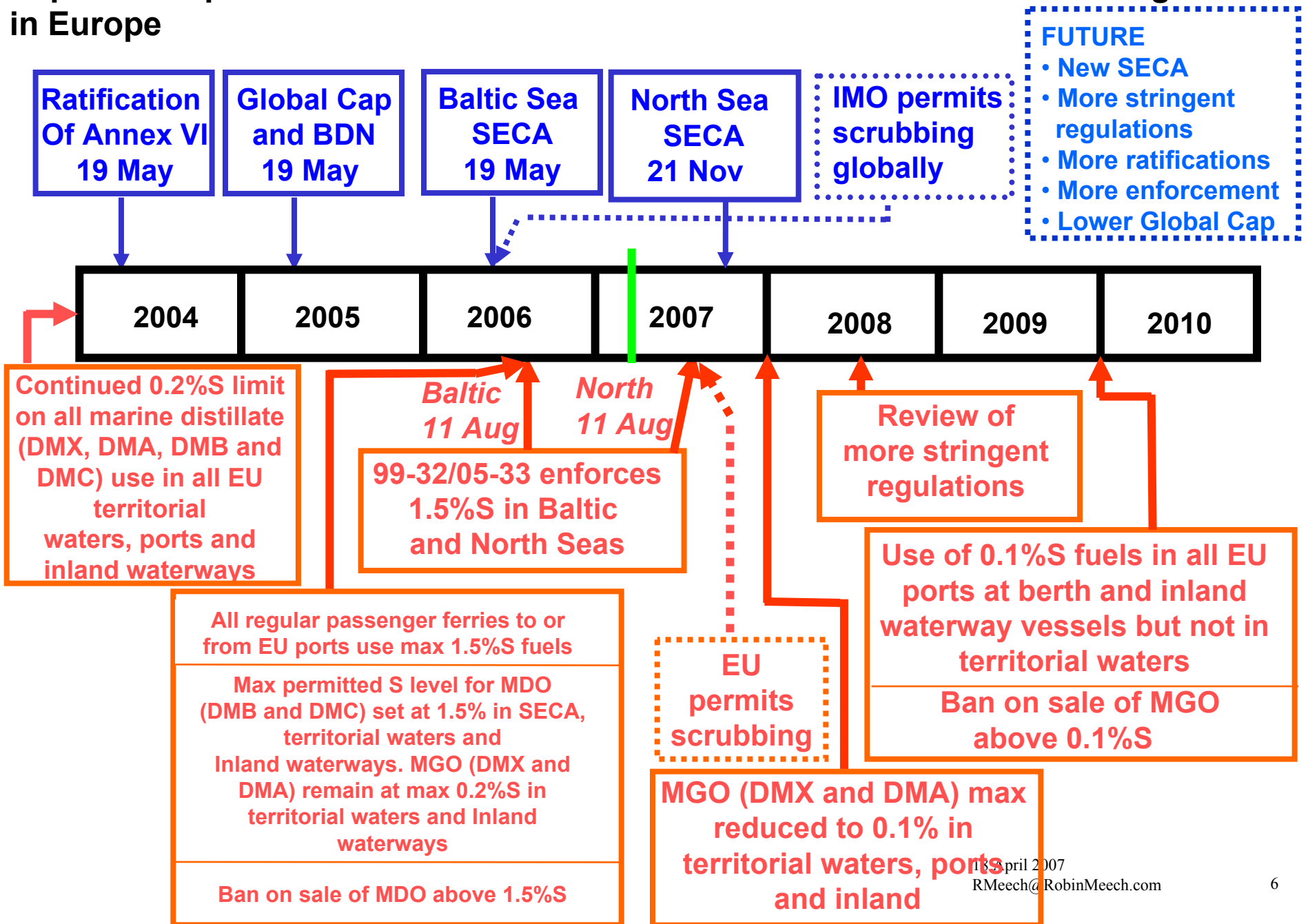
1	Legislation
2	Demand
3	Pricing
4	Ship Owners' Perspective

# Future legislation will be subject to conflicting pressures



**No doubt legislation will be constantly changing  
making it increasingly difficult to plan**

# Expected implementation scenario for marine SOx emission reduction legislation in Europe



## Current implementation scenario for marine SOx emission reduction legislation

### **BY END 2007**

All vessels in the Baltic and North Seas to use LSBFO (1.5%) or scrub

All ferries operating between EU ports to use LSBFO or scrub?

Global Cap of 4.5%

Use of Bunker Delivery Notes

### **BEGINNING OF 2010**

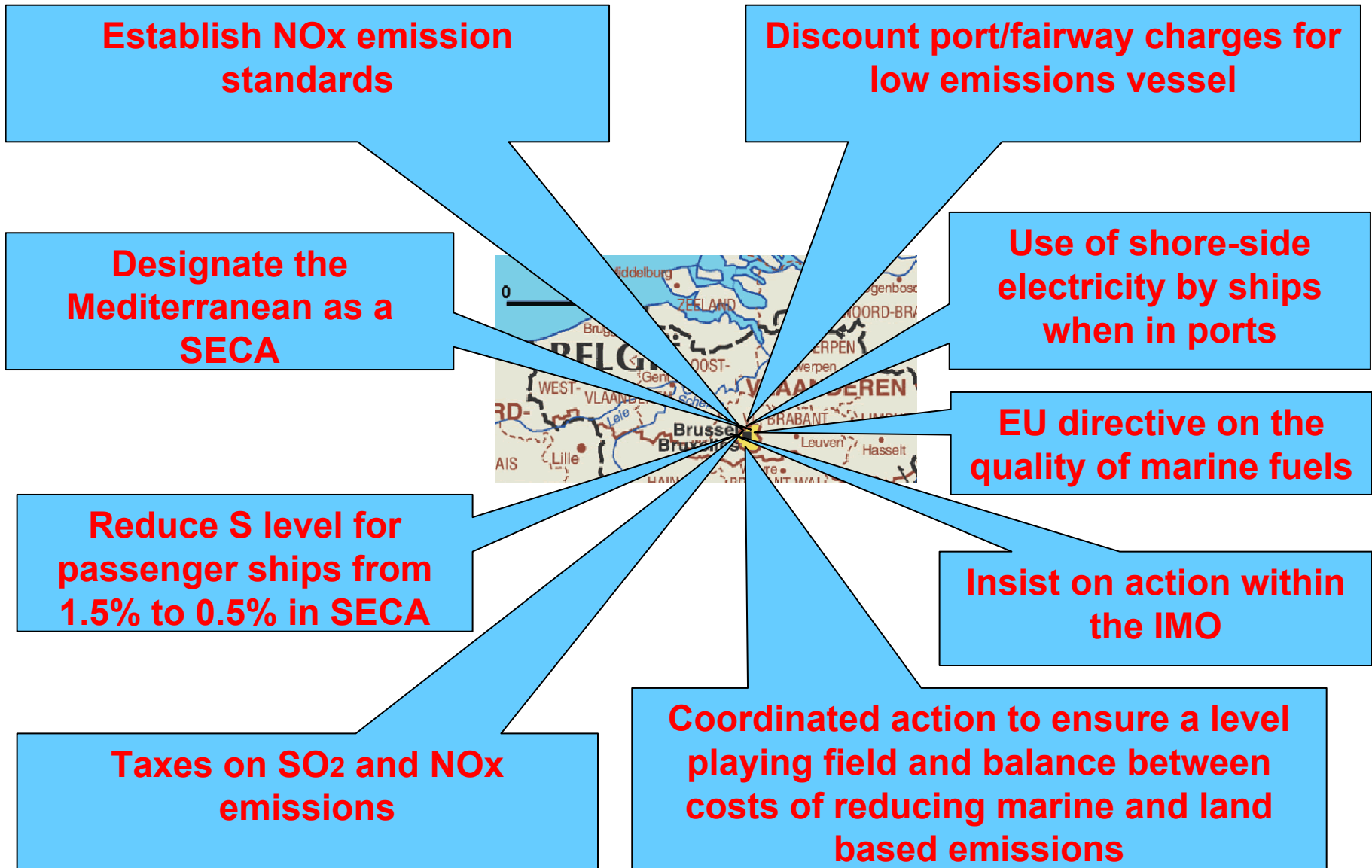
All vessels to use 0.1% S fuels while alongside

### **MID 2007**

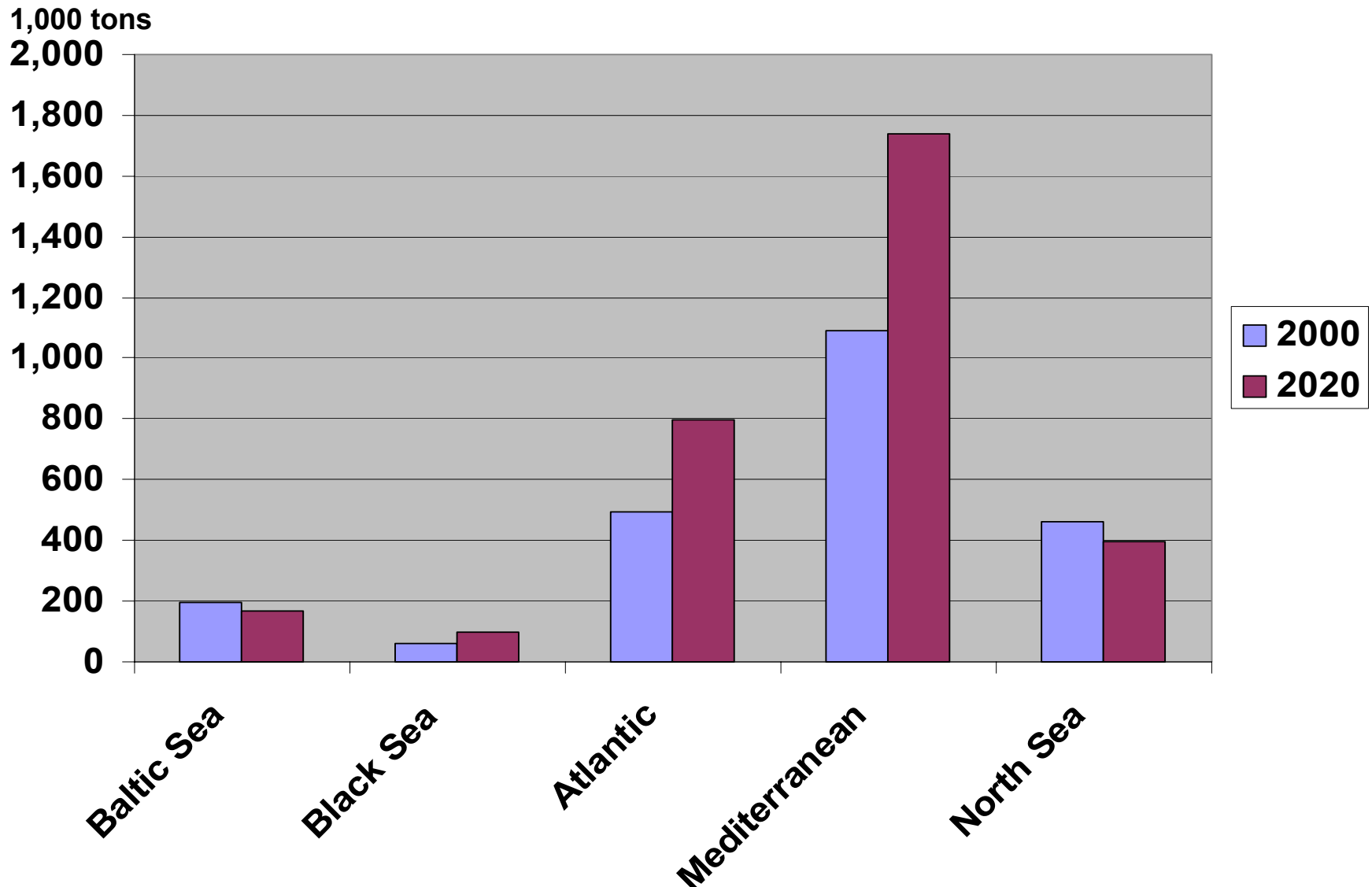
MDO to have max S% of 0.5% up to 24 miles off California

Down to 0.1% by 2010

## The EU Parliament has adopted a forceful approach



# By 2020 the Mediterranean SOx emissions will be over three times greater than the Baltic and North Seas combined



But are reported to have less impact than emissions in the North Sea and Baltic

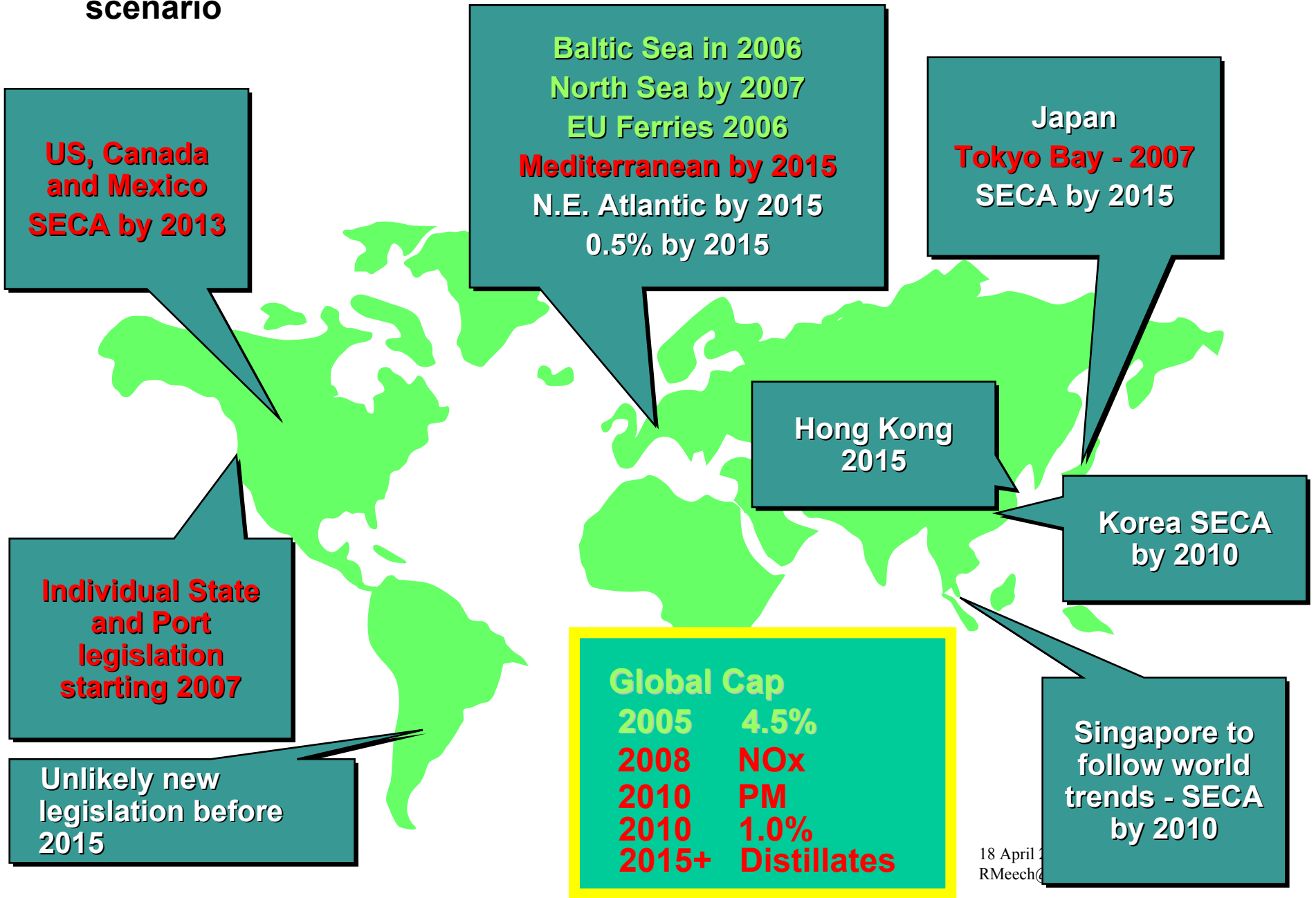
## **The EPA will determine North American marine emission regulations**

- **Come to realise significance of emissions from Ocean Going Vessels**
- **Prediction that in 20 years ships will account for high percentage of emissions from mobile sources**
  - Sulphur                    **80%**
  - PM                            **20%**
  - NOx                           **30%**
- **Initial proposals with respect to Sulphur and Particulate Matter**
  - USA, Canada and Mexico
  - SECA out 200 miles
  - Use of 0.1% distillates in SECA
  - OR Scrubber to 0.4g gm/kW-Hr – equivalent to scrubbing 2.0%S fuels
  - By 2011
- **Implementation complicated by**
  - Multiple agencies
  - Federal v State legislation
  - Tri-nation cooperation
  - Regulating foreign flag ships
- **But US is about to ratify Annex VI with enabling legislation**

## INTERTANKO – Have proposed an all distillate option

- **INTERTANKO's view is that any revisions to Annex VI should be based upon the following:**
  - Ensuring a solid platform of requirements
  - Are **realistic and feasible**
  - Produce a long term and positive reduction of air emissions from ships, and
  - Contribute to a long term and a predictable regulatory regime
- **INTERTANKO's proposal**
  - Global use of distillate fuels
  - From [2010], a maximum of 1.00% Sulphur content and
  - For ships' engines installed on and after [2015], a maximum [0.50]% Sulphur
- **If the above two issues were considered feasible, then the provisions for checking and monitoring compliance with Regulation 14 and 18 to be revised accordingly**
- **There is much debate and analysis required before realistic and feasible regulations can be introduced**

# Bunker legislation can only become more stringent – a possible scenario



## Cleaning up marine emissions

### Retardants

- Increasing costs
- Operational difficulties
- Investment environment deteriorating
- Non dissuasive penalties
- Poor enforcement

### It will be

- More costly
- More complex

### Accelerants

- Increasing public awareness
- Increasing avails of LSBFO outside SECA
- Future abatement cost reductions
- EU mandate to reduce marine emissions
- US enforcement
- Emission trading

### New Directions

- Increased focus on NOx, PM's, CO2 & VOC
- Shipper pressure
- Slow steaming
- Increasing inconsistency

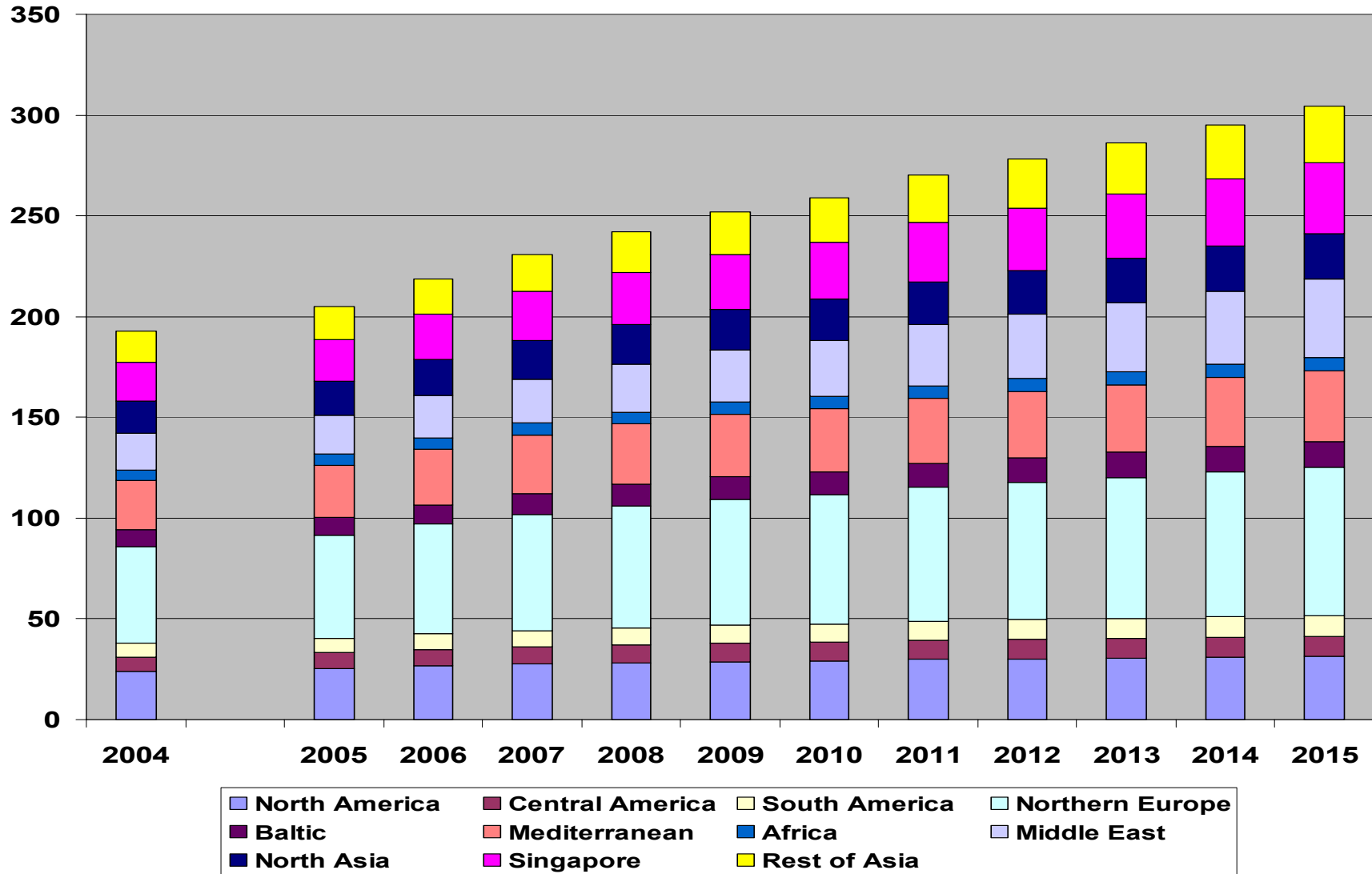
**BUT  
CLEANER**

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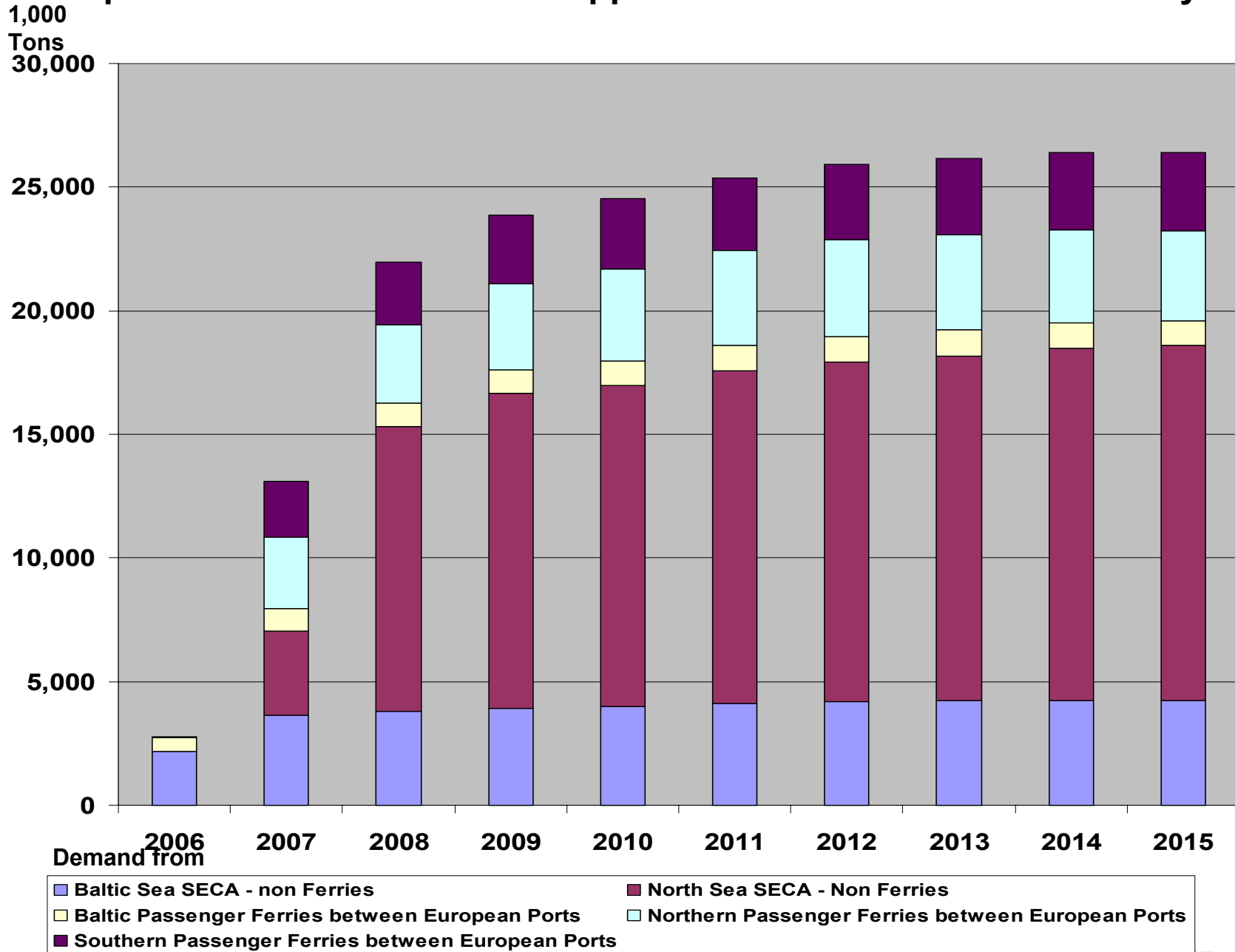
# Demand growth will average 4% pa over the next 10 years

Million  
Tons



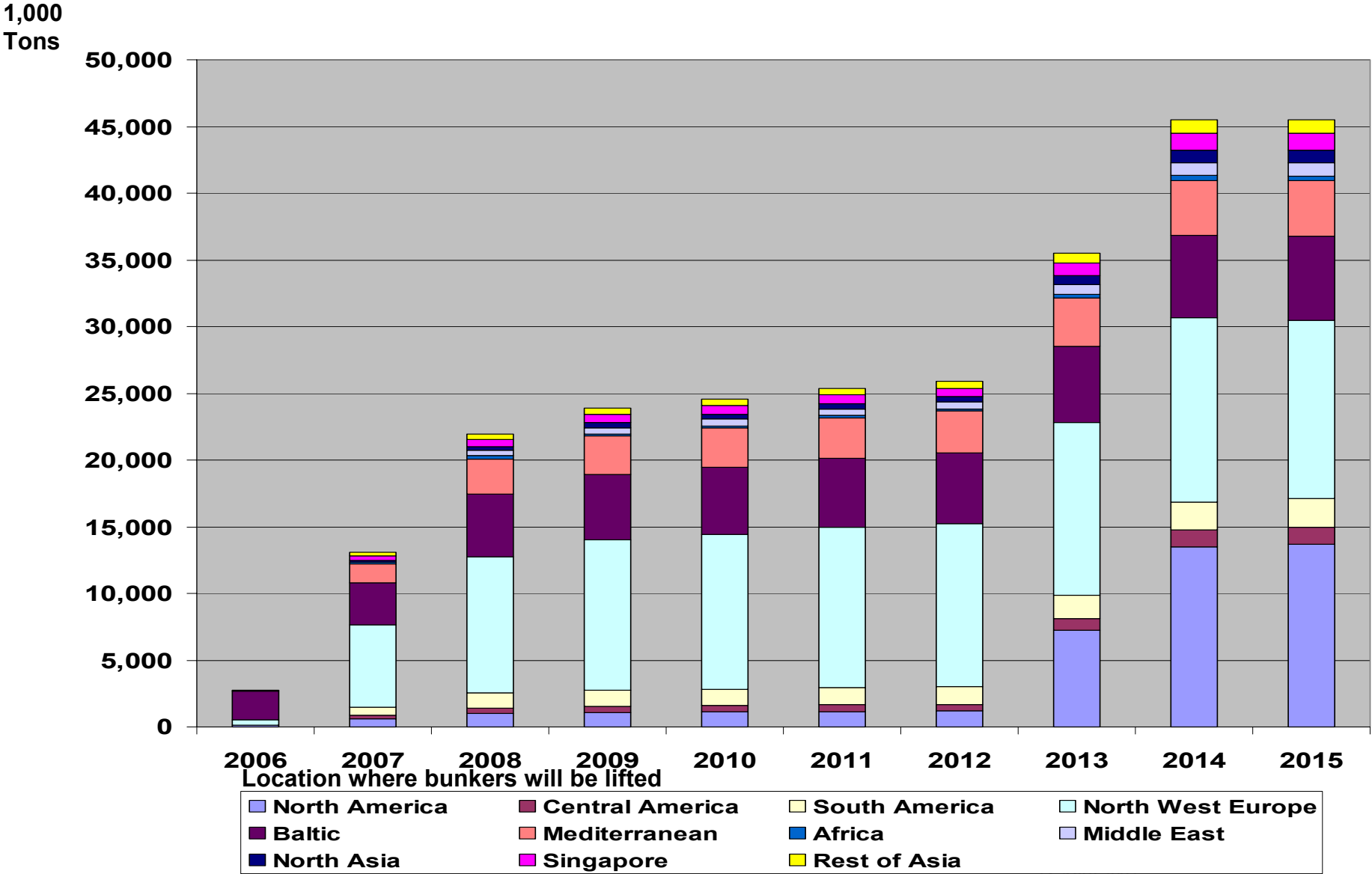
16 April 2007  
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# European demand for LSBF will approach 25 million tons within five years

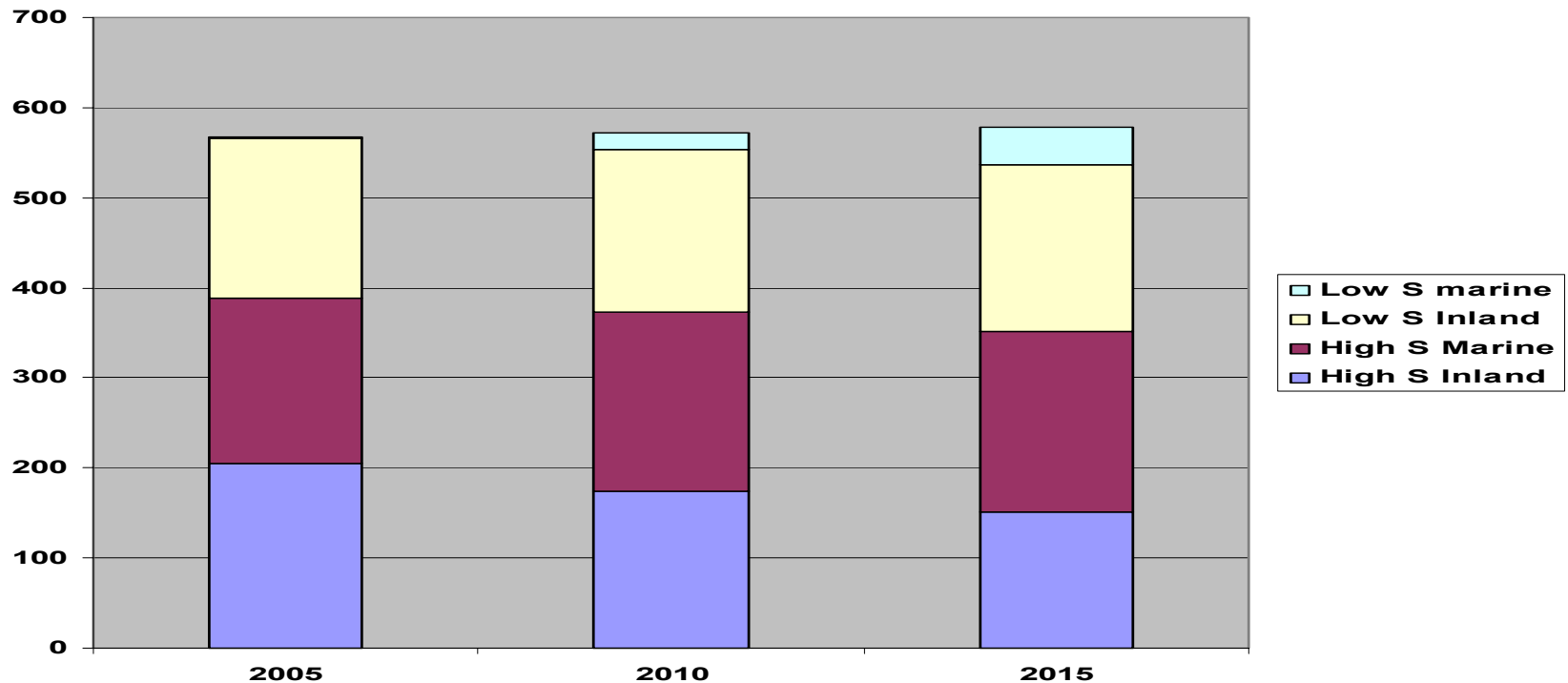


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# Global demand for LSBF will increase by 75% when SECA are implemented in North America



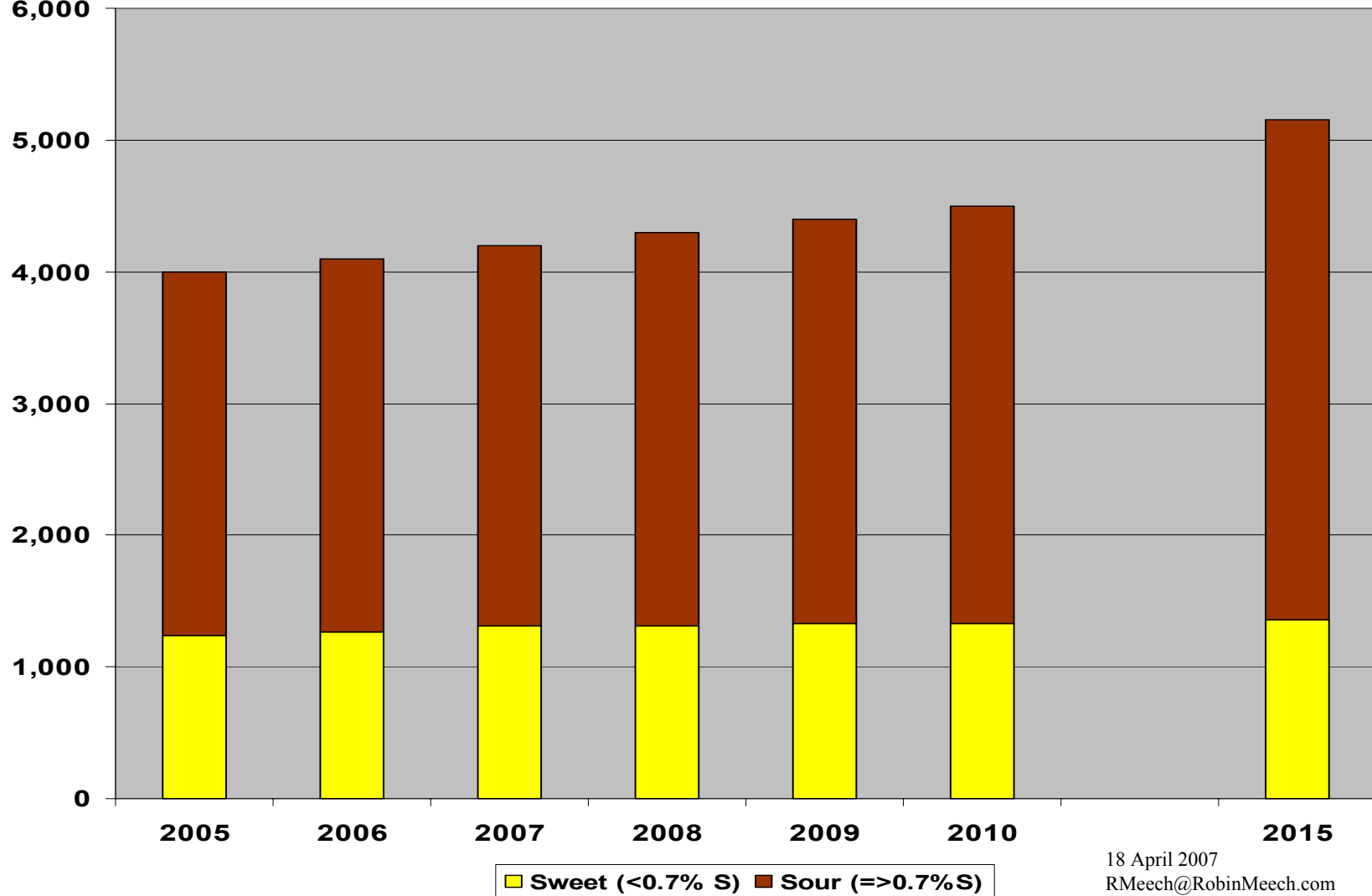
## Global fuel oil markets will be transformed over the coming decade



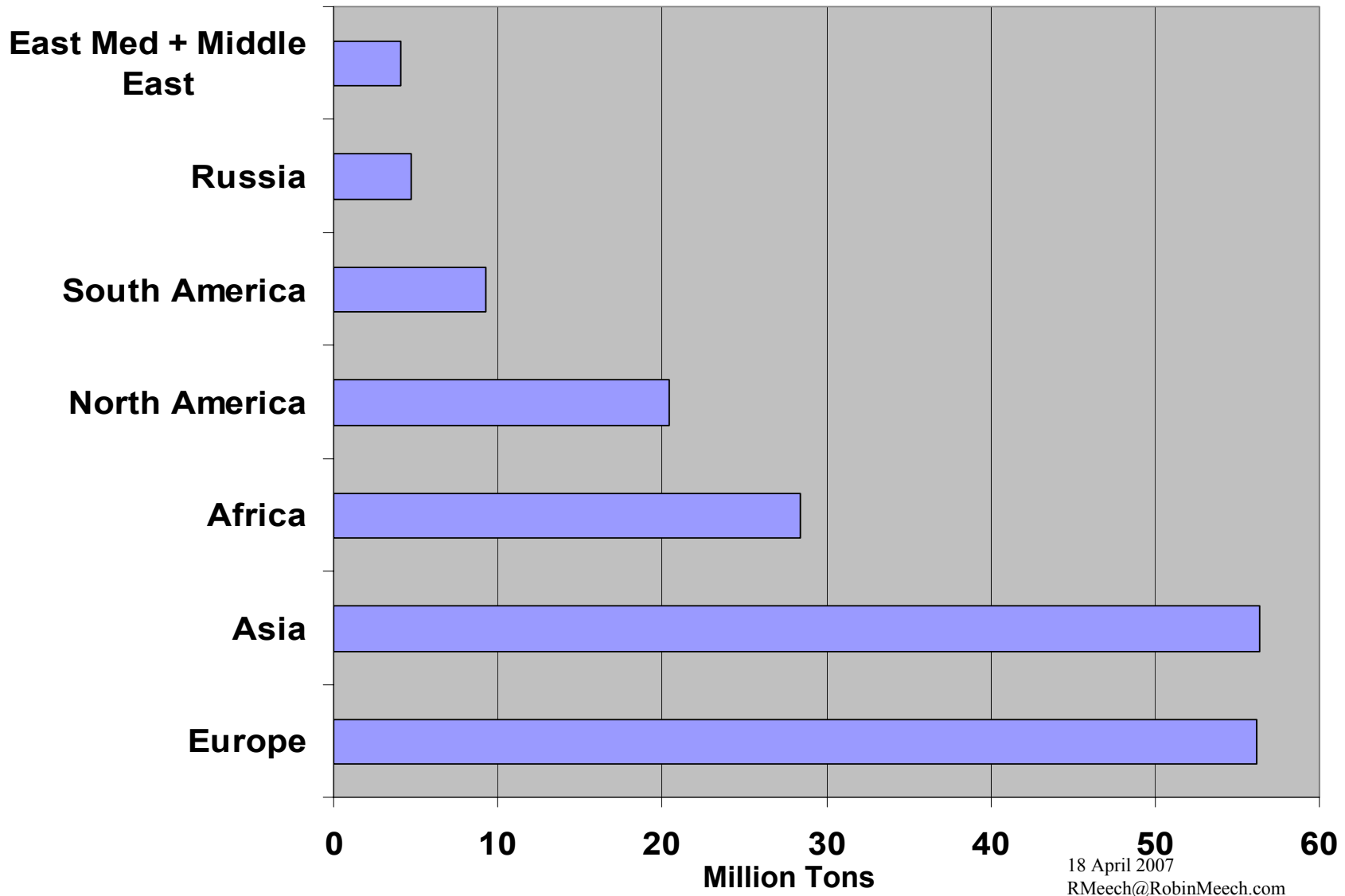
- Over the next decade global fuel oil demand remains practically constant
- By 2015 - 40% of fuel oil demand will be low sulphur
  - 20% of bunker demand will be low sulphur

# Proportionally the avails of lower sulphur crude oils is diminishing further reducing the avails of LSFO

Million  
tons

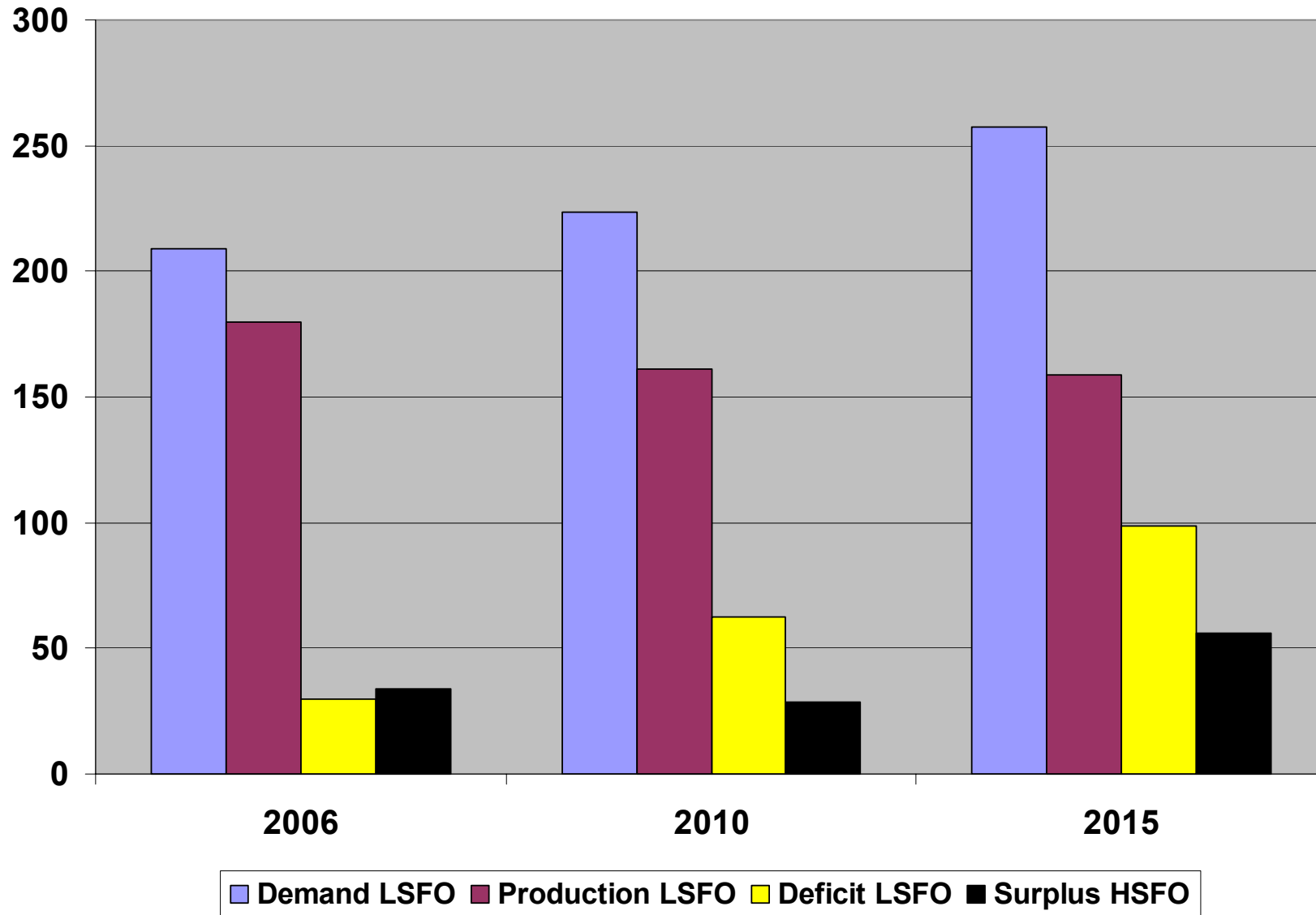


# Over 60% of global LSFO production is in Europe and Asia



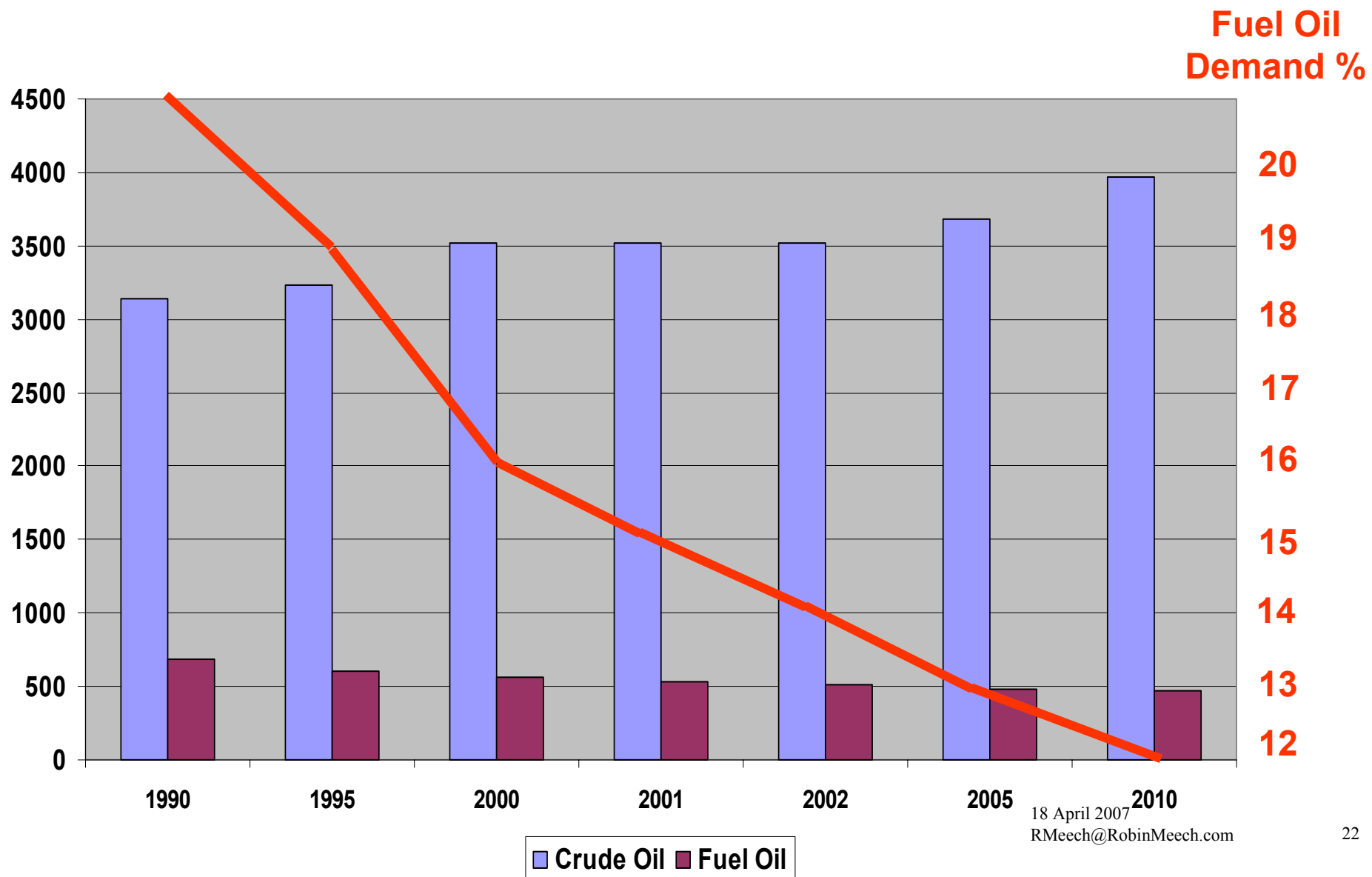
**By 2015 the deficit of LSFO will be 60% of production and 75% greater than the HSFO surplus**

Million  
tons

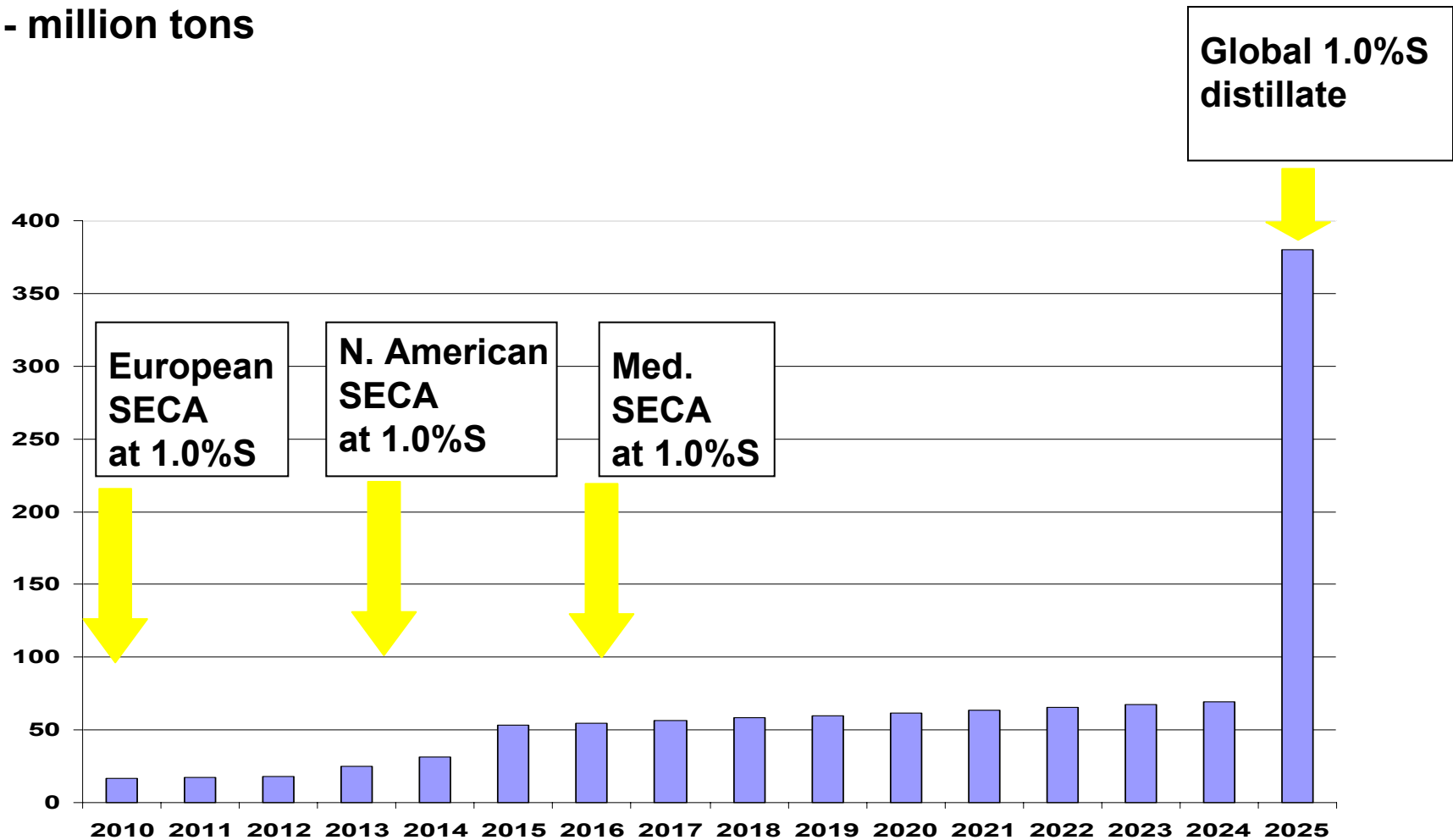


**And 75% greater than the HSFO surplus**

# The required fuel oil yield will result in increases in cracking capacity - million tons



# Potential additional demand for distillate fuels as blend stocks - million tons

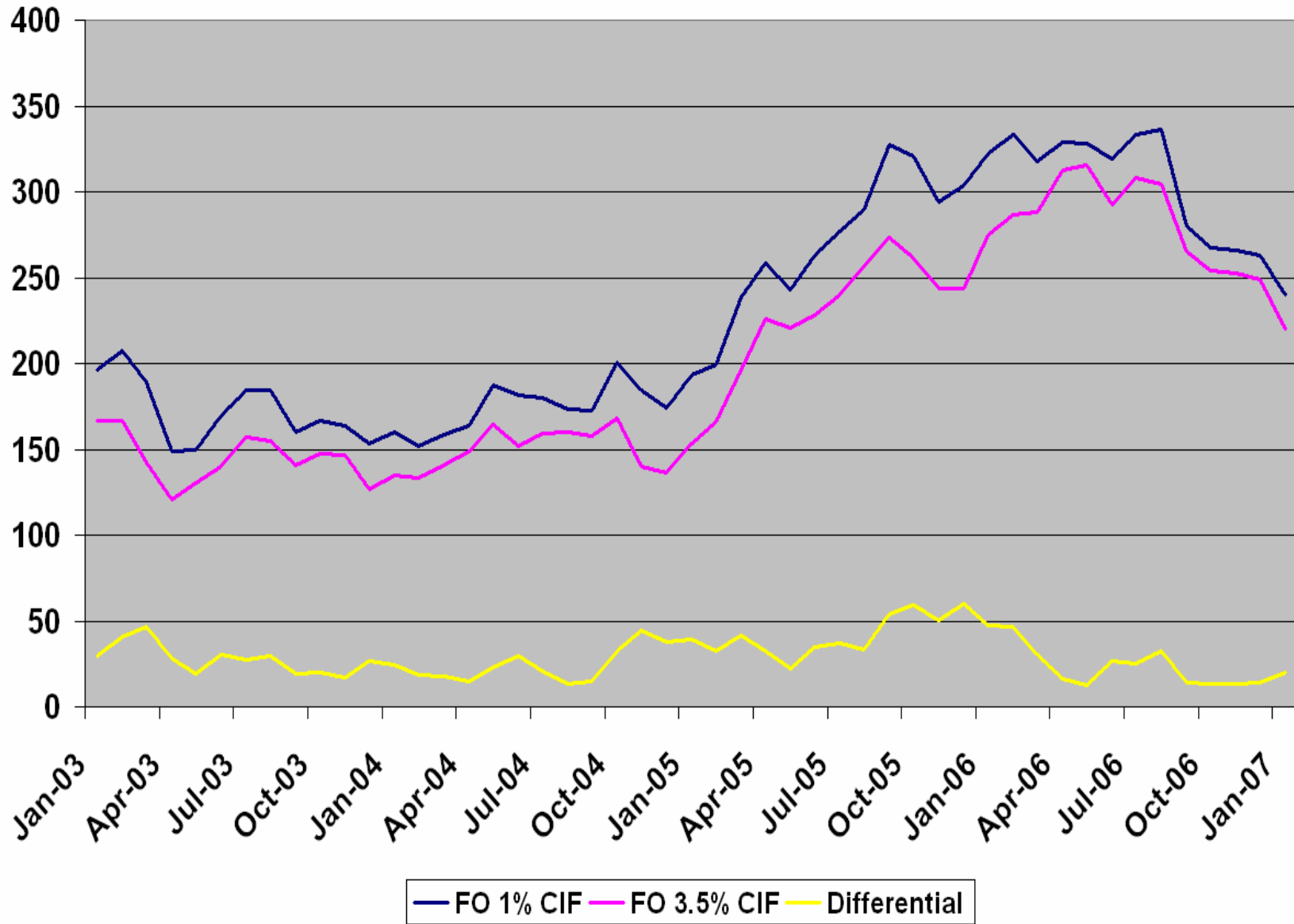


- An additional 70 million tons (1.4 mmbpd) of distillates by 2024 is probably feasible
- BUT 380 million tons ( 7.8 mmbpd) is not
- By 2024 additional marine distillate demand for smaller craft and auxiliaries will be approach 90 million tons (1.8 mmbpd)

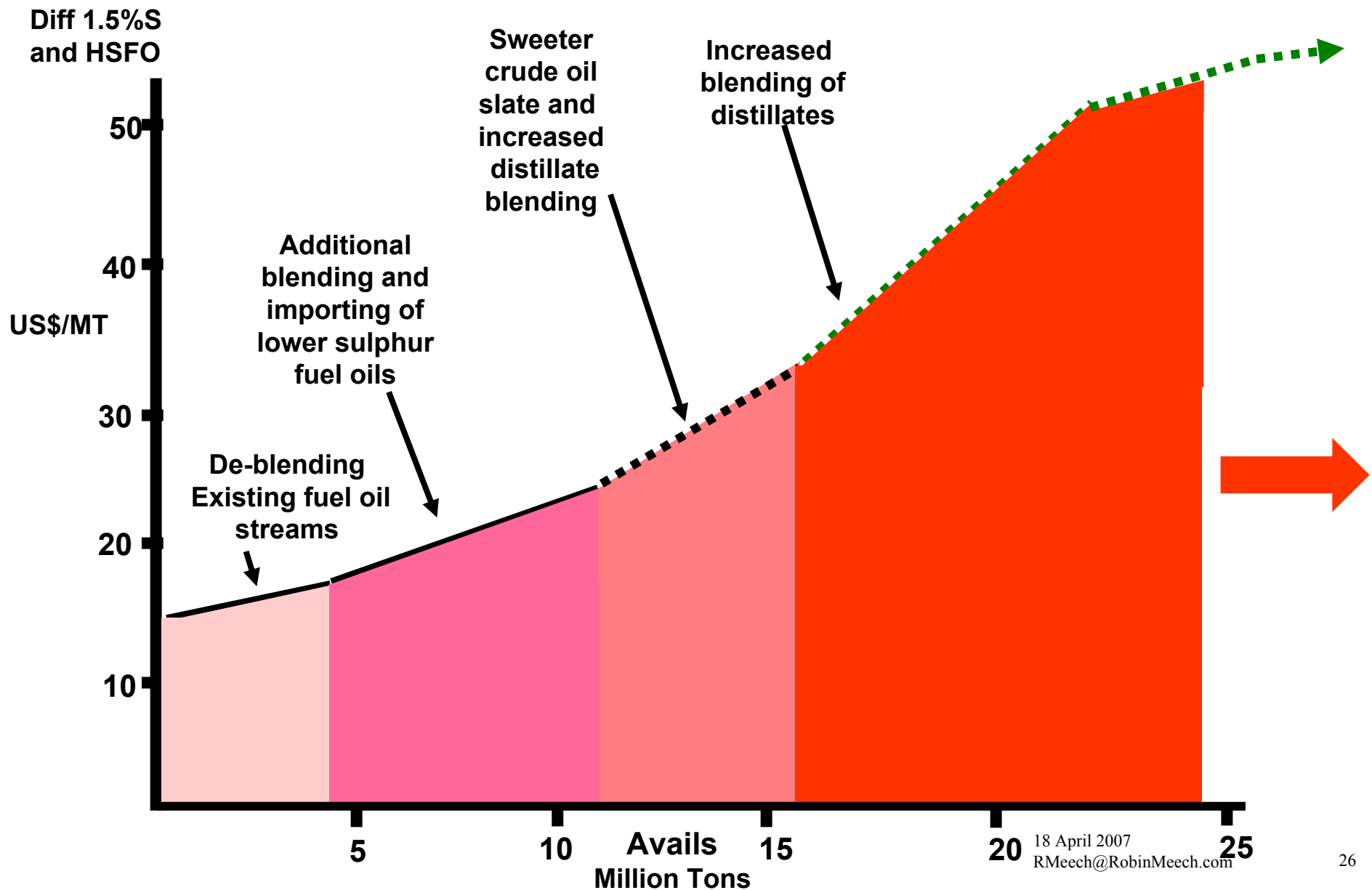
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Since 2003 the European sulphur premium (1.0% to 3.5%) has averaged **\$32/ton**



# There are adequate avails of lower sulphur residual material but at increasing prices



# Basic blending economics for low sulphur fuels

	Residual		MGO
Sulphur %	3.0		0.2
cSt	430		4
Density	991		852
CCAI	843		-
Cost \$/ton	250		500
<b>Blend to 380 cSt</b>			
	98%		2%
Sulphur %		3.0	
cSt		<b>380</b>	
Density		990	
CCAI		843	
Cost \$/ton		255	
<b>Blend to 1.5% S</b>			
	46%		54%
Sulphur %		<b>1.5</b>	
cSt		15	
Density		934	
CCAI		856	
Cost \$/ton		385	
<b>Blend to 1.0% S</b>			
	30%		70%
Sulphur %		<b>1.0</b>	
cSt		12	
Density		889	
CCAI		850	
Cost \$/ton		425	

- Viscosity very low
- Cost premium \$130 at 1.5% and \$170 at 1.0%
- Judicious blending can reduce the premium to \$70 to \$80/ton at 1.5% and \$90 to \$100/ton at 1.0%

**BUT**

- Compatibility problems
- Ignition problems
- Premium will increase as gas oil - fuel oil differential grows
- Reflects refiners propensity to invest in fuel oil conversion / coking
- Three times more costly to remove a ton of SOx than scrubbing



## Economics of Residual Desulphurisation

Capacity	million tons p.a.	1.5
Capital cost	US\$ million	475
Required capital return	%	22
Operating costs	\$/ton	9
Fuel costs	\$/ton	33
Annual costs	US\$Mill	
Capital charge		105
Operating costs		64
Total		<u>169</u>
Production yield	%	93
Desulphurisation efficiency	%	90
Feedstock sulphur content	%	4.5
Costs per ton of 0.45% S Fuel	\$/ton	120
Sulphur price premium for 1.5% S fuel when blending with 3.0%S	\$/ton	70
Cost of SOx removed	\$/ton	1,500

Max S %	Premium \$/ton
1.5	70
1.0	95
0.5	118

Refiners and bunker suppliers will find ways to minimise these costs

Generates significantly more GHG than scrubbing or blending

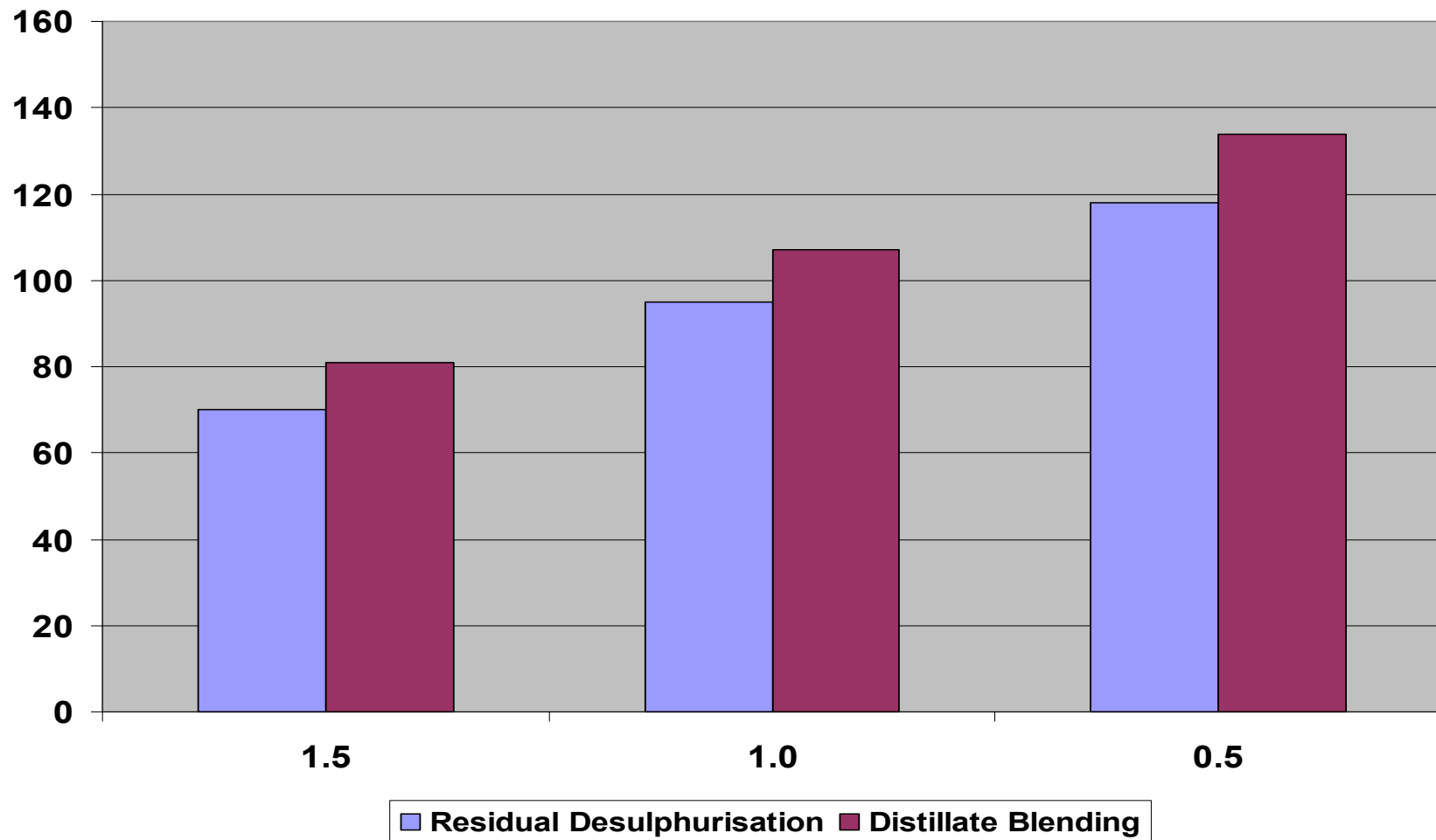
Potential compatibility problems

Almost twice as costly to remove a ton of SOx than scrubbing

**BUT**

Could be an option in the future

## Residual desulphurisation appears less costly than distillate blending –



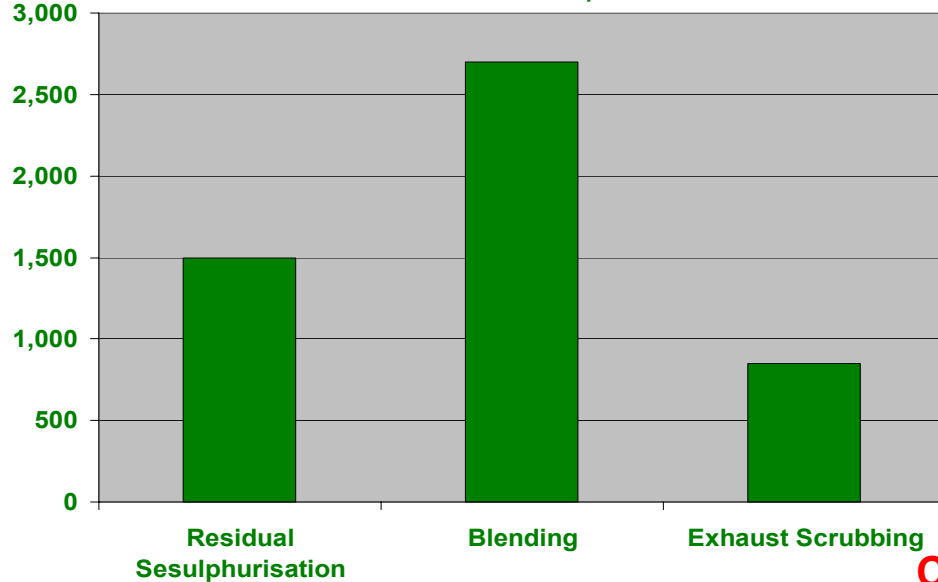
**But refiners are far less likely to build desulphurisation units**

## **Economics of cracking – demonstrative only**

- **Typical worldscale cracker is 50mbpd capacity equivalent to 2.5 million tons pa**
- **Yield of low sulphur distillate is 2.2 million tons**
- **To convert all current BFO to distillate would require 115 crackers by 2010**
- **Unit cost of a worldscale cracker within an existing refinery is \$750 million**
- **Total capital investment would be over is \$85 billion**
- **Typical Major's total annual refinery capital budget is of the order of \$3 billion**
- **If refiners go down this route it will take at least 10 years to be able to switch all vessel to 1% diesel fuels**
- **The premium on LSBFO would average \$250/ton**
- **Cost of reducing a ton of SO<sub>x</sub> by this approach would be \$6,700**

# Comparative costs of producing LSFO

Cost of SOx removal \$/ton of SOx



**Residual Desulphurisation**

- Is a less attractive investment
- Significant GHG generation

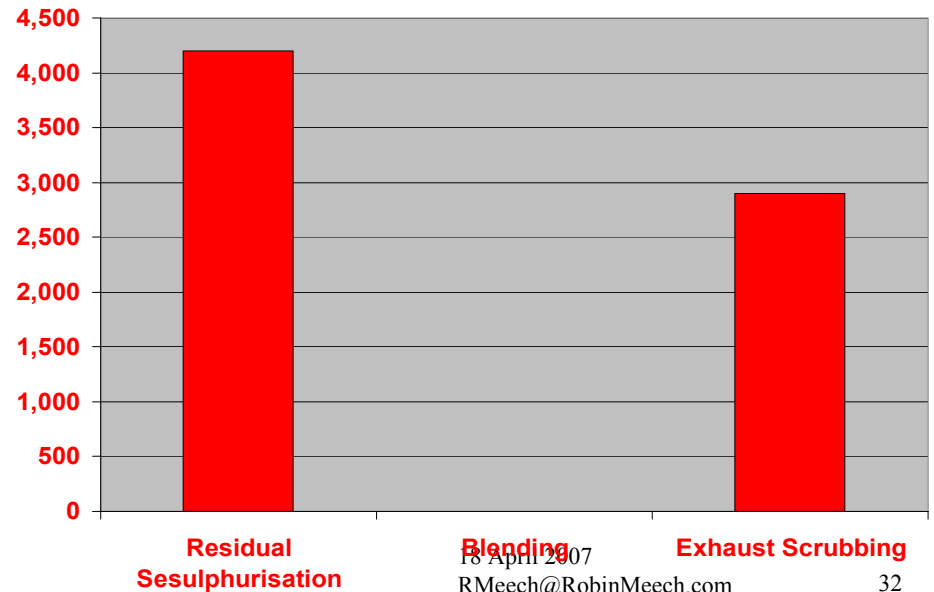
**Blending**

- No capital investment
- Cost / price risk

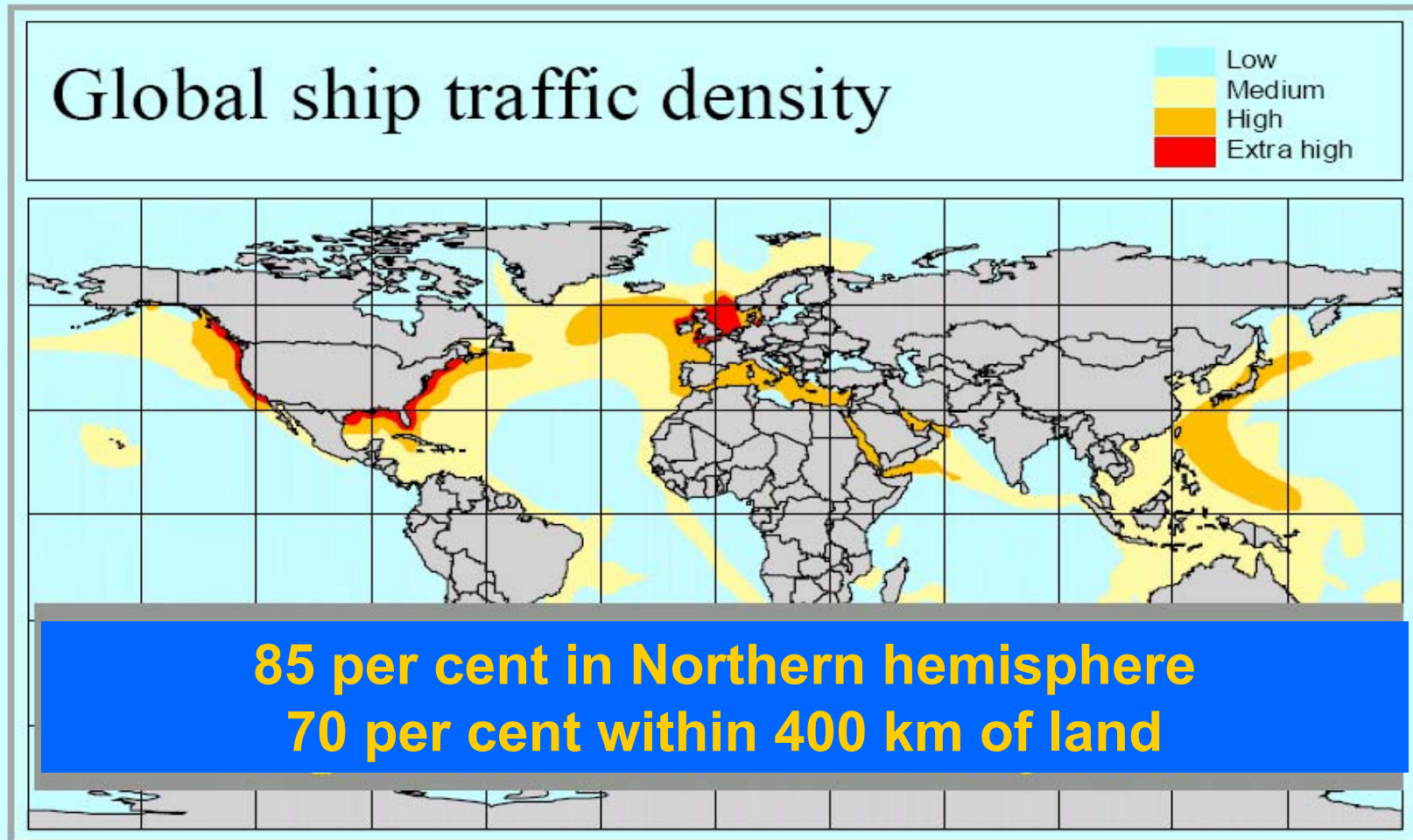
**Marine Exhaust Gas Scrubbing**

- Removes 80% of PM's
- Little extra GHG generation
- BUT multiple decisions

Capital Investment (\$) per ton of SOx removed



**There is little doubt that a large proportion of ships emissions have an impact on land**



**Relative benefits of switching to 1% S diesel globally in 2010 would appear economically unattractive**

<b>Pollutant</b>	<b>Reduction in deposition on land assuming 70% falls on land</b>	<b>Value of reducing deposition by 1.0 ton \$/ton</b>	<b>Total Benefit/ Costs \$billion</b>
<b>SOx</b>	<b>6,700</b>	<b>4,300</b>	<b>29</b>
<b>PM</b>	<b>1,000</b>	<b>29,000</b>	<b>29</b>
			<b>Total <u>58</u></b>
<b>Cost increase in global fuel purchases/manufacture</b>			<b>65</b>
<b>Net loss</b>			<b>8</b>

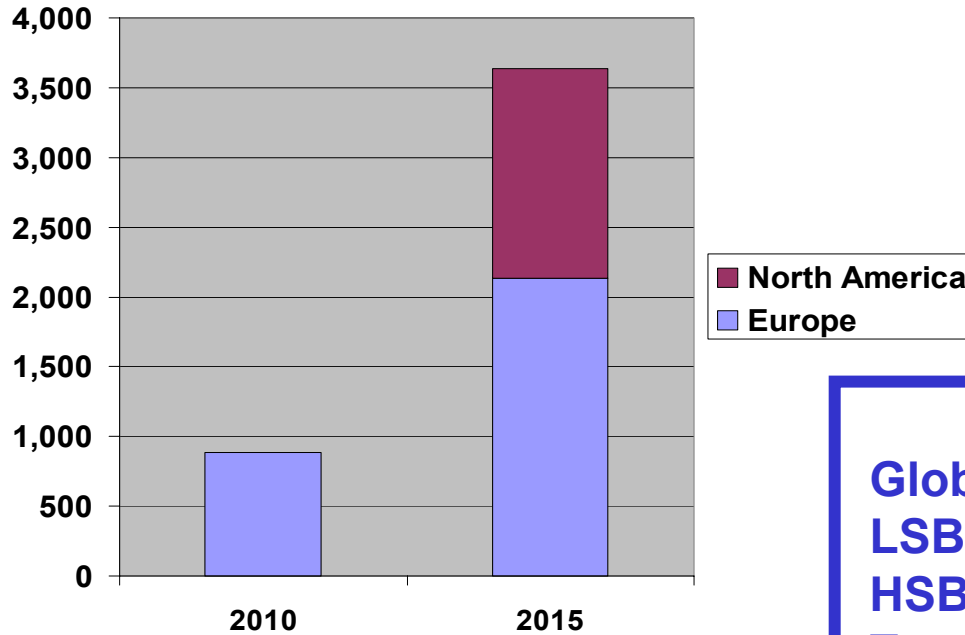
- **It is recognised that converting fuel oil to distillates generates significant emissions**
- **These economic losses would only increase as bunker consumption grows in the future**

## **Relative benefits of switching to 1% S diesel globally in 2010 would appear economically unattractive**

- **Bunker consumption would be reduced by 3 - 5% but fuel consumed in converting fuel oil to diesel would be of the same order or greater generating a net global increase in CO<sub>2</sub> and NO<sub>x</sub>**
- **SO<sub>x</sub> and PM emissions from refineries, which are generally in populous areas, would increase but can be removed by existing technology**
- **PM emissions from diesel are considered, by some, to be more harmful than from residual fuels**
- **There would be reductions in sludge disposal from ships**
- **Lower ship building costs in the future from reduction in fuel processing and tankage**
- **Easier to enforce and reduce risks from fuel change overs with a single bunker fuel worldwide**

# Additional Global Expenditure on LSBFO \$millions

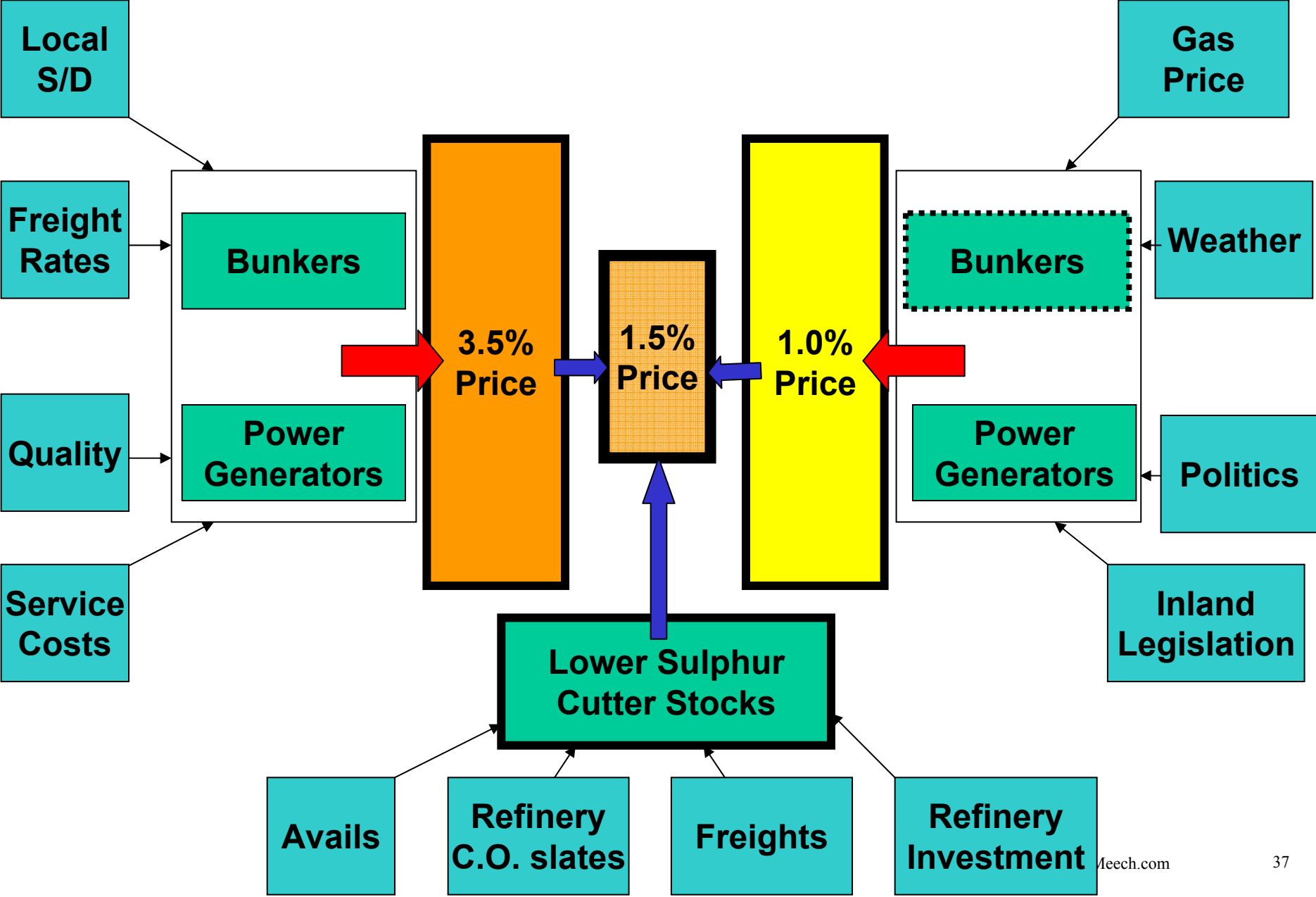
Additional Expenditure on LSBFO \$ mill



	2010	2015
<b>Global expenditure adopting INTERTANKO resolution (\$billion)</b>		
1% Diesel	100	138
<b>Average Global Cost Increase</b>		
\$/ton	190	206
%	200	185
<b>Reduction in SOx</b>		
Million tons	9.3	10.9
Cost/ton	5,960	6,400

	2010	2015
<b>Global expenditure (\$billion)</b>		
LSBFO	5	14
HSBFO	45	61
<b>Total</b>	<b>50</b>	<b>75</b>
<b>Average Global Cost Increase</b>		
\$/ton	3.70	11.80
%	1.9	5.0
<b>Reduction in SOx</b>		
Million tons	0.68	1.20
Cost/ton	\$1,410	\$3,000

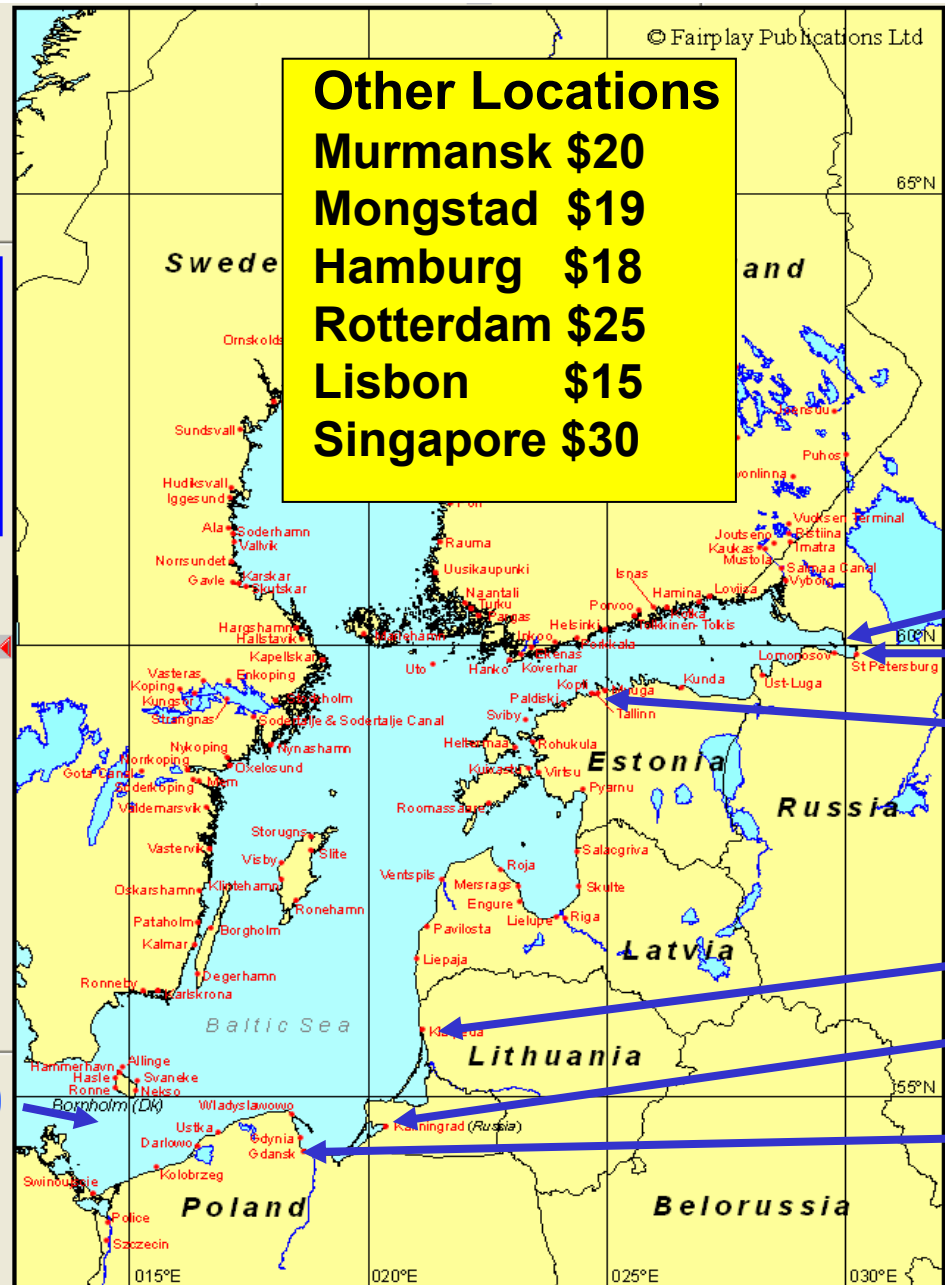
# Sulphur price differential formulation



# The 1.5% sulphur premium in the Baltic is averaging at about \$23/ton

Rotterdam \$/ton		
	380 cSt	180 cSt
HS	298	318
LS	323	343
Diff	25	25

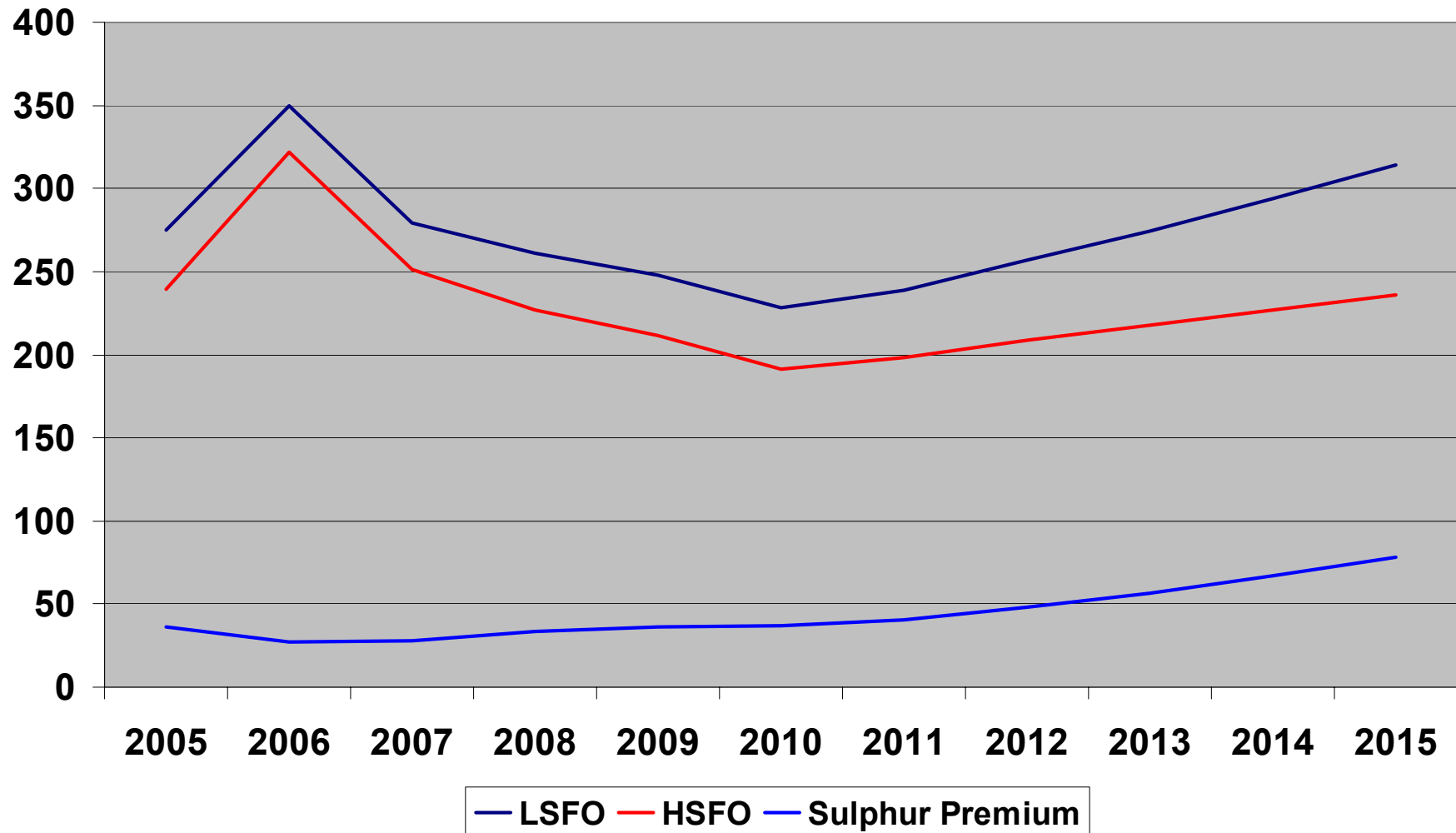
**Other Locations**  
**Murmansk \$20**  
**Mongstad \$19**  
**Hamburg \$18**  
**Rotterdam \$25**  
**Lisbon \$15**  
**Singapore \$30**



- Primorsk \$20
- St Petersburg \$27
- Tallin \$11
- Klaipeda \$21
- Kaliningrad \$40
- Gdansk \$25

Great Belt \$20

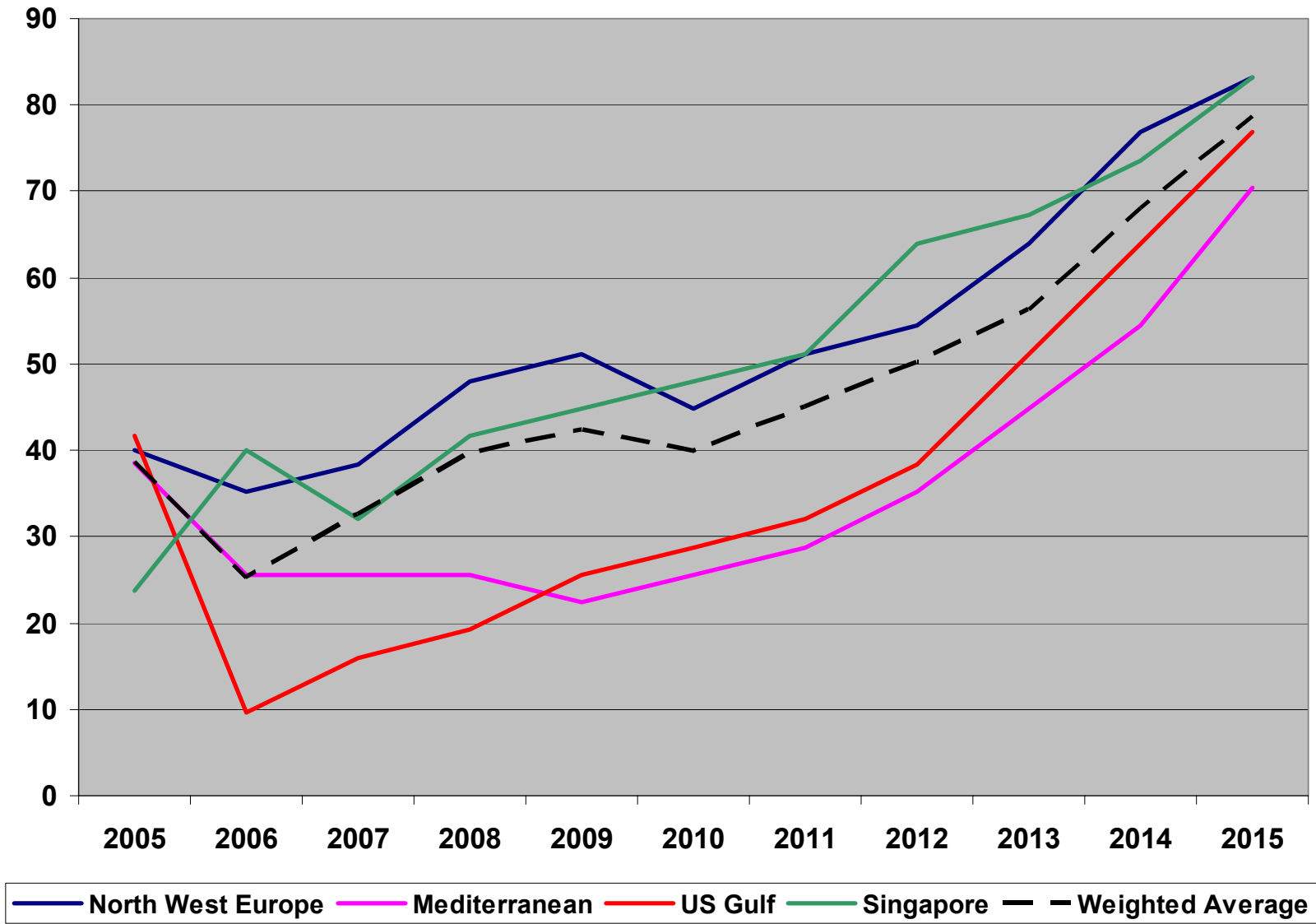
## Global average fuel oil prices \$/ton



Source: "Outlook for Bunker Fuel Oil and Heavy Fuel Oil to 2015"

18 April 2007  
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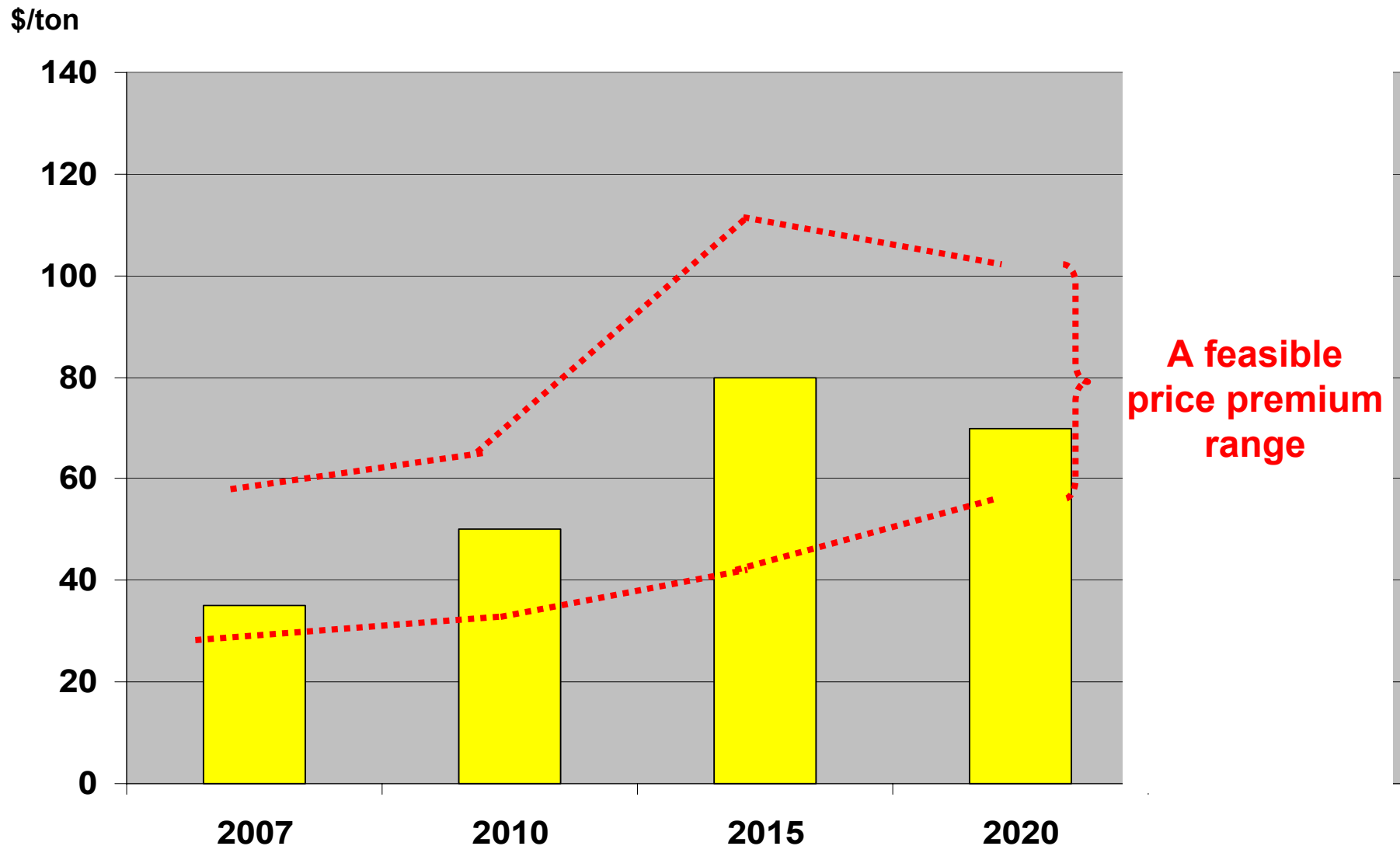
# The 1.5%S premium will climb steadily to \$80/tons over the coming decade



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Source: "Outlook for Bunker Fuel Oil and Heavy Fuel Oil to 2015"

The 1.5% to 3.0% S price premium will increase until refiners invest in cracking/coking and abatement technologies start to mature

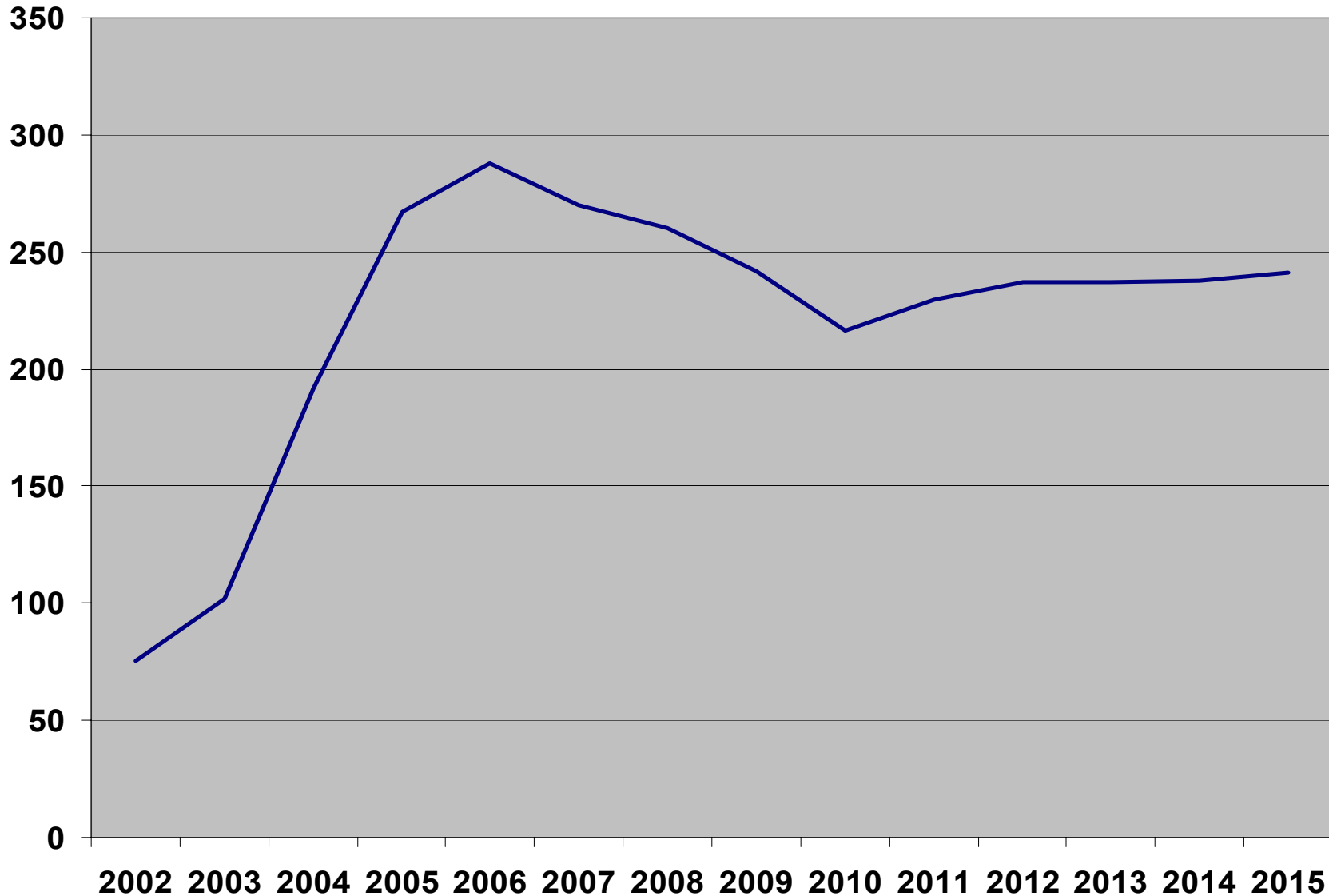


Quality issues will ensure 1.5% S bunkers prices are above 1.0% S inland utility fuels

Source: "Outlook for Bunker Fuel Oil and Heavy Fuel Oil to 2015"

18 April 2007  
RMeech@RobinMeech.com

# Over the next decade the HSFO – Gas Oil differential will average \$245/ton



Source: "Outlook for Bunker Fuel Oil and Heavy Fuel Oil to 2015"

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# What are the options for the ship owner?

OPTION	Days pa spent in SECA		
	0	183	365
1.5%S at all times			
Switch to gas oil on entry			
Segregated Bunker Tanks and switch to LSFO on entry			
On board blending			
Scrubbing			
Emission Trading (Buying)			
Non Compliance			

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[ken@ecm.com](mailto:ken@ecm.com)

## Semi-Automatic fuel blending



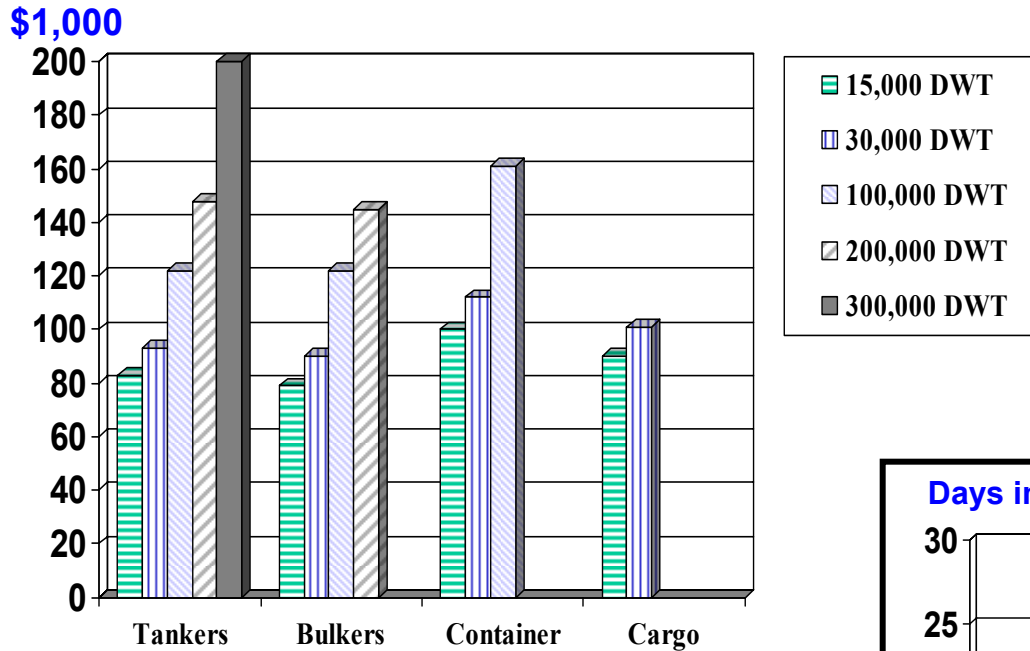
- Can be readily installed in most engine rooms
- Blending immediately prior to consumption will reduce instability problems
- Careful operation required but automation reduces risks

The cost to retrofit an inline blender is between \$40,000 and \$80,000

Justified after 15 days steaming in a SECA



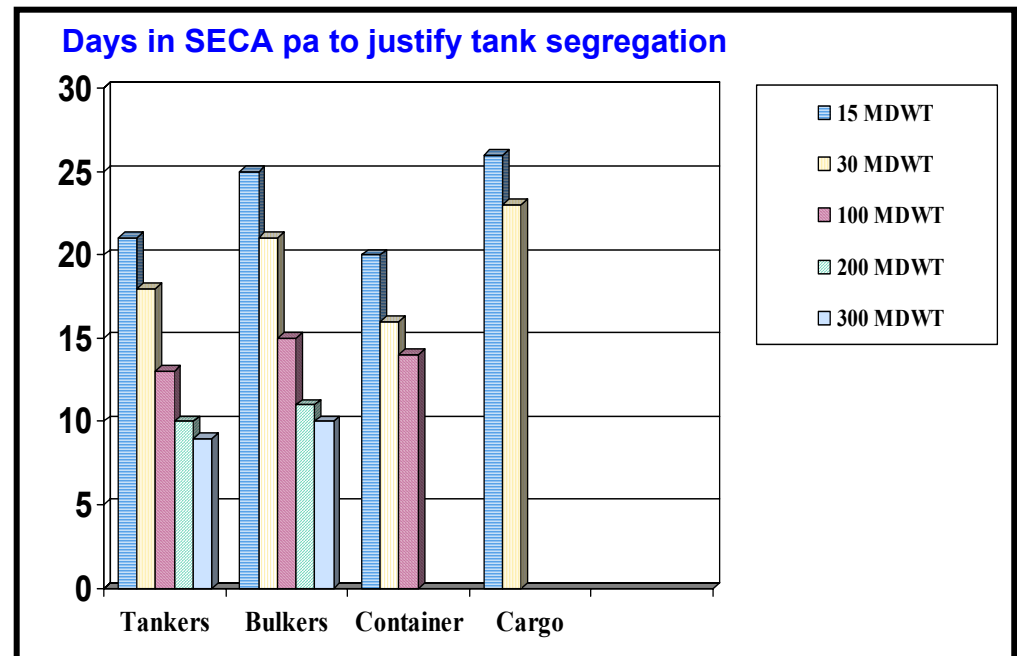
## Retrofitting segregated bunker tanks is attractive to most owners trading into a SECA



Any vessel making more than five visits a year will benefit from increasing bunker segregation compared with consuming distillate material

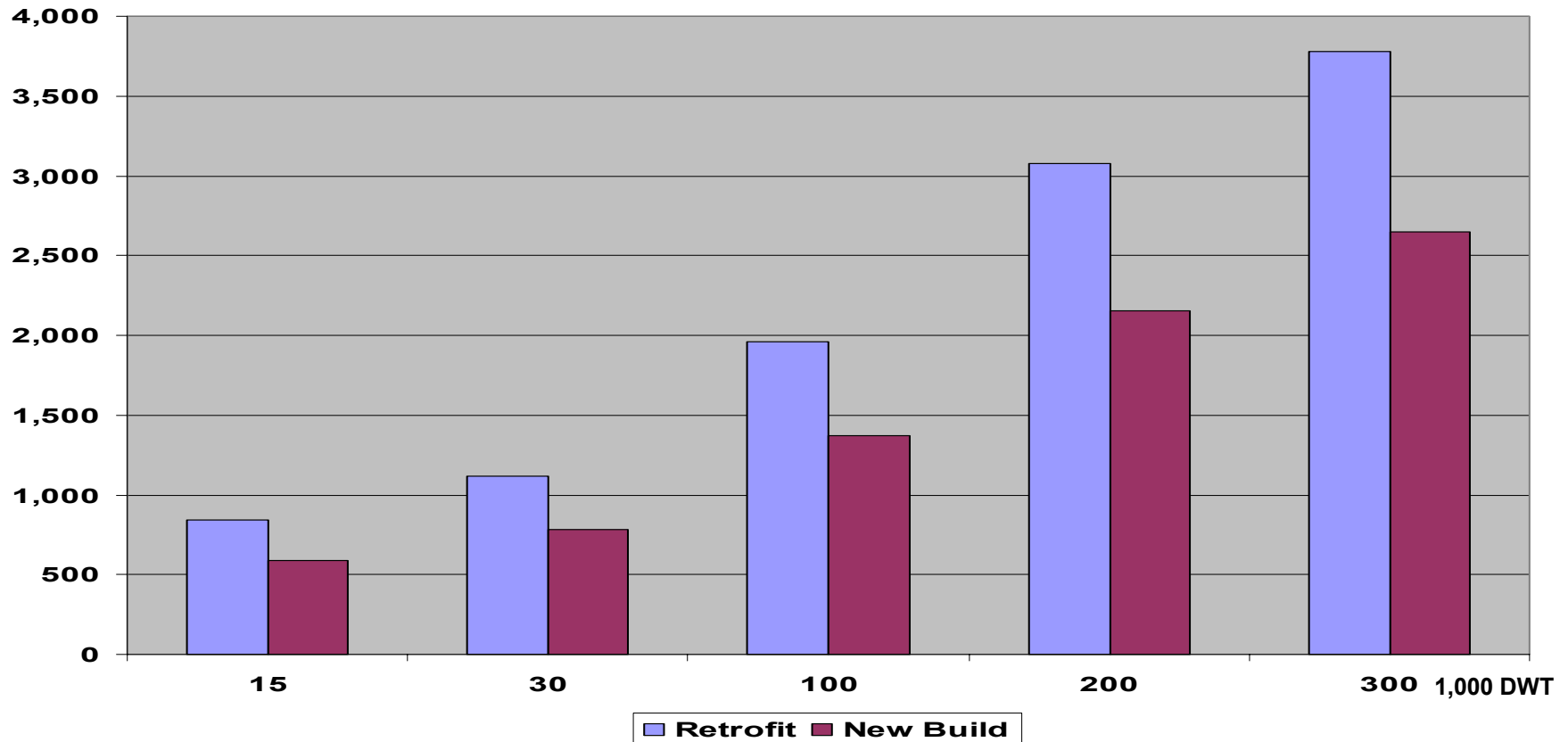
Greater flexibility can be achieved by duplicating settling and day tanks

Multiple bunker tanks should be included in all new builds



# The cost of retrofitting scrubbers on a VLCC will approach \$4.0 million

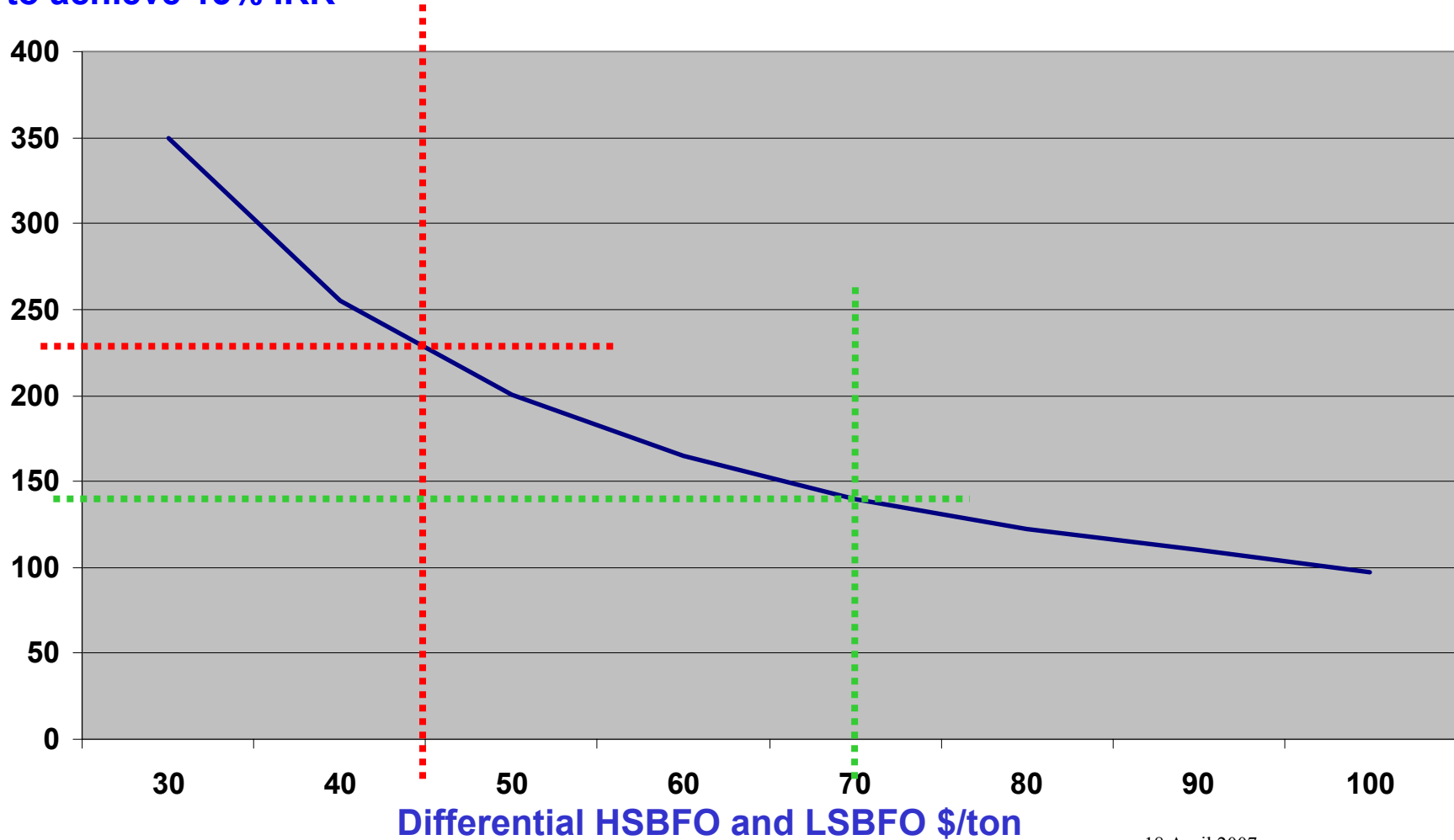
## Investment costs of scrubber \$ 1,000



**Costs will subsequently become lower for new builds and as the technology develops**

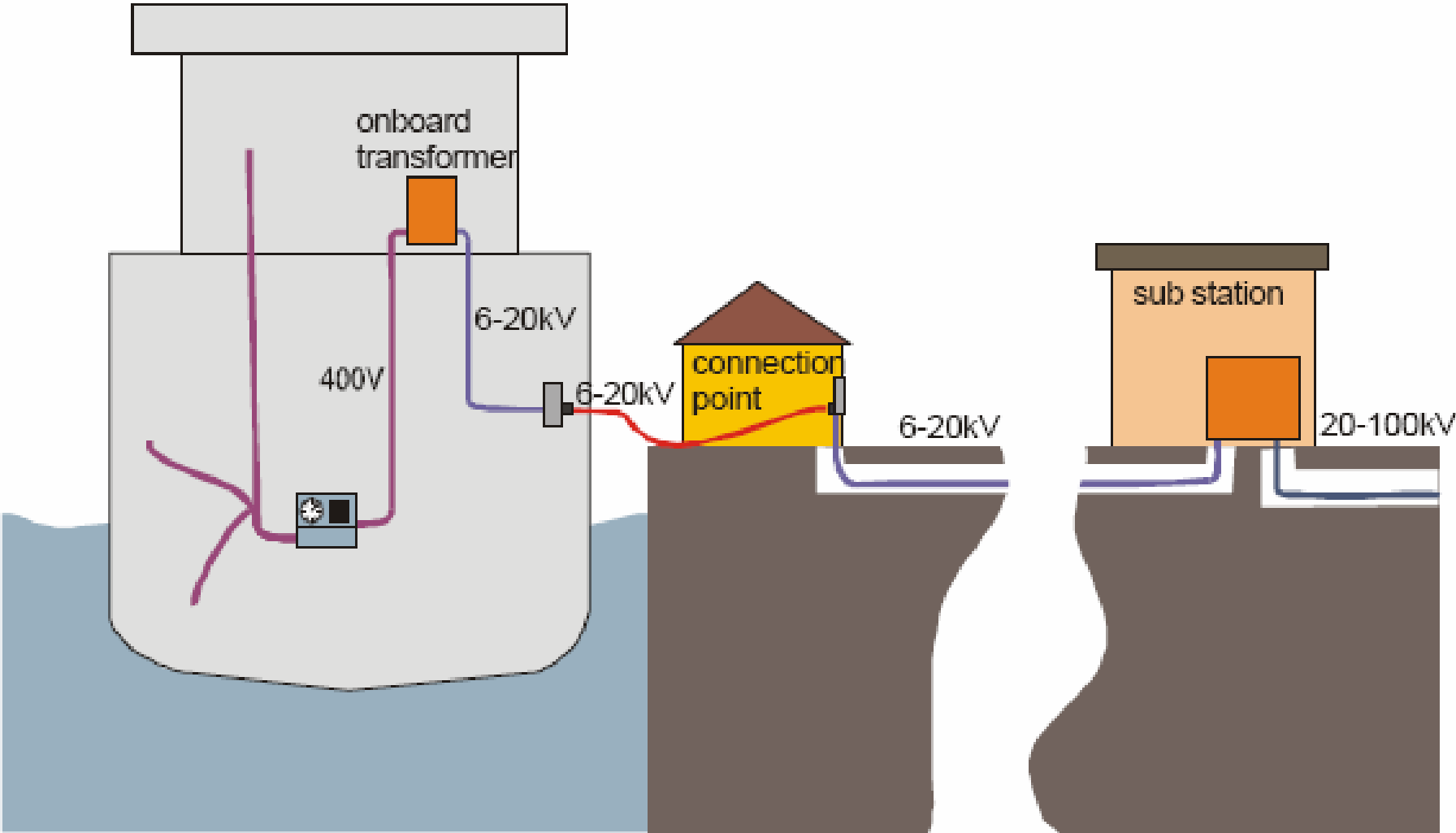
In the short term in order to achieve an IRR of 15% on retrofitting scrubbers the vessels will have to operate full time in the SECA

Days steaming  
in the SECA pa  
to achieve 15% IRR

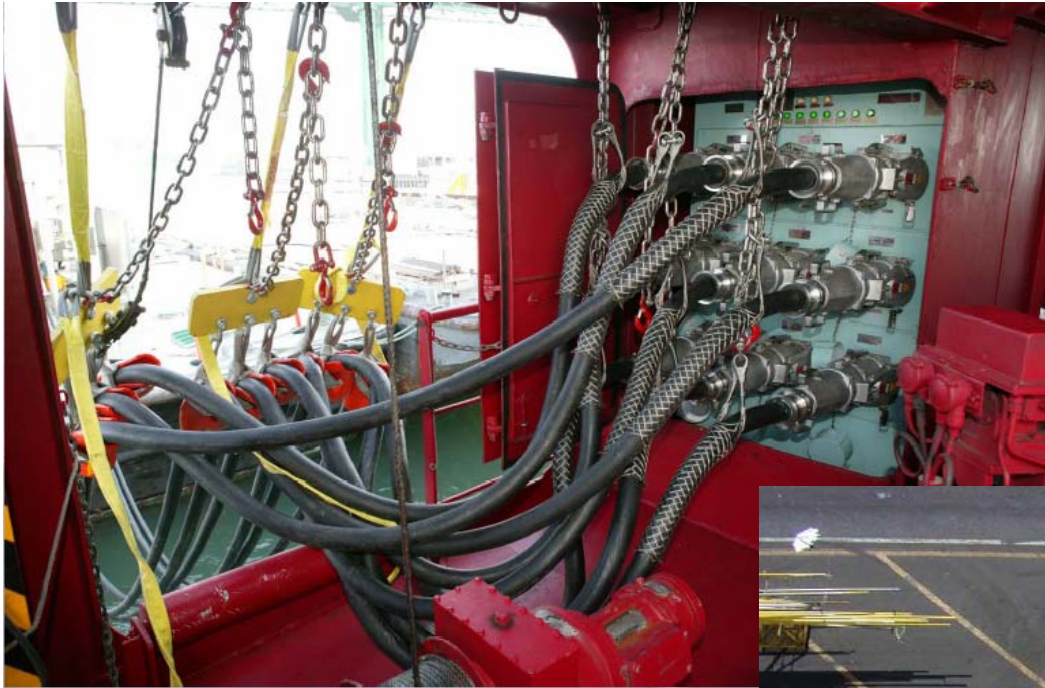


Longer term the economics will become more favourable

# The basic concept



# Complex electrical connections for in-port power supply



## **Switching to on-shore power in port (Cold Ironing) is being introduced**

- **The procedure of shutting down all on board power and connecting to a shore electrical source while alongside is again being promoted in Europe and the US.**

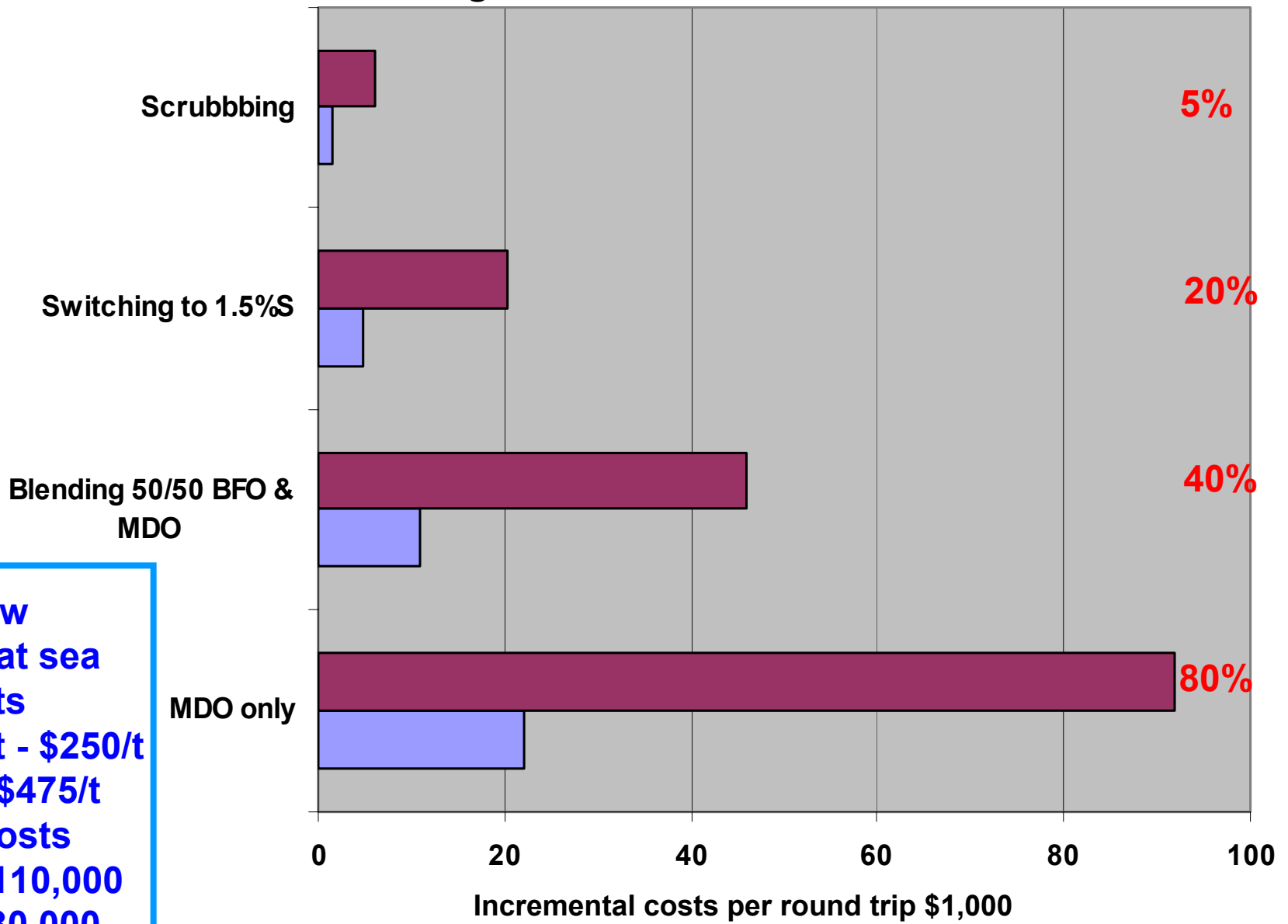
**Facilities exist in**

- **Gothenburg**
  - **Major US West Coast ports**
- 
- **Conversion costs for owners are reported to be as high as \$2 million for large box ships**
  - **Technical difficulties associated with tankers needing power for pumping are as yet unsolved**
  - **There is an urgent need for standardization if the approach is to expand**
  - **There is also a need for financial incentives that encourage participate**

## SOx abatement technology possibly applicable to the marine sector

<b>EcoSilencer®</b> MES	<b>Sea Water Scrubbing</b>	<b>New project – Expanding</b>
<b>Krystallon</b> (BP/Kittewake)	<b>Sea Water Scrubbing</b>	<b>Starting commercial operations</b>
<b>Neste</b> (Kvaerner Power)	<b>Sea Water Scrubbing</b> <b>Land based technology</b>	<b>Recent announcement</b>
<b>JIME Nishida</b>	<b>Three phase electrolytic</b>	<b>One of a number of new Japanese developments</b>
<b>Aquafuel</b>	<b>Additives - particle extraction replicates on shore technology</b>	<b>Test bed stage -18 month program to trials in summer 2007</b>
<b>Green Plus</b> Biofriendly Corporation	<b>Additive</b>	<b>Tested on MDO and now on VLCC's</b>
<b>Sonocracking™</b> SulphCo	<b>Ultrasonics</b>	<b>Claim up to 30% sulphur reduction in crude/fuel oils with new facility commissioning in Fujairah in 2007</b>
<b>Japanese shipyards</b>	<b>Advanced carbon fibers</b>	<b>Early developments</b>
<b>Residual desulphurization</b>	<b>Hydrogen/sulphur extraction high energy/costly</b>	<b>Over 30 units operating in refineries worldwide</b>

# Comparative economics 30,000 DWT tanker steaming into the SECA to either the ARA or St. Petersburg

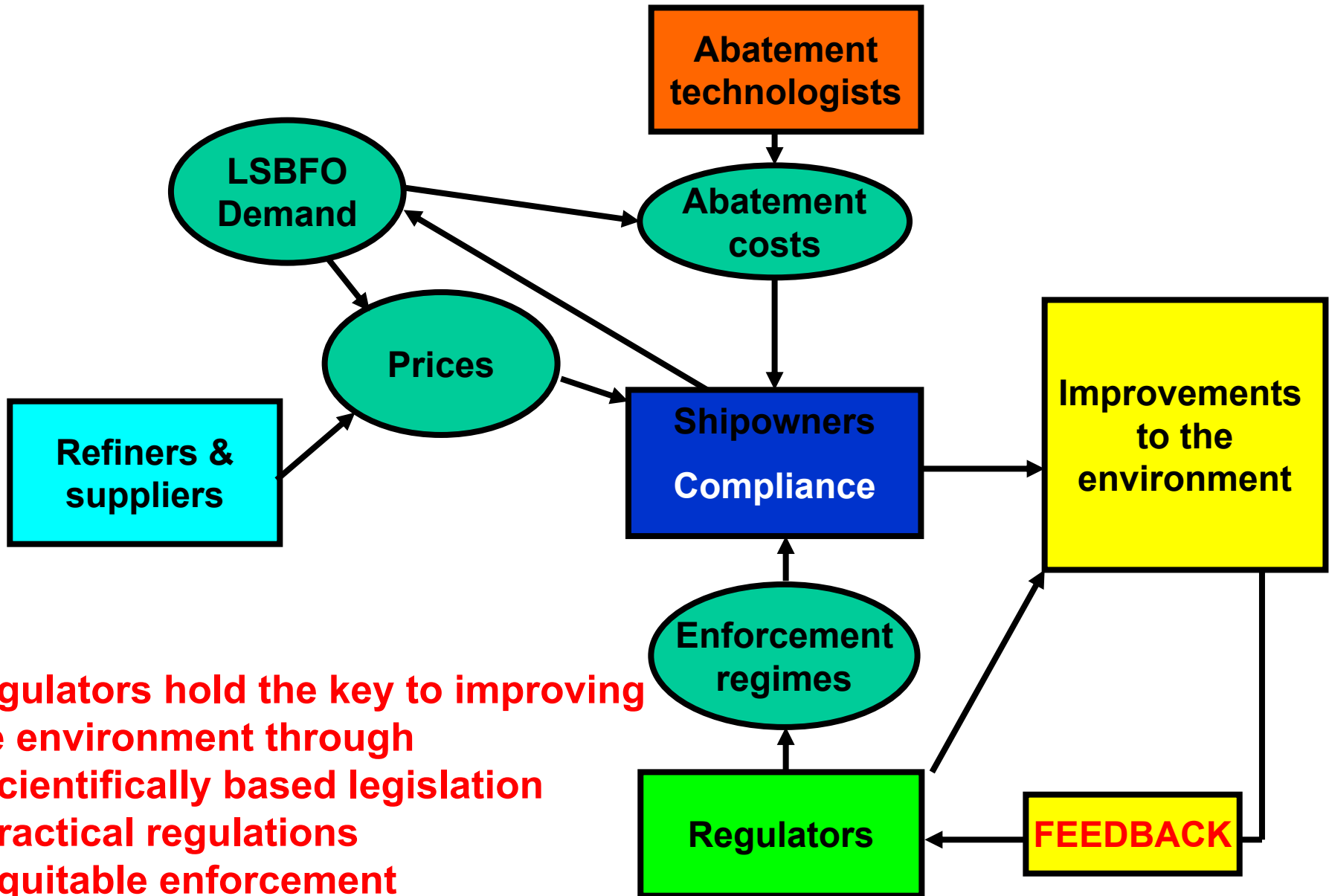


**8,400 kw**  
**40 tpd at sea**  
**14 knots**  
**380 cSt - \$250/t**  
**MDO - \$475/t**  
**Total costs**  
**St P. \$110,000**  
**ARA \$30,000**

## **Other related costs of compliance must be addressed**

- 1. Investment in bunker tank segregation/abatement**
- 2. Increased lube costs**
- 3. Smaller steams increase delivery costs**
- 4. Increased operating risks**
- 5. More training**
- 6. Increased working capital costs**
- 7. More complicated charter parties**
- 8. More disputes/ legal and technical fees**
- 9. Possible fines/penalties**
- 10. Greater chance of incompatible/unstable fuels**
- 11. More fuel testing**
- 12. More de-bunkerings**
- 13. More samples to hold**
- 14. More administration**
- 15. Reduced fleet flexibility**
- 16. Installation and maintenance of monitoring equipment**
- 17. The costs of uncertainty**

## The dynamics of improving the environment



**Regulators hold the key to improving the environment through**

- **Scientifically based legislation**
- **Practical regulations**
- **Equitable enforcement**

**Mid-Atlantic and Northeast Collaboratives**

**The Impact of Marine Emission Legislation  
on the Bunker Industry  
A European Perspective**

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