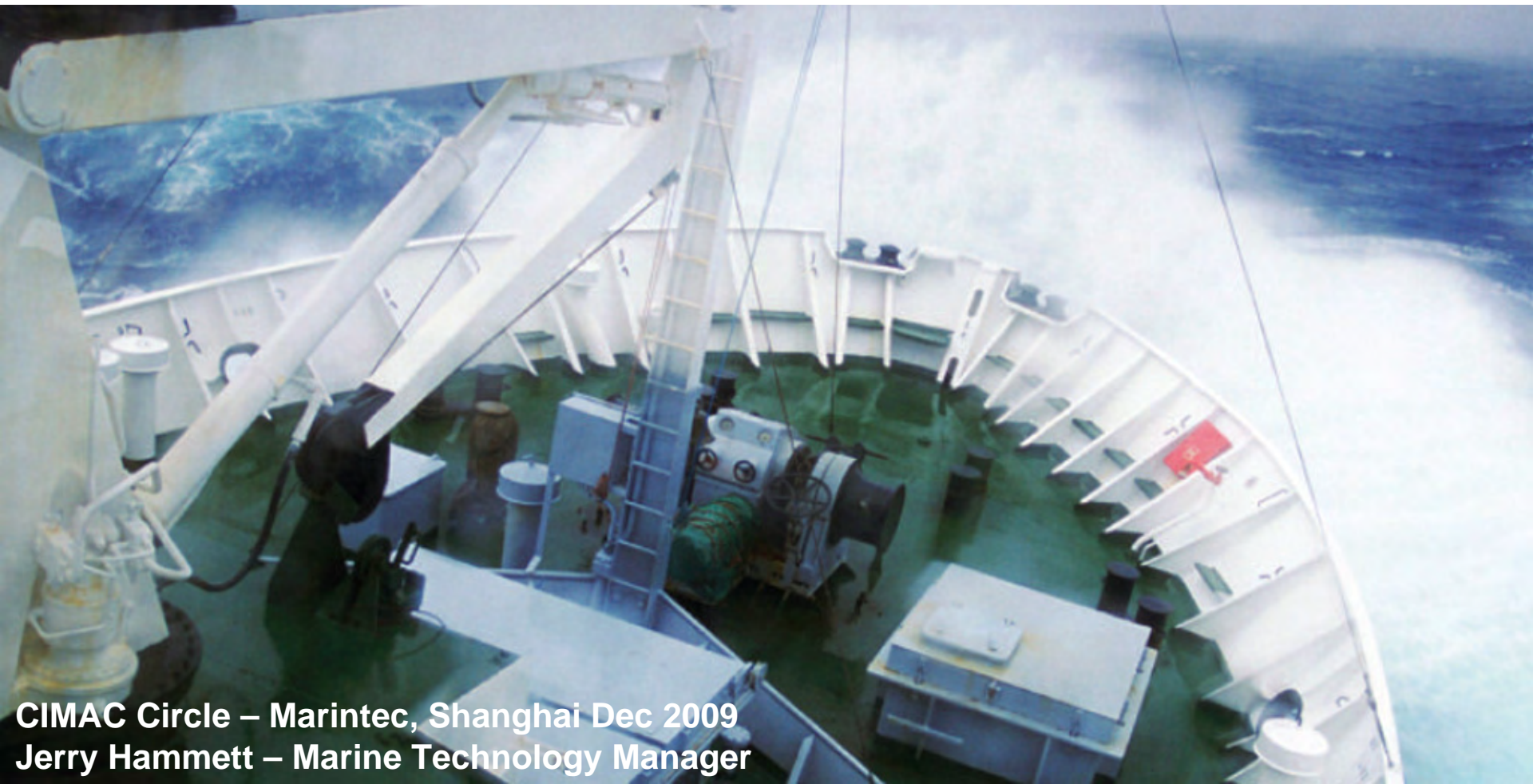




Shell Global Solutions

ABATEMENT TECHNOLOGY, RFO vs DISTILLATE - impact on costs & emissions



CIMAC Circle – Marintec, Shanghai Dec 2009
Jerry Hammett – Marine Technology Manager

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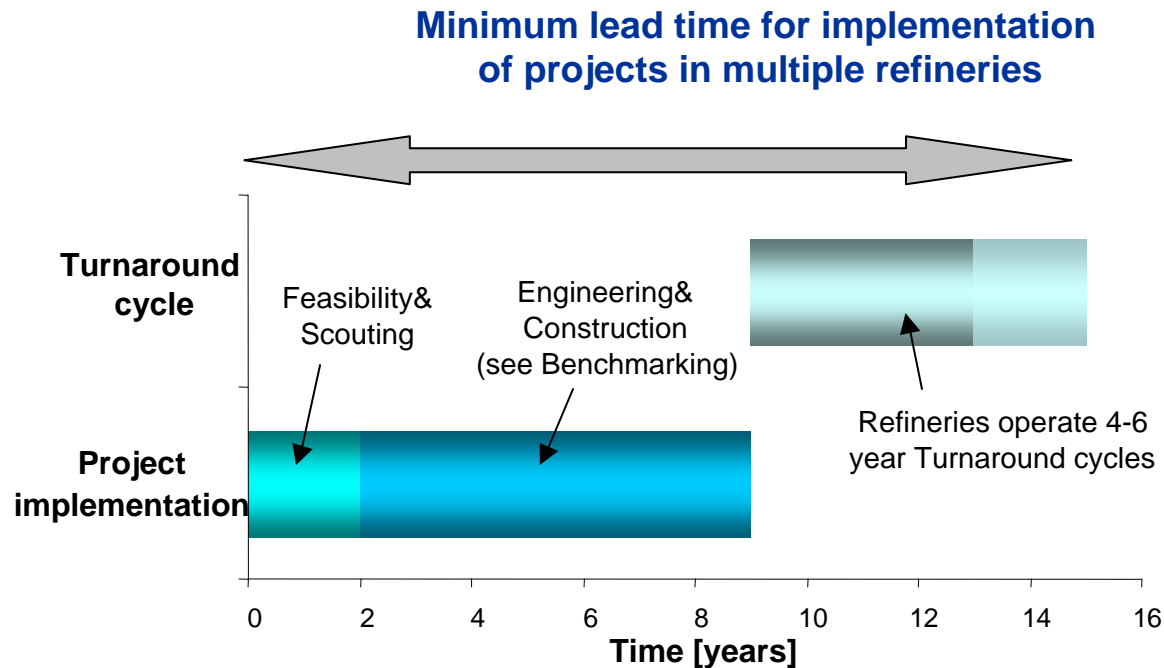
LEGISLATION WILL SHAPE FUTURE MARINE FUELS

- ECA bunkers reduced from 1.5 to 1.0 wt% 1st July 2010
- Global bunker spec reduced from 4.5 to 3.5 wt% sulphur, effective 1st Jan 2012

LEGISLATION WILL SHAPE FUTURE MARINE FUELS

- ECA bunkers further reduced to 0.1 wt% by 2015
- Global bunker spec reduced to 0.5 wt% sulphur, effective 1st Jan 2020. May be postponed to 2025 subject to a feasibility review scheduled to be completed no later than 2018.

REFINERIES NEED INVESTMENT LEADTIME



We could find that when 2020 arrives much of the refining infrastructure may look as it does today.

A DEMAND FOR MORE DISTILLATES BY SHIPPING WOULD HAVE A GLOBAL IMPACT

EUROPE ALONE CURRENTLY IMPORTS >30 MILLION MT/A DISTILLATES: PRIMARILY FROM FSU AND MIDDLE EAST

- An additional 50+ million MT/A will be required to supply the needs of the shipping industry if there is a full switch to distillates
- There will be global competition for these barrels, not just within the shipping industry...

“RED ALERT TO ALL YOU FARMERS AND TRUCKERS OUT THERE -- SHIPPING PLC IS THINKING HARD ABOUT MAKING A RAID ON THE GLOBAL VILLAGE AND SIPHONING OFF ALL YOUR DIESEL.”

Source: DAVE ERNSBERGER, "THE BARREL" WEBLOG, PLATTS, 30/05/08

“COULD THE RISING COST OF SHIPPING CHANGE GLOBAL TRADE? PRICE INCREASE FOR SHIPPING CARGO OVER LONG DISTANCES MAKES IT EASIER FOR DOMESTIC MANUFACTURERS TO WITHSTAND COMPETITION FROM LOWER-WAGE COUNTRIES...US STEELMAKERS, FOR THE FIRST TIME IN OVER A DECADE HAVE BECOME COMPETITIVE AGAINST CHINESE IMPORTS”

Source: CIBC WORLD MARKETS INC, REPORTED IN BUNKERWORLD, 05/06/08

THE ENERGY CHALLENGE WILL IMPACT MARINE FUELS

- Surge in energy demand
- Supply will struggle to keep pace
- Environmental stresses are increasing

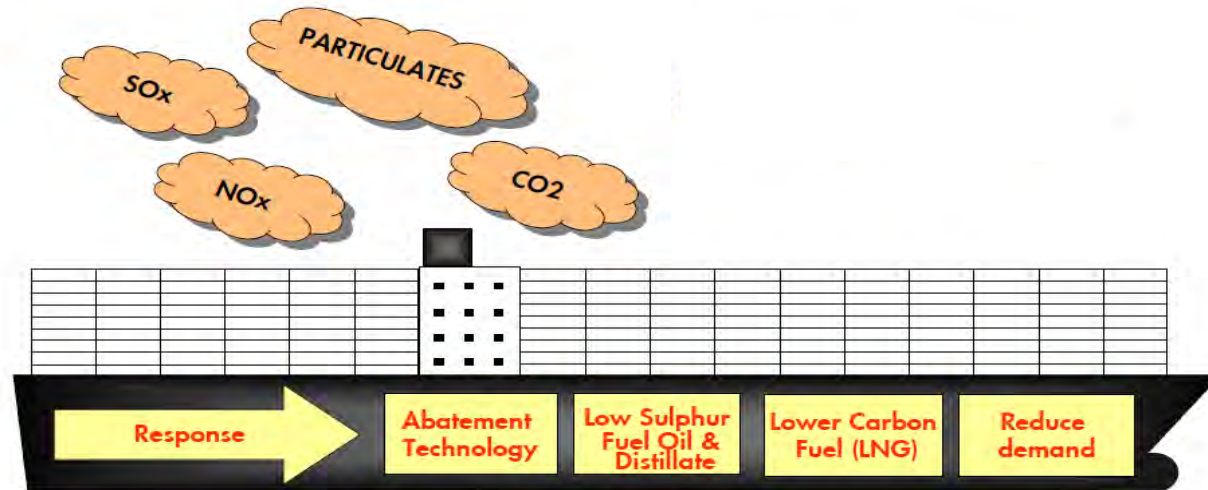


COMPLEX ECONOMIC SIGNALS WILL HELP DEFINE MARINE FUEL EVOLUTION

- Will new refinery projects and expansions be delayed to take advantage of an expectation of lower materials costs and to avoid periods where demand growth is low ?
- Will Fuel Oil be converted to maximise middle distillate production ?
- Will refinery capacity additions, current infrastructure capability outpace demand growth through to 2015 and beyond ?

SO WILL AN INCREASED FOCUS ON ENVIRONMENTAL CONSIDERATIONS

- Climate change is the next big challenge for shipping
- New designs & new practices required
- There are no “silver bullets”

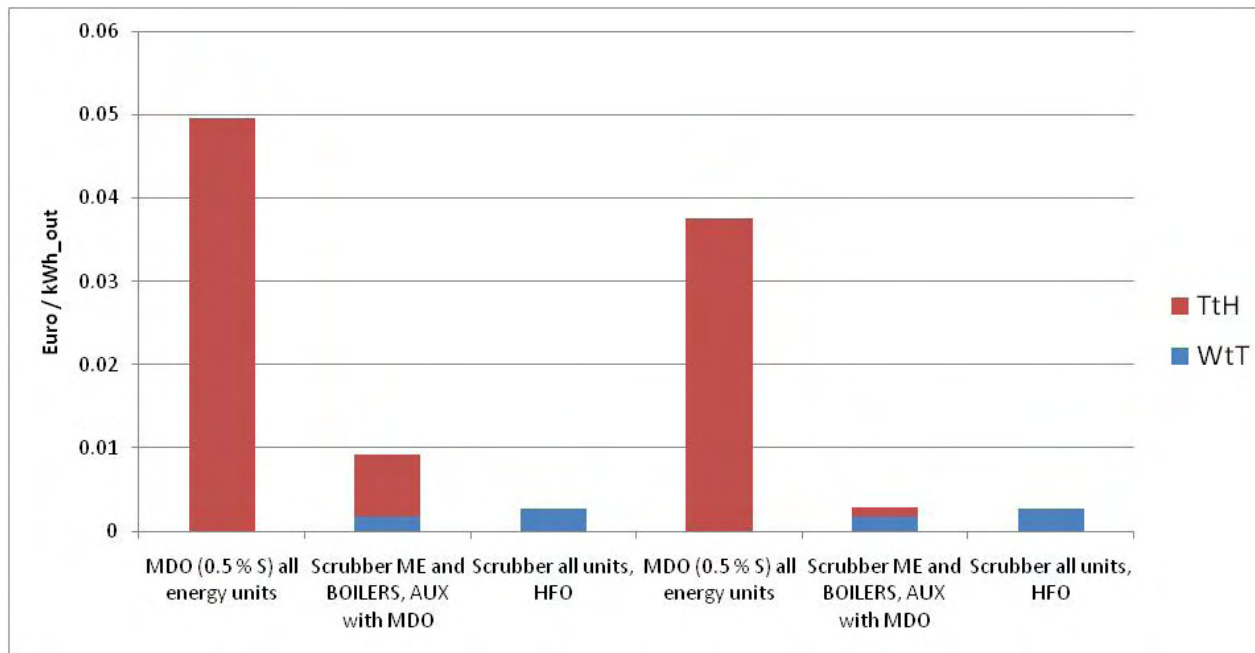


Tank-to-Stack emissions reduced significantly by seawater scrubbing and use of low sulphur (distillate) fuel

(Car carrier)	Tank-to-Stack emissions			
	CO ₂ g/kWh out	SO _x g/kWh out	NO _x g/kWh out	PM g/kWh out
Scenarios				
HFO all energy units	--	--	--	--
MDO (0.5 % S) all energy units	-4%	-83%	-3%	-83%
Scrubber (full capacity) ME and BOILERS, AUX with MDO	1%	-91%	0%	-79%
Scrubber all units, HFO	2%	-93%	0%	-80%

- ❑ Scrubbing and using low S fuel both effectively reduces SO_x and PM (>70%).
- ❑ CO₂ emissions from fuel combustion reduces when switching to distillate fuel.*
- ❑ CO₂ emissions from ship operation increases as result of operating the seawater scrubber.
- ❑ NO_x emissions are not affected by scrubbing.

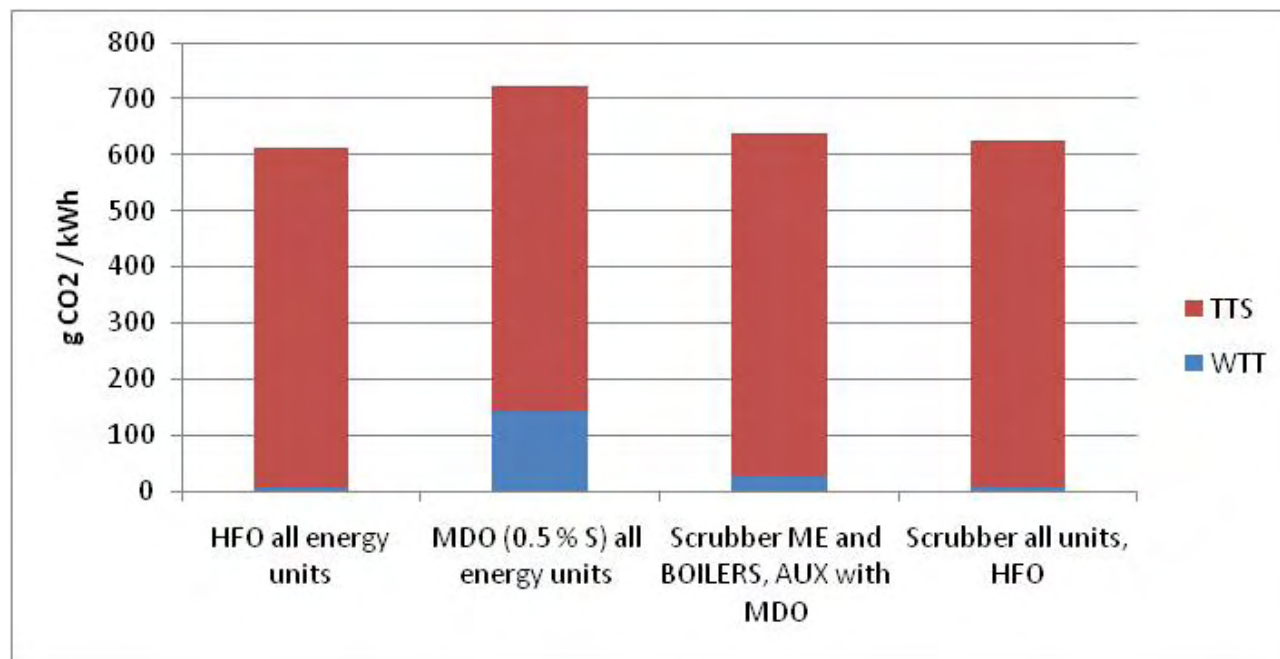
Significant increase of Well-to-Hull costs when switching to low sulphur (distillate) fuels



- ❑ Both scenarios show a significant increase in overall Well-to-Hull costs with a 100% switch to low sulphur (distillate) fuel
- ❑ The combination of seawater scrubbing and usage of high sulphur fuel appears most cost effective way of reducing SOx emissions.

Strongest contribution from ship fuel use on overall Well-to-Hull CO₂ emissions

Car carrier and 0.5%S – 100% conversion



- ❑ Ship fuel combustion is the main contributor to well-to-hull CO₂
- ❑ Appreciable increase of overall CO₂ emissions when switching to distillate fuel

WORKING TOWARDS COST EFFICIENT ENERGY SOLUTIONS WILL DEPEND ON:

- Legislation and incentives that encourages investment in technological solutions
- Understanding how world energy demand will develop and how refiners will respond.
- The shipping industries appetite to tackle environmental stress with a wide range of measures

