



# Biofuels and their effect on the shipping industry

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# Biofuels & the Effect on the Shipping Industry

- What are Biofuels? The three Generations
- Existing use
- Drivers – Political / Environment / Economic
- Production Areas
- Refining Areas
- Shipping Economics Implications
- Ship Design Implications
- Use of Biofuels on board ships
- Conclusions
- Discussion and Questions



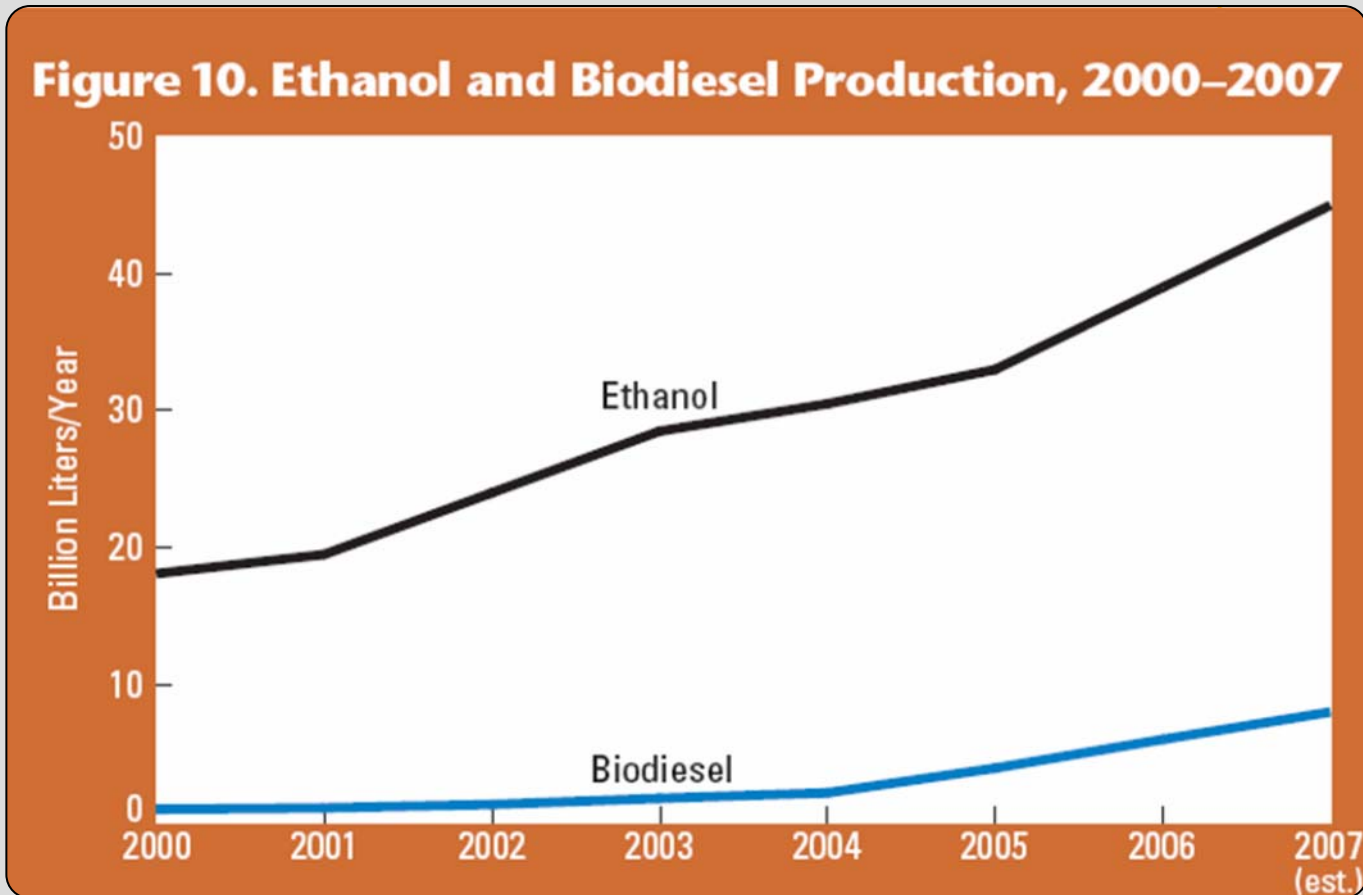
Picture by kind permission of Jonathan Morley

# Types of Biofuels

	1st Generation	2nd Generation	3rd Generation
Feedstock	<p><u>Ethanol Based</u> Sugar Starch <u>Oil Based</u> Corn Rapeseed Soybean Palm</p>	<p>Agriculture/food processing waste Grasses Trees</p>	<p><u>Transgenic Materials</u> Low lignin Eucalyptus Poplar Trees Sorghum <u>e.g. Higher Yield Feedstocks</u> and.. Algae</p>
Process	<p>Fermentation (bio-alcohol) Transesterification (biodiesel)</p>	<p>Fischer Tropsch Biomass-To-Liquid (BTL) Fermentation Gasification</p>	<p>Fischer Tropsch Biomass-To-Liquid (BTL) Fermentation Gasification Algae Processing</p>
Product	<p><u>Bio Alcohols</u> Ethanol <u>Biodiesel</u> Fatty Acid Methyl Esther (FAME)  Unprocessed Vegetable Oil as fuel</p>	<p>Cellulosic Ethanol Biogas Biohydrogen Fischer Tropsch Diesel</p>	<p>Cellulosic Ethanol Biogas Biohydrogen Fischer Tropsch Diesel Algal Oil</p>

# Global Biofuel Production Trends

Source: REN21 Renewables 2007 Global Status Report



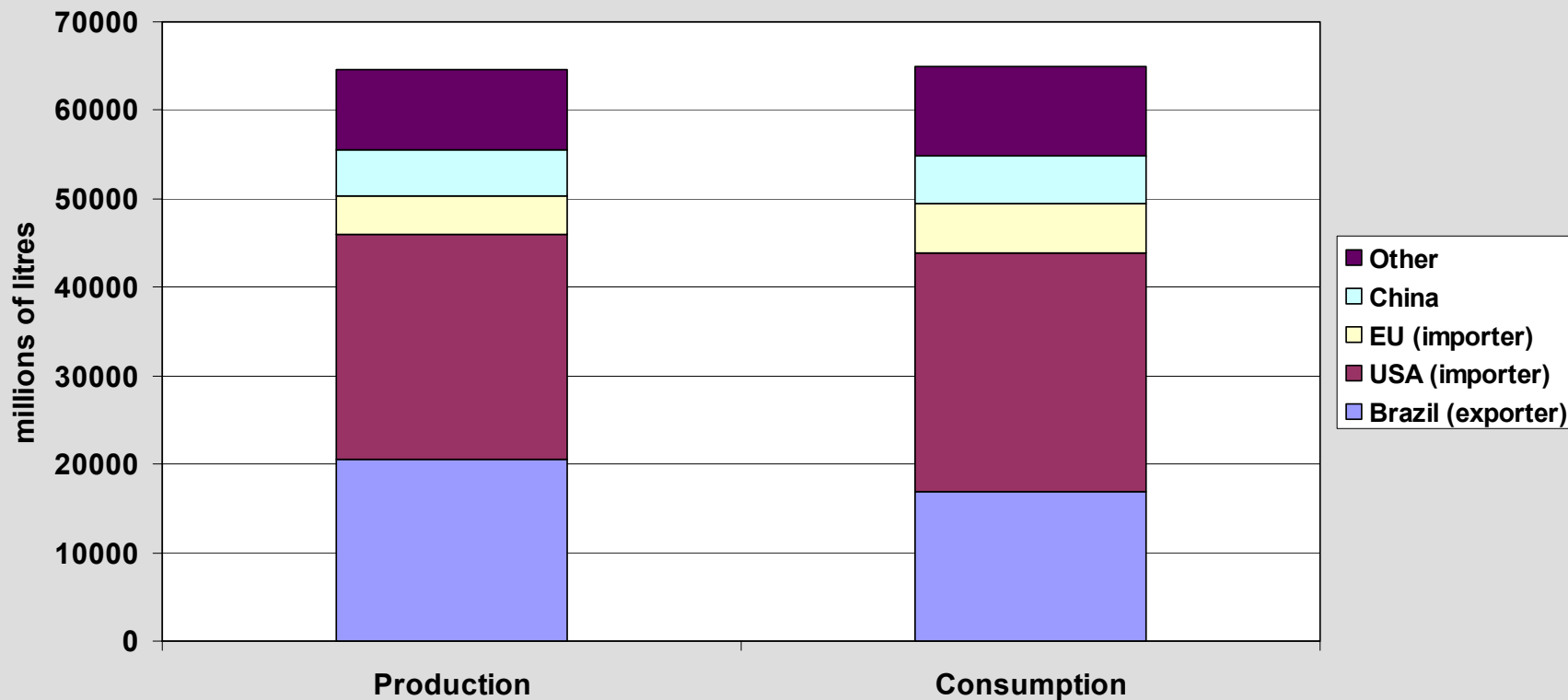
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# World ethanol production / consumption 2007

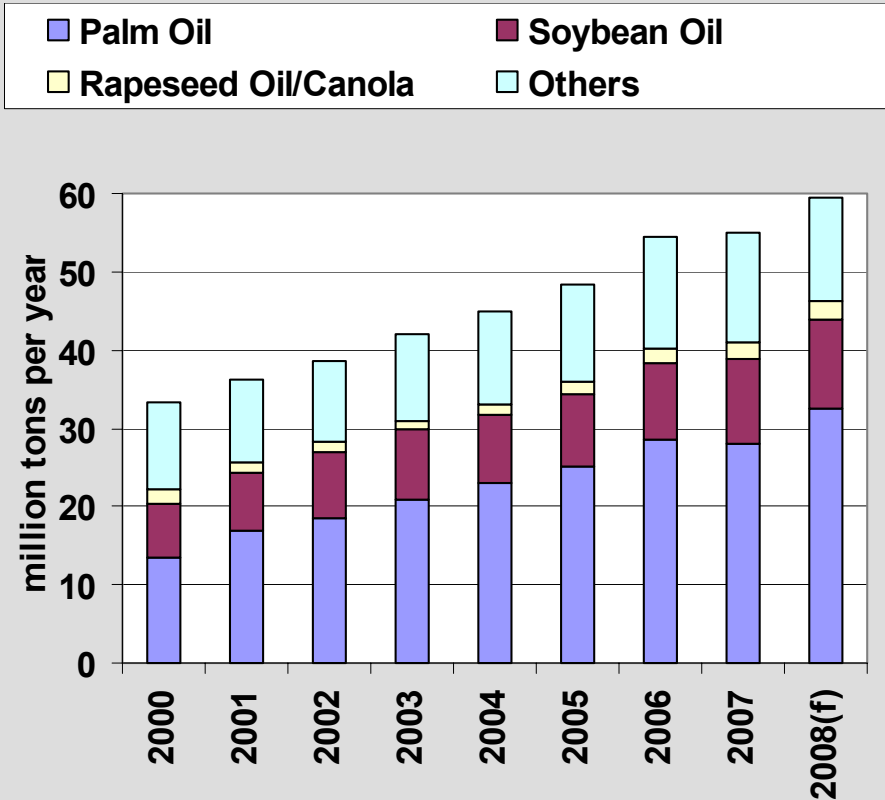
Source: LMC

World ethanol 2007

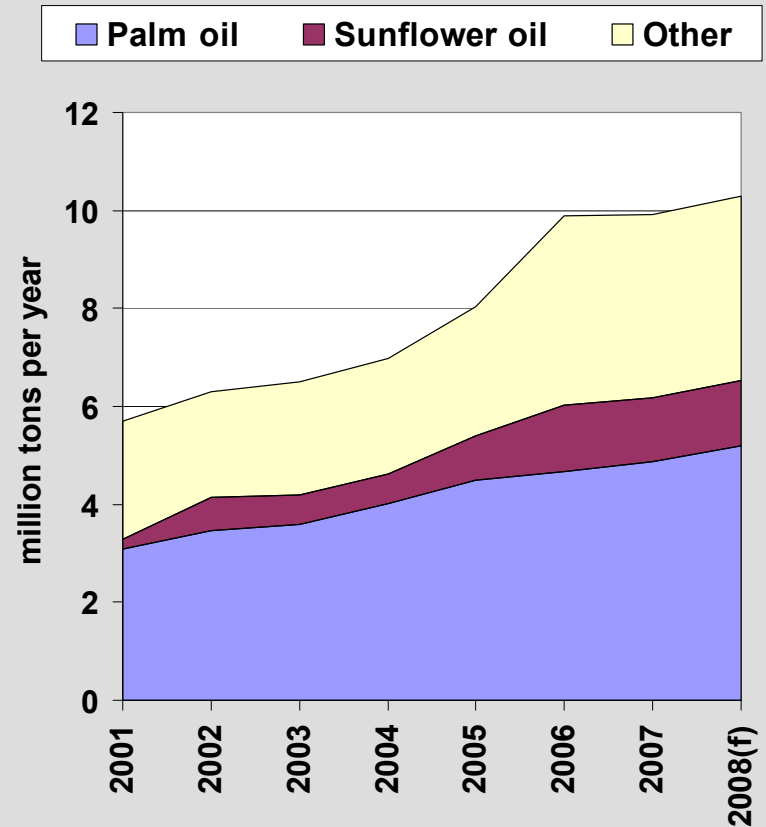


# Growth in vegoil trade

Seaborne vegoil trade



EU-25 Vegoil Imports



# Biofuel Use

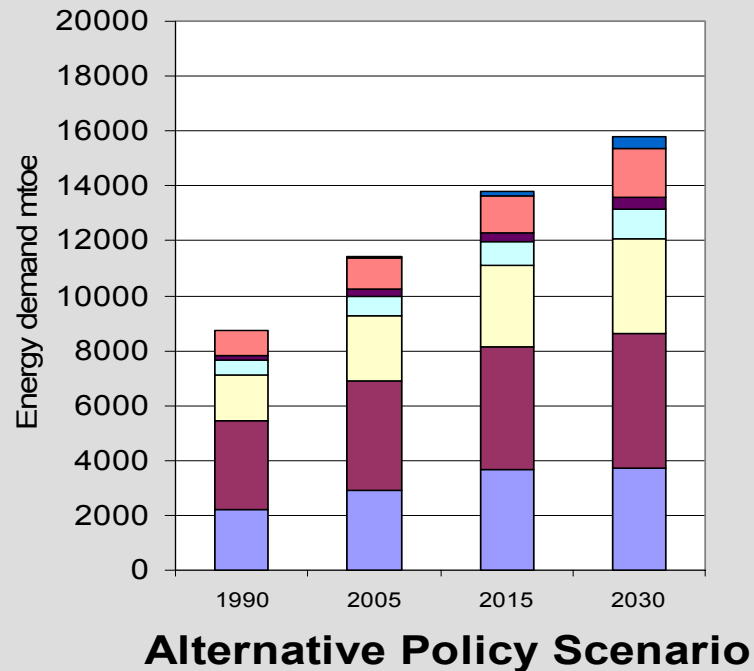
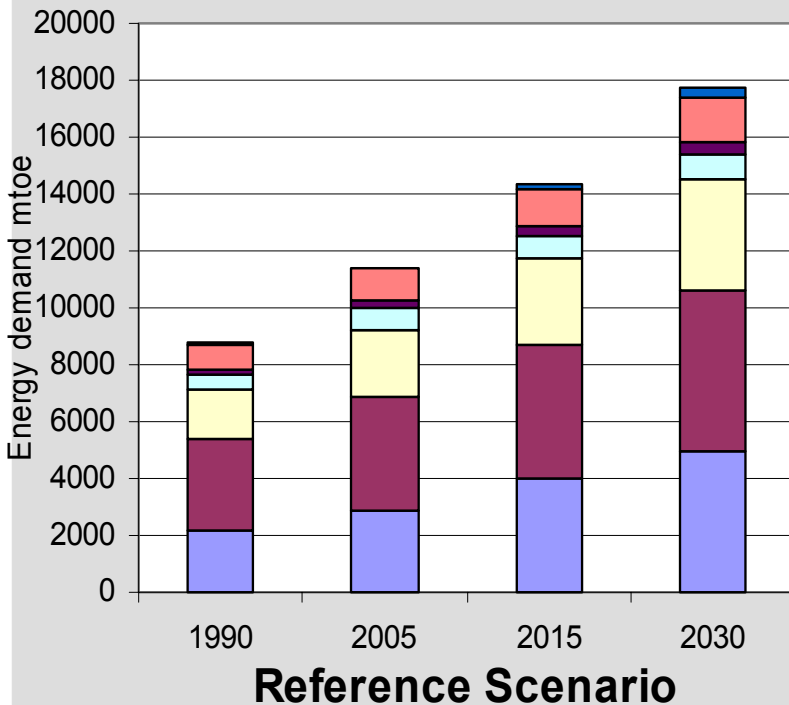


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# World energy consumption: With and Without Strong Policy Support for Biofuels and Renewables.

Source: IEA World Energy Outlook

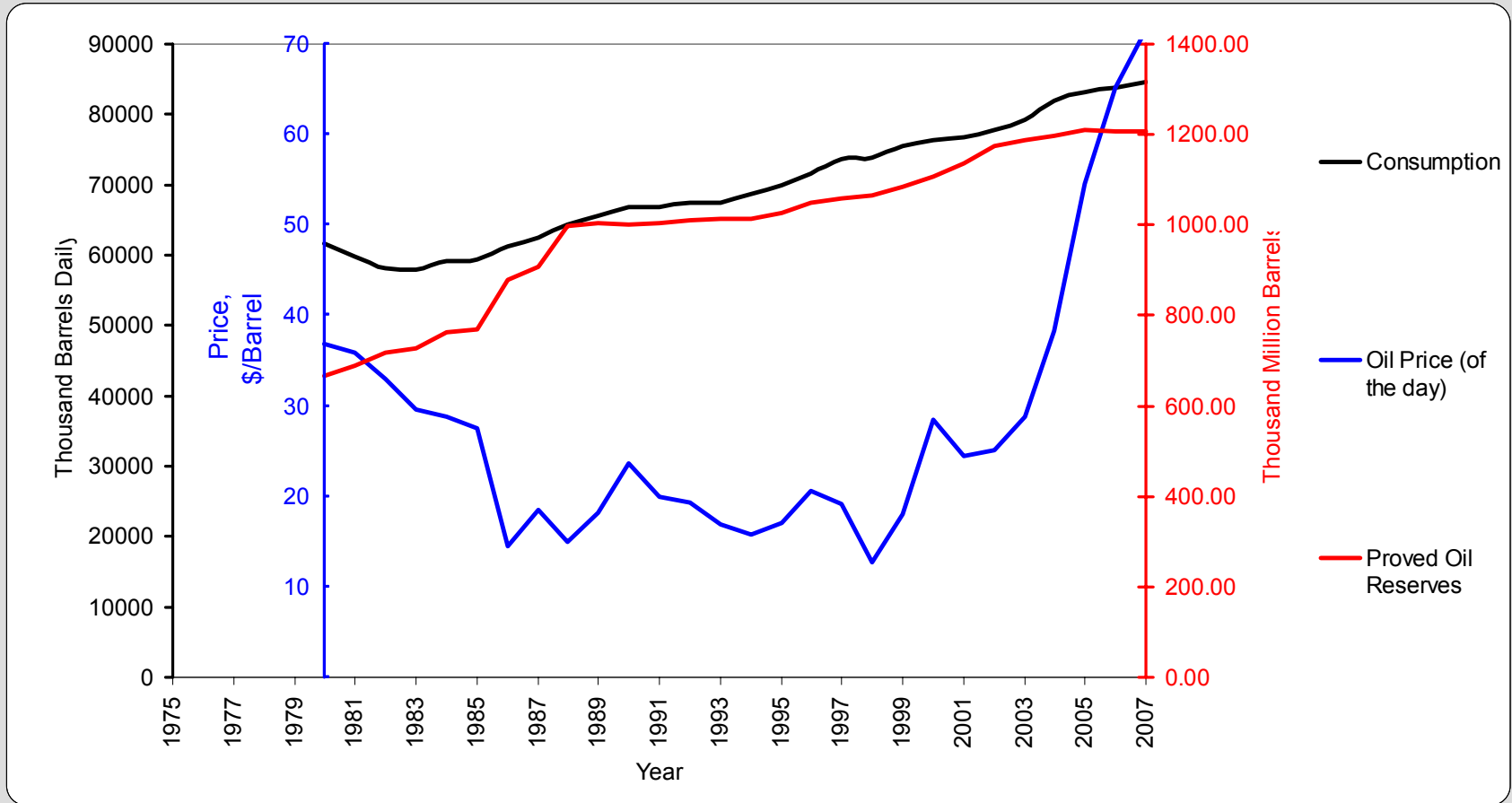
■ Coal 
 ■ Oil 
 ■ Gas 
 ■ Nuclear 
 ■ Hydro 
 ■ Biomass/Oth Waste 
 ■ Oth renew





# Oil Price / Consumption / Reserves Trends

Source: BP Statistical Review of World Energy 2007



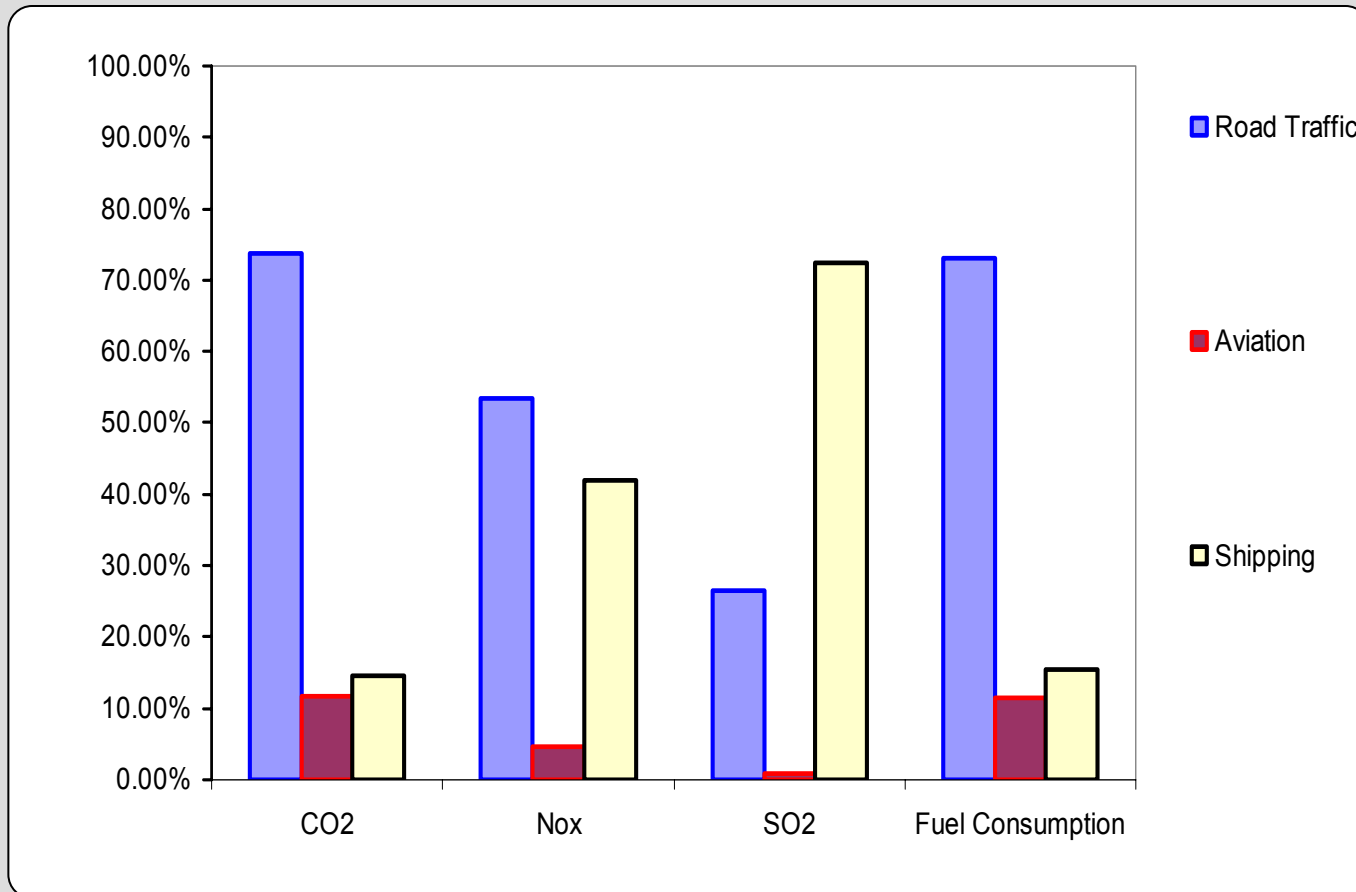
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# Worldwide Fleet Fuel Consumption and Transport Related Emissions – 2007

Source: Lloyd's Maritime Information Services



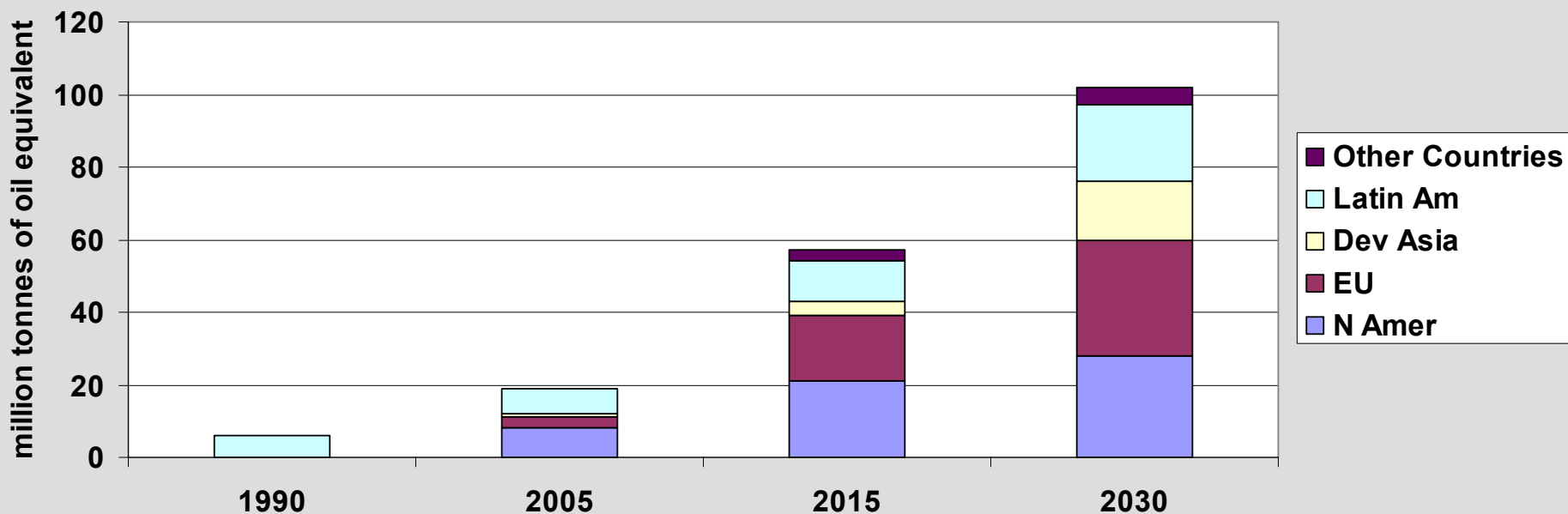
# Political factors vary by region, so regulation varies by region

Factors	EU	US	SE Asia	NE Asia
<b>Environmental</b>	Medium-High	Medium	Low*	Low*
			*High in certain major cities	*High in certain major cities
<b>Energy Security</b>	High	High	Low	High
<b>Agriculture Support</b>	Medium	High	High	Medium
<b>Examples</b>	France: B5.75 in 2008, B7 in 2010, B10 in 2015	Renewable fuel standard requires 35 billion gallons renewable fuels by 2022	Indonesia: 5% bioenergy by 2025	China: 15% renewable energy by 2020
	Germany: B4.8 in 2007, B100 available	\$1.00 per gallon tax incentive for biodiesel	Malaysia: National policy with B5 target	Japan: Kyoto commitment
	UK: Renewable Transport Fuel Obligation 2.5% 2008, 3.75% 2009 and 5% 2010		Philippines: B1 2007, B2 2009	S. Korea: B0.5 now, B3/B5 in 2012
			Thailand: B5 in Bangkok, B5 all in 2009	India: Jatropha target 11 mHa by 2012

Source: Rabobank as quoted by Malaysian Palm Oil Board, Doll Shipping Consultancy analysis

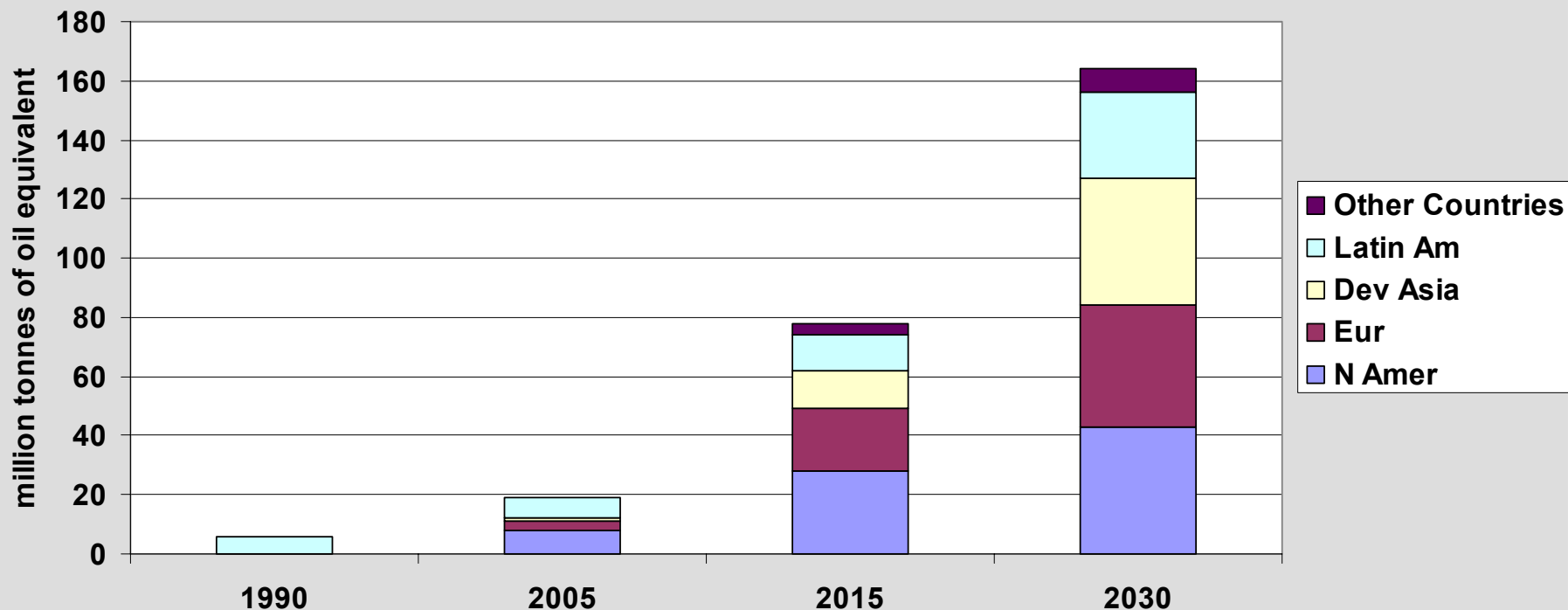
# Forecast Biofuels Demand per IEA: Reference Case

Forecast Biofuels Demand IEA Reference Case

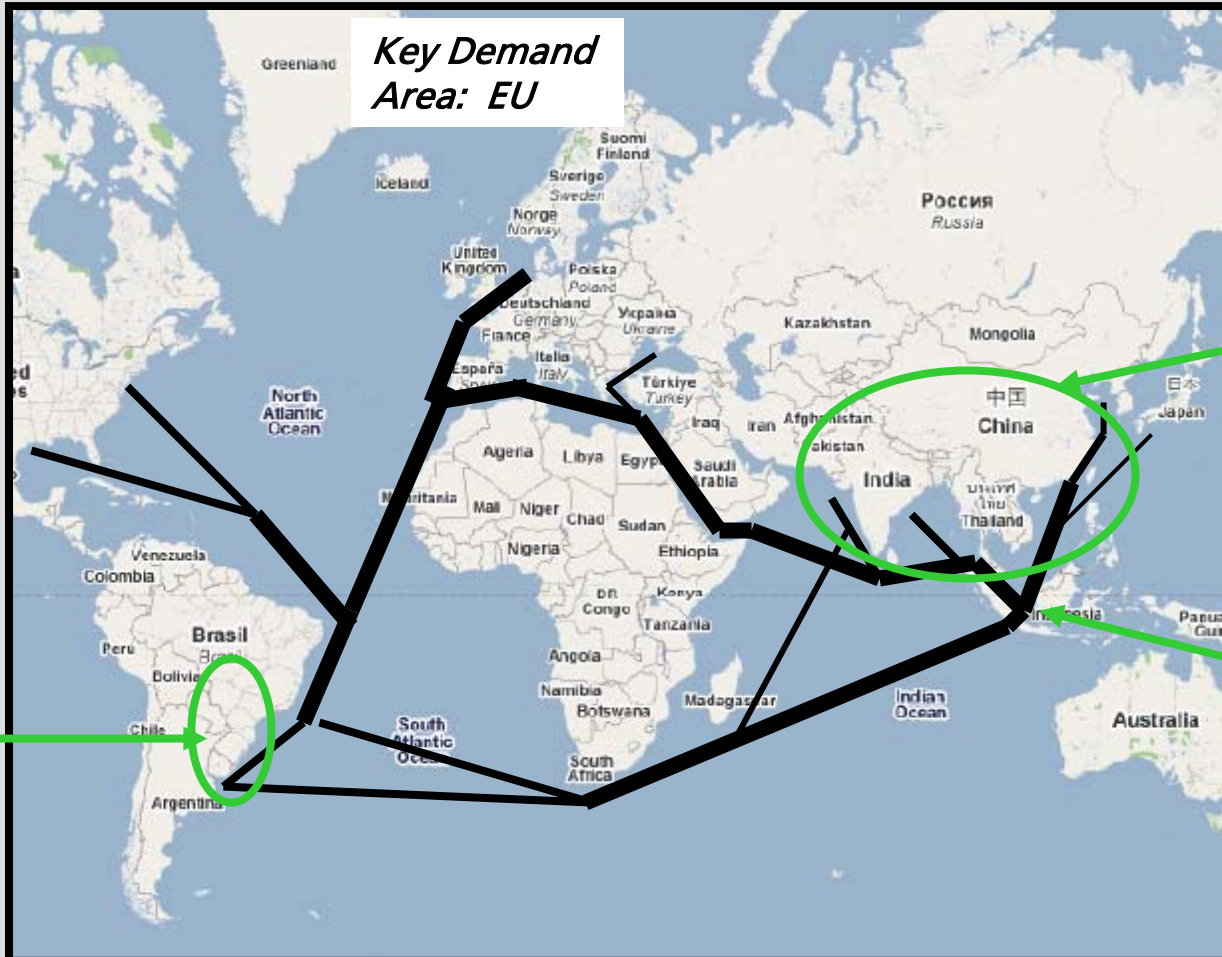


# Forecast Biofuels Demand per IEA: Stronger government support for biofuels

Forecast Biofuels Demand IEA Alternative Policy Case



# Key Production Areas and Shipping Routes



**Key Demand Area: USA**

**Key Demand Area: EU**

**Key Demand Area: Developing Asia**

**Key Supply Area:**

**Brazil, Argentina, Paraguay, Bolivia**

**Key Supply Area:**

**SE Asia, incl. Indonesia, Malaysia, PNG, Philippines, Thailand**

# Shipping Routes: North America

- Plateau Case
  - 2015 ethanol consumption 33 million tons per year (“mtpy”), stable thereafter
  - Biofuels imports (% of total Biofuels) up from current 8% to 20%
    - 75% of Biofuels imports from Brazil
  - Indicative requirements : 32 Handysizes in 2015 and 2030
  - Vessel size: Handysize
- Tech Breakthrough Case
  - Biofuels 80 mtpy by 2022, stable thereafter
  - Biofuels imports up to 20% at 2015, 30% by 2030
    - 66% of Biofuels imports from Brazil
  - Indicative requirements : 32 Handysizes in 2015, 115 in 2030
  - Vessel Sizes: Handysize, some Panamax

# Shipping Routes: Europe

- Plateau Case
  - 2015 EU Biofuel consumption reaches 30 mtpy
    - 50:50 Ethanol:Biodiesel
  - Biofuels imports (% total biofuels) at 50%
    - 45% from S America, 33% SE Asia
  - Indicative requirements: 80 Handysizes in 2015 and 2030
  - Vessel sizes: Handysize, some Panamax
  - Growth in short haul and transshipment requirements
- Tech Breakthrough Case
  - 2030 EU Biofuels use up to 55 mtpy
  - Biofuels imports at 50%
    - 55% of imports from S. America, 20% from SE Asia
  - Indicative requirements: 80 Handysizes in 2015, 145 in 2030
  - Vessel sizes: Handysize, some Panamax and Aframax
  - Growth in short haul and transshipment requirements



# Shipping Routes and Economics: Developing Asia

- Plateau Case
  - 2015 Dev Asia biofuels consumption 18 mtpy split 50:50 ethanol and biodiesel
  - Biofuels “imports” (% of total biofuels) at 70% incl international SE Asia trade
    - 40% of “imports” from SE Asia, 25% from S. America
  - Indicative requirements: 50 Handysizes in 2015 and 2030
  - Vessel sizes: Handysize, some Panamax
  - Growth in short haul and transshipment requirements
- Tech Breakthrough Case
  - 58 million tons biofuels (6% of oil transport fuel energy requirements) split 50:50 ethanol and biodiesel
  - Biofuels “imports” (% of total biofuels) at 70% incl international SE Asia trade
    - 70% of total biofuels come from SE Asia domestic or seaborne “imports”
    - 25% of total biofuels from S. America in 2015, 20% in 2030
  - Indicative requirements: 50 Handysizes in 2015, 140 in 2030
  - Vessel sizes: Handysize, some Panamax and Aframax
  - Growth in short haul and transshipment requirement

## Biofuels trades: Indicative Economies of Scale

**Clear incentives for larger vessels if rest of supply chain can handle them.**

<b>Cargo size tons</b>	<b>30,000</b>	<b>45,000</b>	<b>65,000</b>	<b>95,000</b>
SE Asia - Europe	89.00	67.50	56.10	41.20
SE Asia - Europe Triang	64.60	49.90	41.40	30.50
S Amer - Europe	62.00	47.70	39.40	29.10
S Amer - China	105.40	78.50	65.20	48.00
S Amer - China Triang	83.80	63.30	52.40	38.60
Braz - USGEC	55.10	41.90	34.60	25.40

Indicative \$ per ton estimates for forecast main biofuels routes. Round voyage basis unless triangulation basis specified.

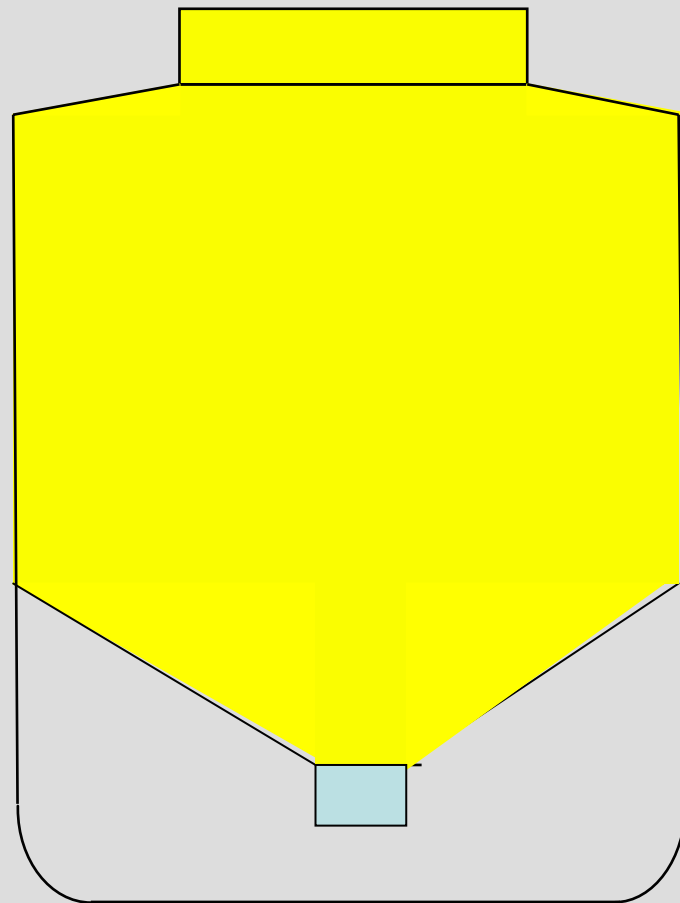
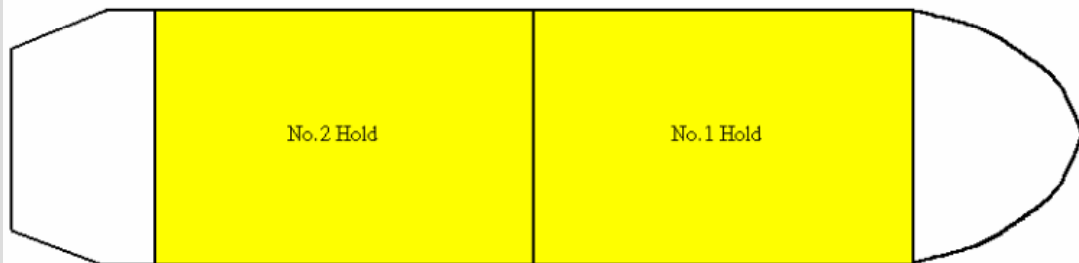
# Shipping Routes and Economics: Implications

- Overall requirements significant
  - 2015: 162 Handysizes, total 5.1 million deadweight tons (“mdwt”)
  - 2030: 400 Handysizes, total 12.5 mdwt
  - Current Handysize tanker fleet (10,000 to 59,999 dwt) about 2,560 vessels of 81 mdwt including 1,490 chemical tankers of 44 mdwt
- Chemical tankers or product tankers?
  - First generation biodiesel (fatty acid methyl ester) is IMO 2
  - Vegoil feedstocks are IMO 2 with double hull IMO 3 vessels allowed
  - Ethanol typically uses chemical tankers due to its cargo requirements
  - Uncertain whether second generation biofuels will or will not require chemical tankers
- Ship designs that offer flexibility and cost control will have additional value

# Ship Design and Implications

## Coastal Vessel / wood chip carrier

**5,000 Tonne Deadweight Dry Cargo Vessel  
Provided with Double Bottom and Single Side**

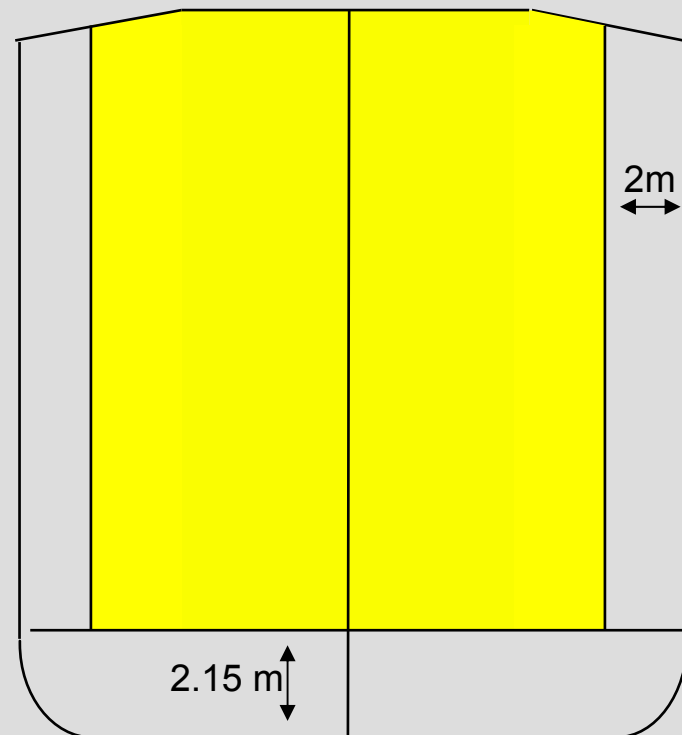
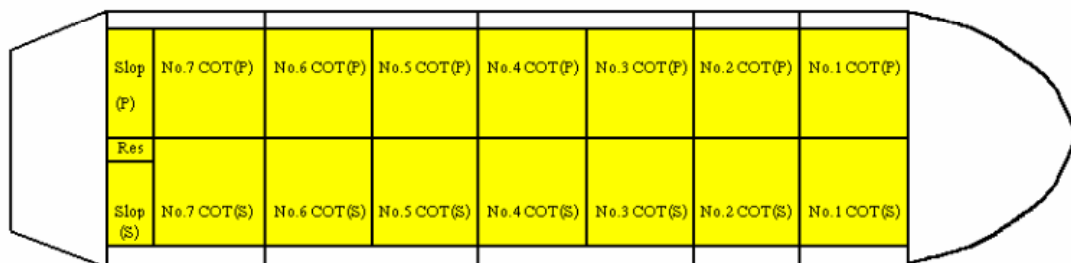


# Ship Design and Implications

## Suggested Panamax Tanker specification:

**80,000 Tonne Deadweight Oil/Chemical Tanker  
Provided with Full Double Bottom and Double Side**

- Oil/Ethanol/unmodified Vegetable Oils

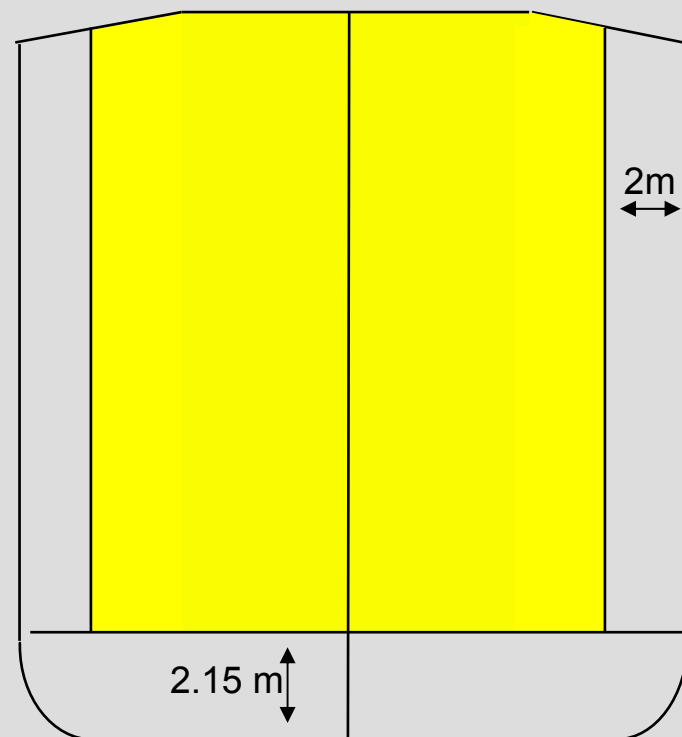
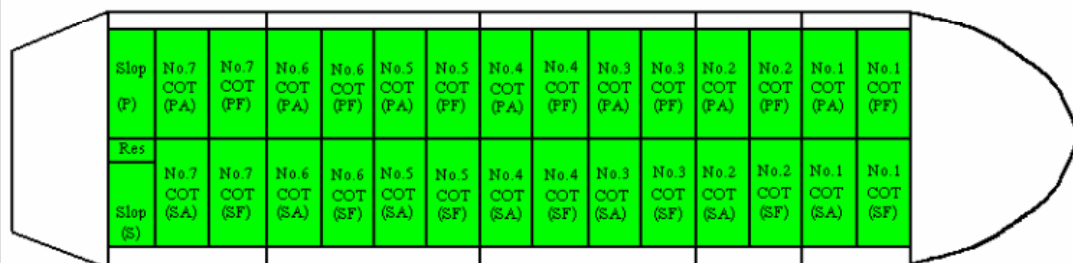


# Ship Design and Implications

## Suggested Panamax Tanker specification:

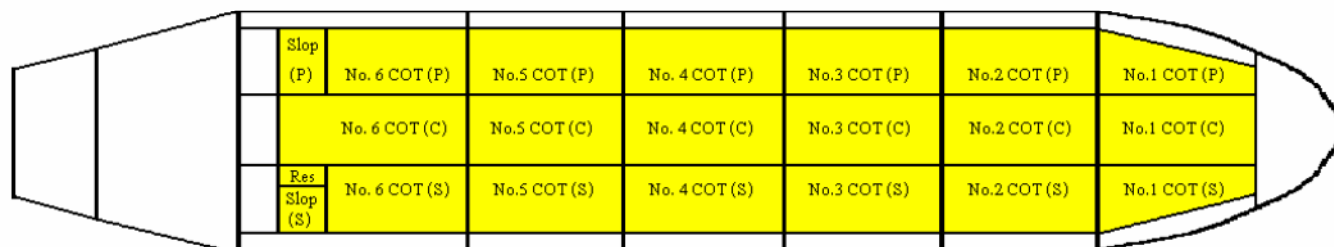
**80,000 Tonne Deadweight Oil/Chemical Tanker  
Provided with Full Double Bottom and Double Side**

- 100% FAME or Ship Type 2 Cargoes



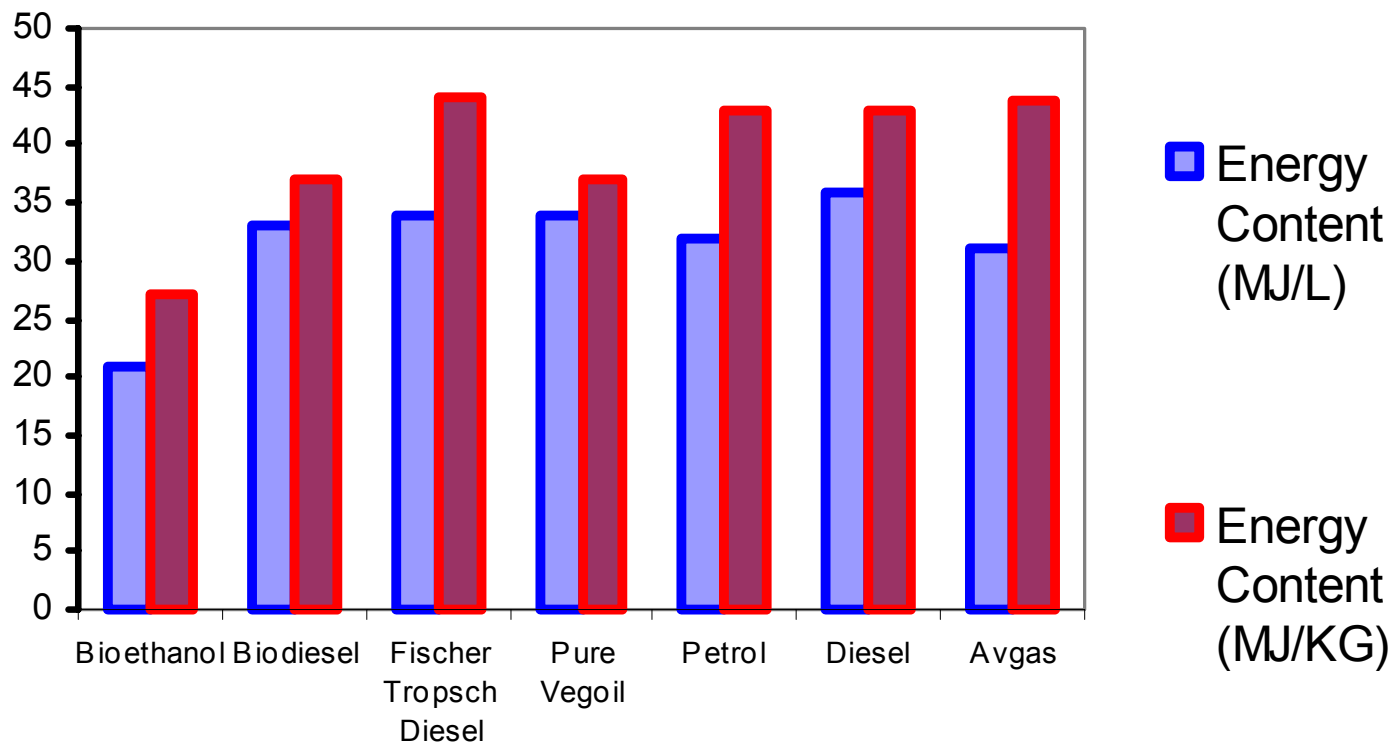
# Ship Design and Implications

## Suggested 115,000 Tonne Aframax Dwt Tanker specification for Oil/Ethanol/unmodified Vegetable Oils



# Energy Content of Fuels

Energy Content of Fuels, both by volume and weight  
(EN Resolution on the promotion of energy from renewable sources)



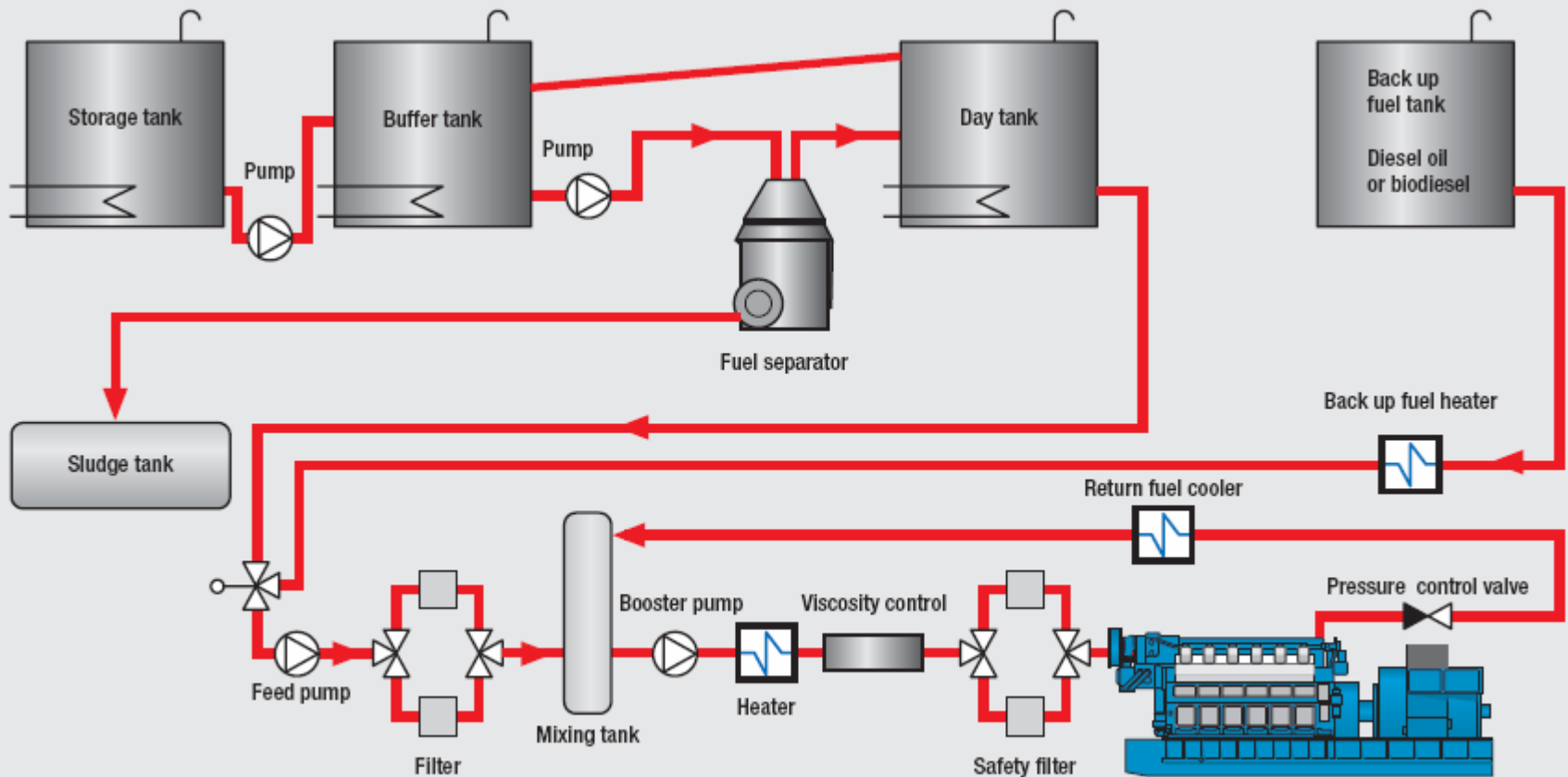


# Use on Board – Challenges Faced

- Lack of standards accommodating Biofuel. → MARPOL Annex VI
- Blending with Diesel
  - Blending On Board
  - Bunkered pre-blended
- Coatings → Reports some are aggressive
- Cold Filter Plug Point (CFPP) → Fuel temperature monitoring
- Water content of fuel → Corrosion in Fuel System
- Fuel in Lube Oil → Increased oil changes
- Injector Fouling
- Shelf Life of fuel

# Fuel System Layout

Source: Wartsila – Biofuel Power Station.



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## Conclusions

- Varied drivers – economic, political, technological, energy security
- Complex resultant global economics
- Legislation leading technology
- Uncertain shipping requirements
- Biofuel as a bunker implications
- More dedicated ship capacity needed
- Product or chemical?
- Maritime legislation may need to adapt to accommodate biofuel scale
- Whatever the problem – shipping will form the solution



# Discussion and Questions?



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[www.michiganhistory.org](http://www.michiganhistory.org)  
Photographer Laurie Catherine Perkins

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