Survey of Marine/Offshore Trends

Strategic Workshop

National Network for Innovative Shipbuilding/Marine Research and Training

Vancouver, BC

6 July 2016

Roger Basu & Associates Inc.

Overview

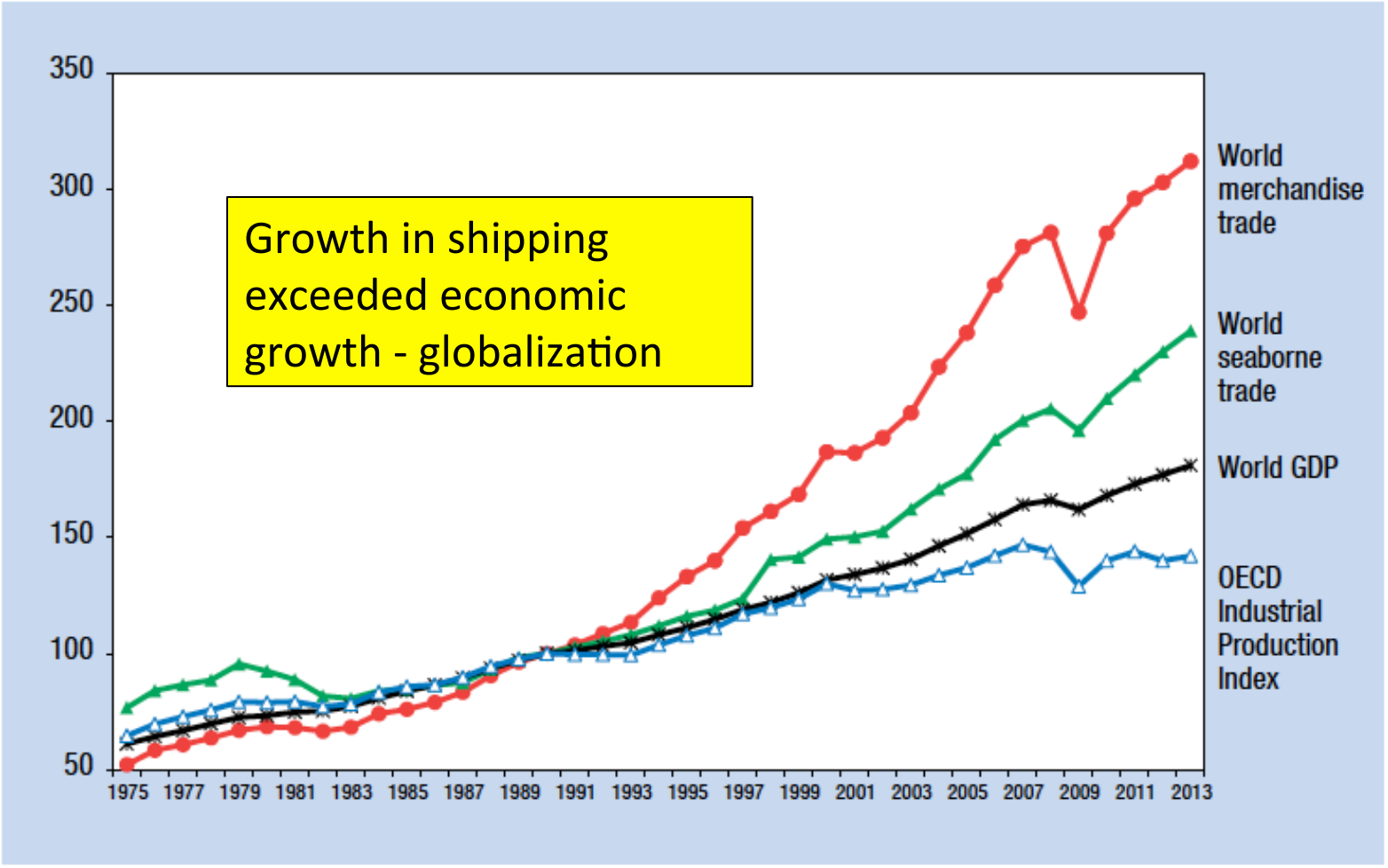
- Sketch of Relevant Global Trends
  - Shipping
  - Energy
- What's Happening Now
- Which Technology Areas
  - Themes
  - Some specific technologies

Global Trends

Global Trends

- *Growth of seaborne trade*

Figure 1.1. The OECD Industrial Production Index and indices for the world: Gross domestic product, merchandise trade and seaborne shipments, 1975–2013 (1990 = 100)

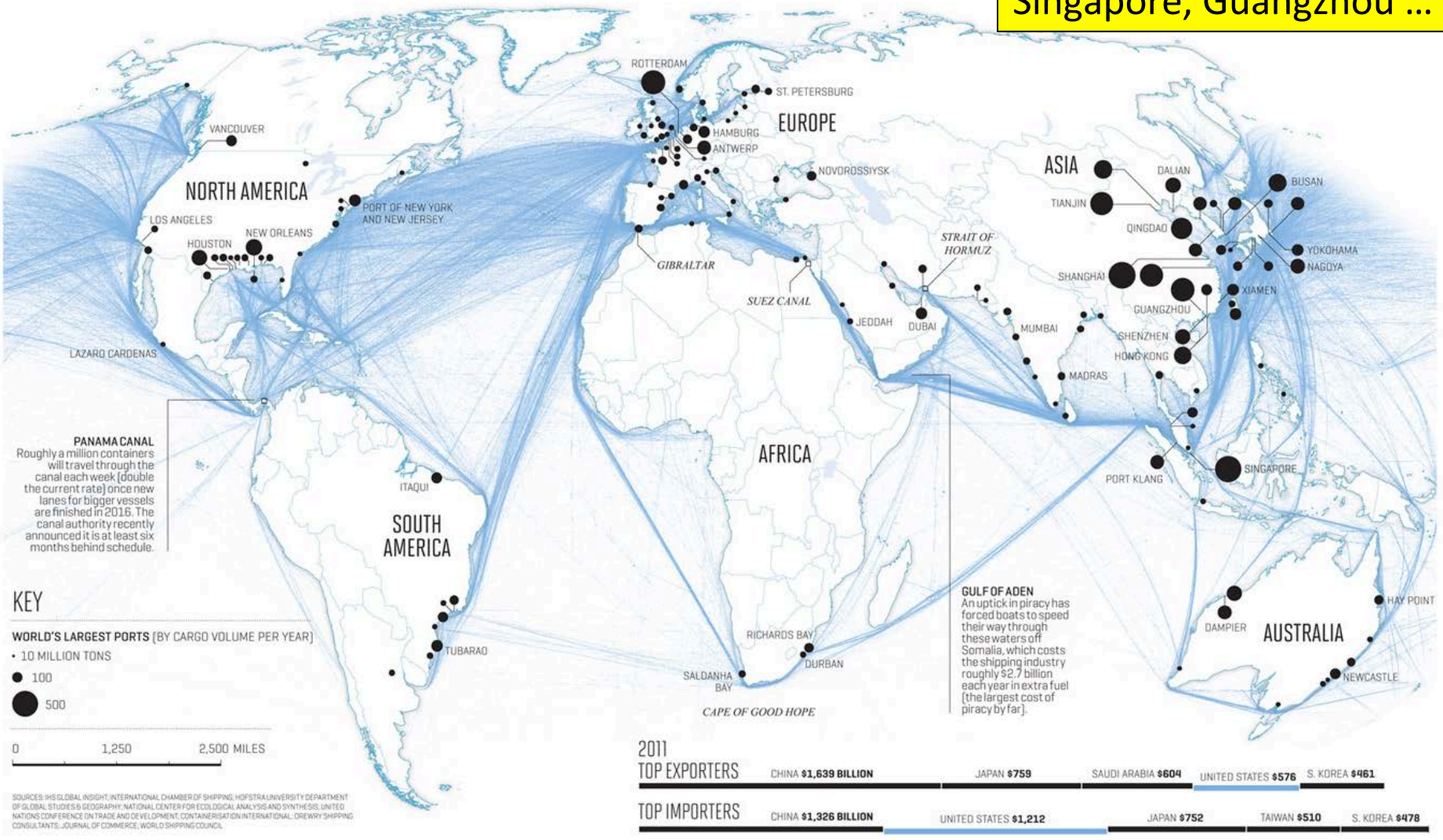


Source: UNCTAD secretariat on the basis of OECD *Main Economic Indicators*, June 2014; UNCTAD, *Trade and Development Report 2014*; UNCTAD *Review of Maritime Transport*, various issues; WTO, appendix tables, table A1a; WTO press release 721, 14 April 2014, World trade 2013, prospects for 2014.

Global Trends

- Shipping routes

Note port activity in the East – Shanghai, Singapore, Guangzhou …

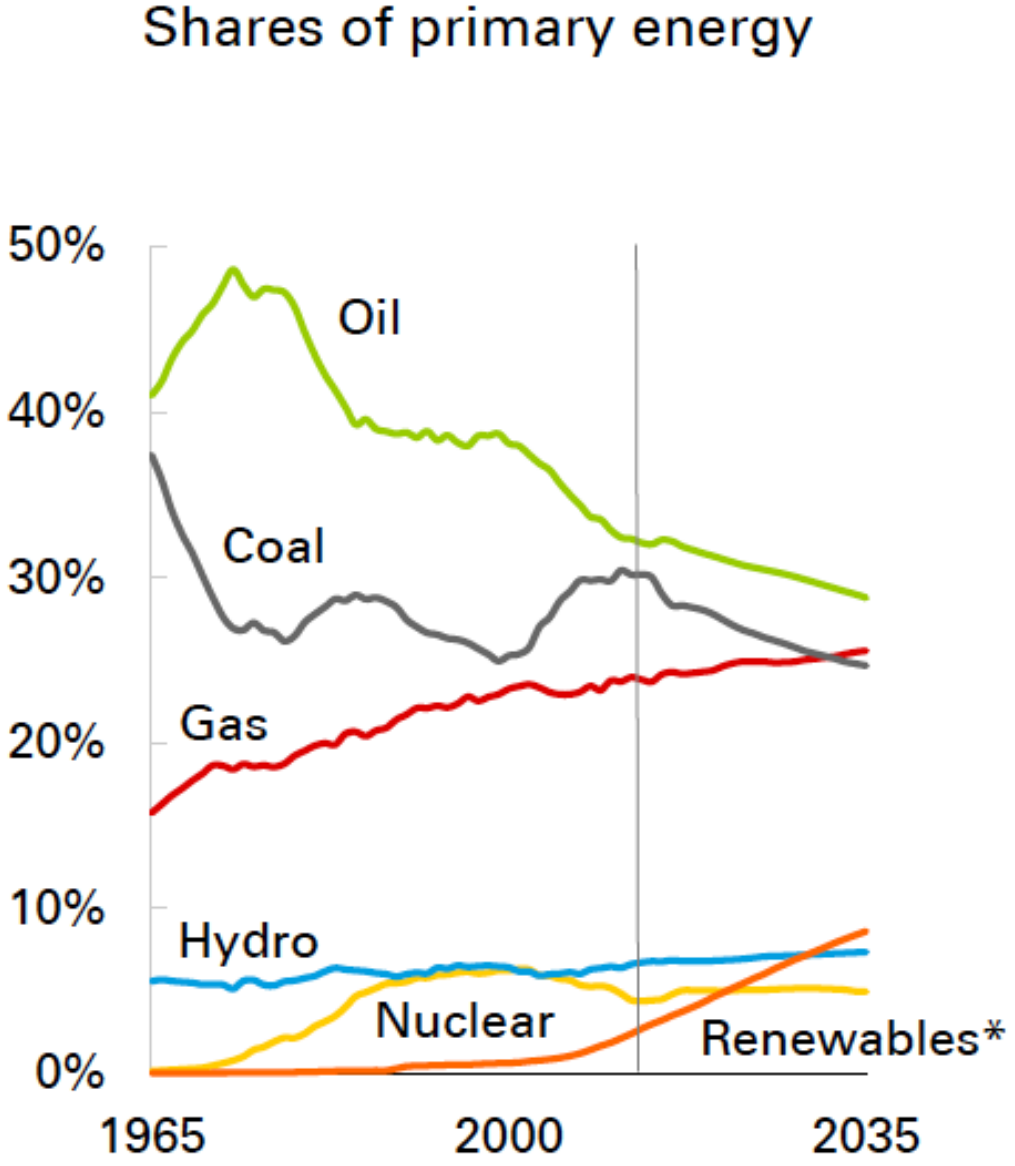


Source: Nicholas Rapp, vox.com

Global Trends

- Energy usage

- Oil, as a %age of energy used, has decreased over several decades
- Gas use steadily increasing
- Renewables
  - Low starting point
  - Rapidly increasing



Source: BP Energy Outlook 2016

What's Happening Now

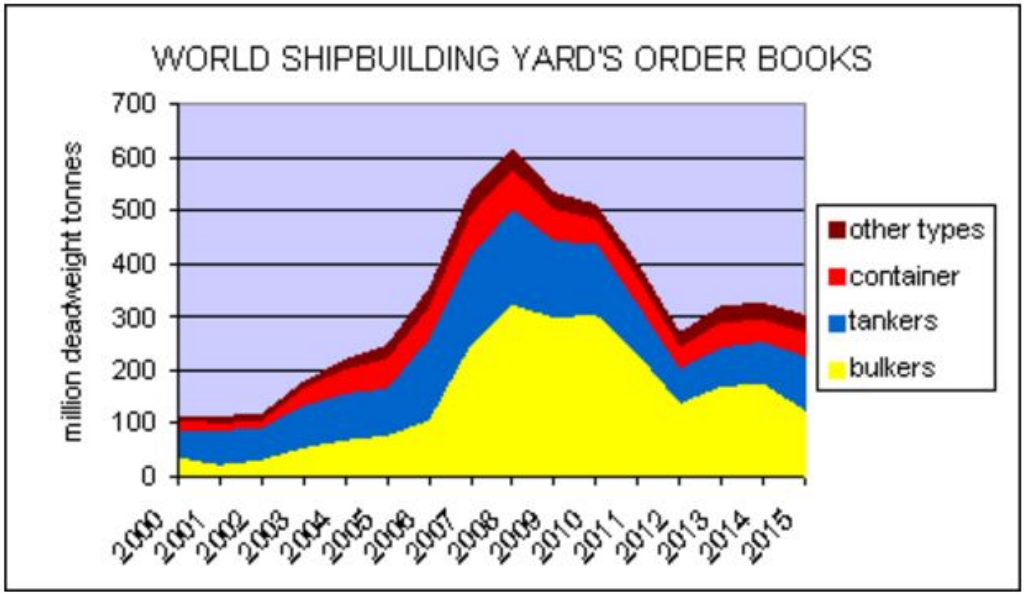
- Bulk carrier rates

- Shipping is a boom and bust industry
- An indirect measure of the shipping industry is the Baltic Dry Index

Source: Bloomberg; BDIY:IND. Value as of first business day of the month.

What's Happening Now
- World Shipbuilding

- Commercial shipbuilding - severe contraction
  - Bulk carriers, as a ship type, have suffered most from the economic downturn
  - Container carriers experienced a mini-boom until last year
  - Tankers also saw a modest increase but not this yyear
  - Overall world shipbuilding has contracted



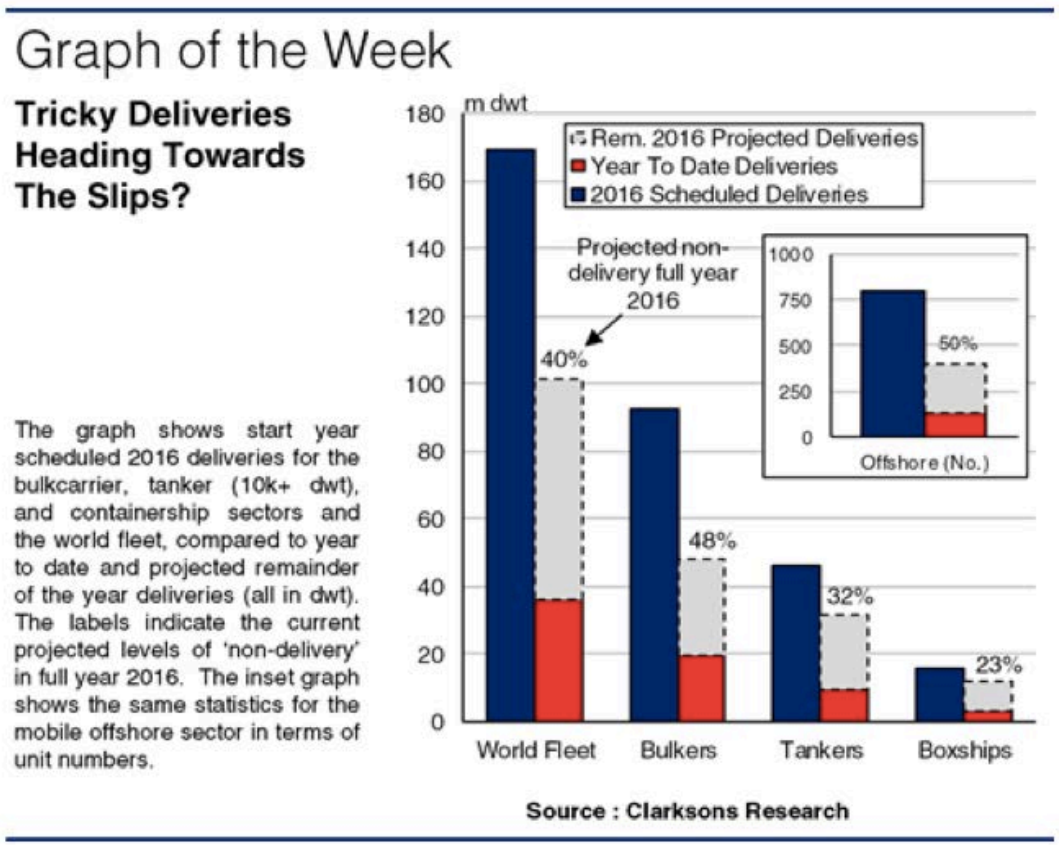
Source: Richard Scott, quoted bunkerist.com

- Overcapacity in the world's shipyards

What's Happening Now

- Glut of ships

- Currently "bust" phase of the shipbuilding
- Clients cancelling orders or delaying delivery
- Low world growth means it will take years to regain stability
- In the meantime shipyards suffer
  - Especially the giants



Source: Clarkson Research, 20 May 2016

What's Happening Now

- Some good news

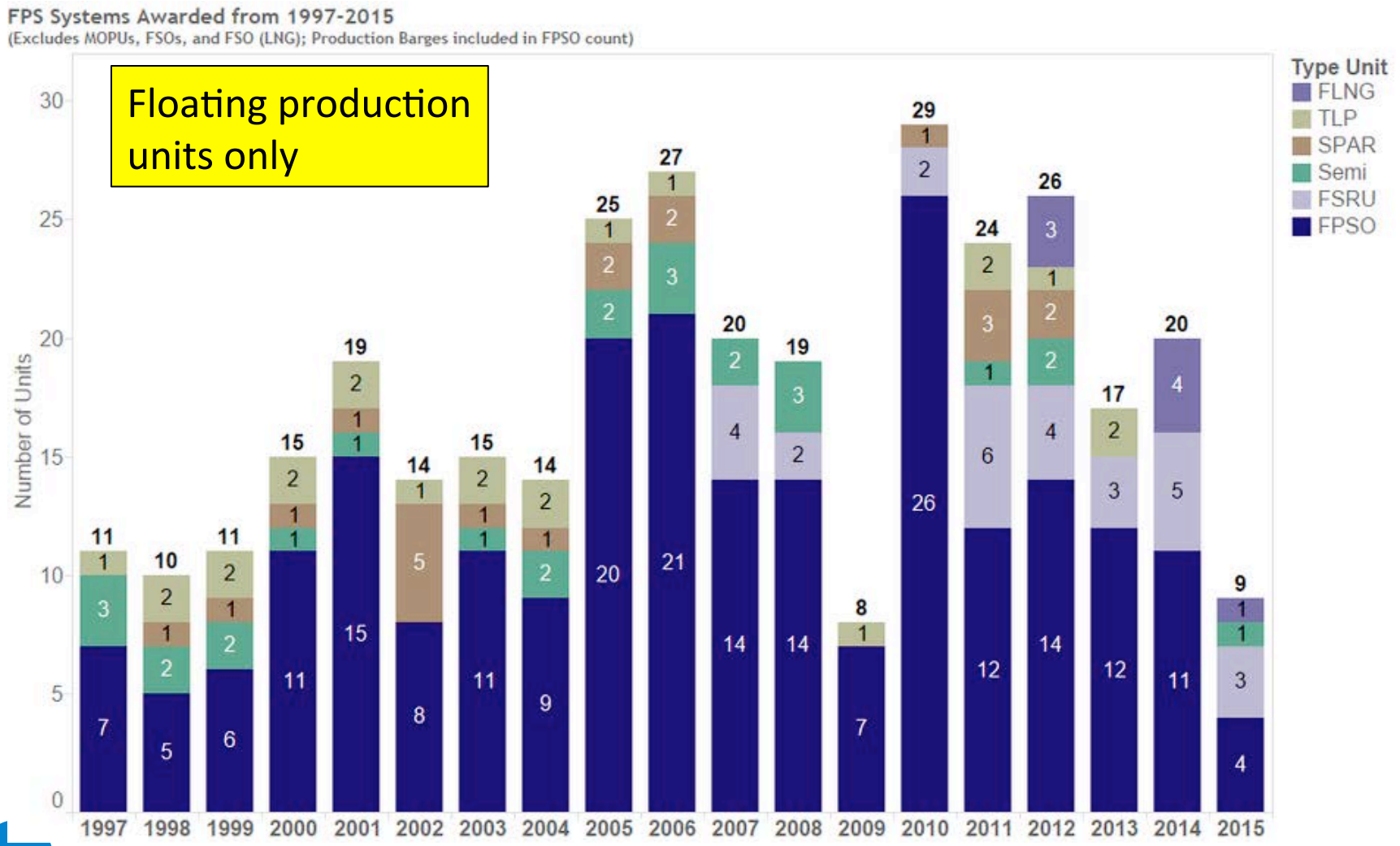
- Cruise ship orders are healthy
  - Dominated by European yards
  - Chinese yards showing interest
- Ships have got bigger
  - Cost ($/berth) goes down with size
- Orders for ferries are also in good shape

Year of Delivery	Number of Ships
2016	10
2017	11
2018	17
2019	16
2020	8

Source: www.amem.at

What's Happening Now

- Orderbook for offshore structures also suffering

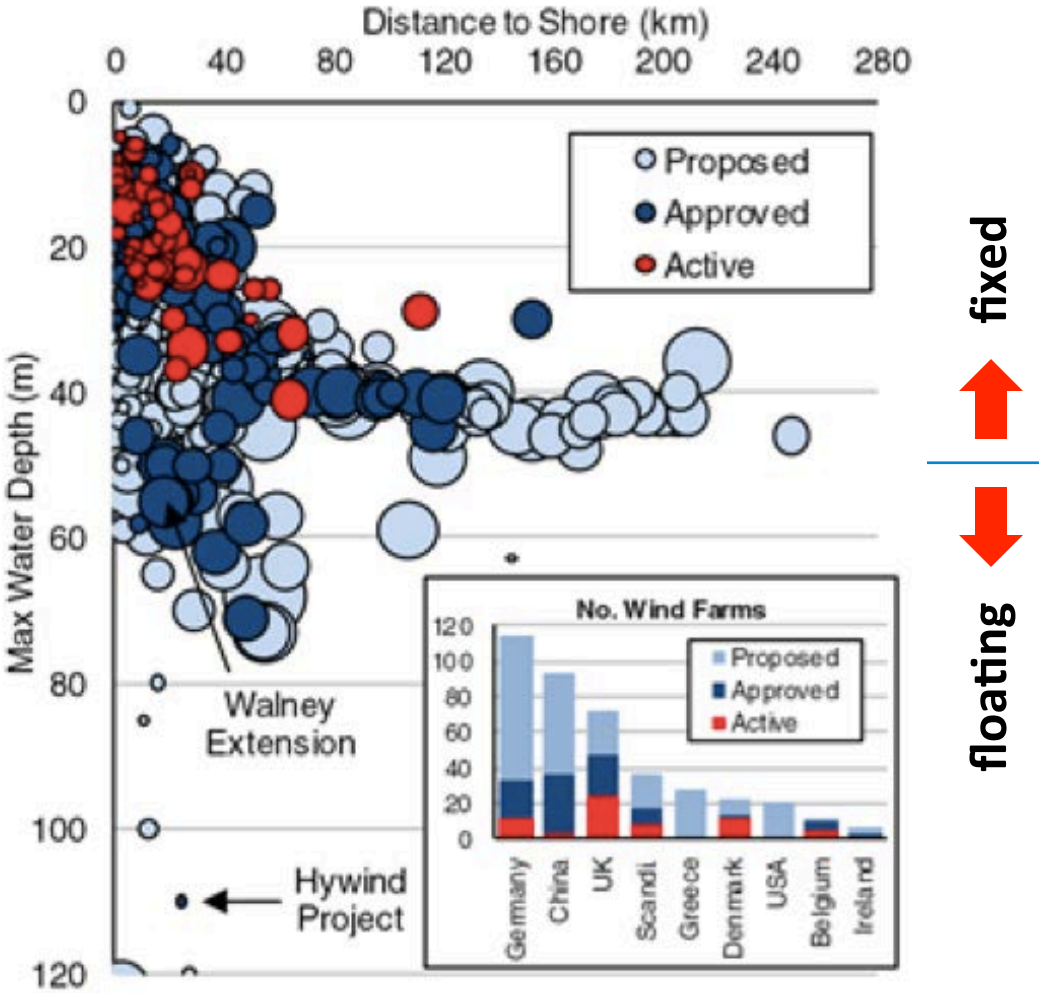


Source: Energy Maritime Associates Pte Ltd website

What's Happening Now

- Renewable Energy

- Wind turbines - greater interest in sites well offshore
- Consequence
  - Deeper waters
  - Floating rather that fixed installations
- Interest in marine renewables growing



Source: Clarkson Research, 1 Dec 2015

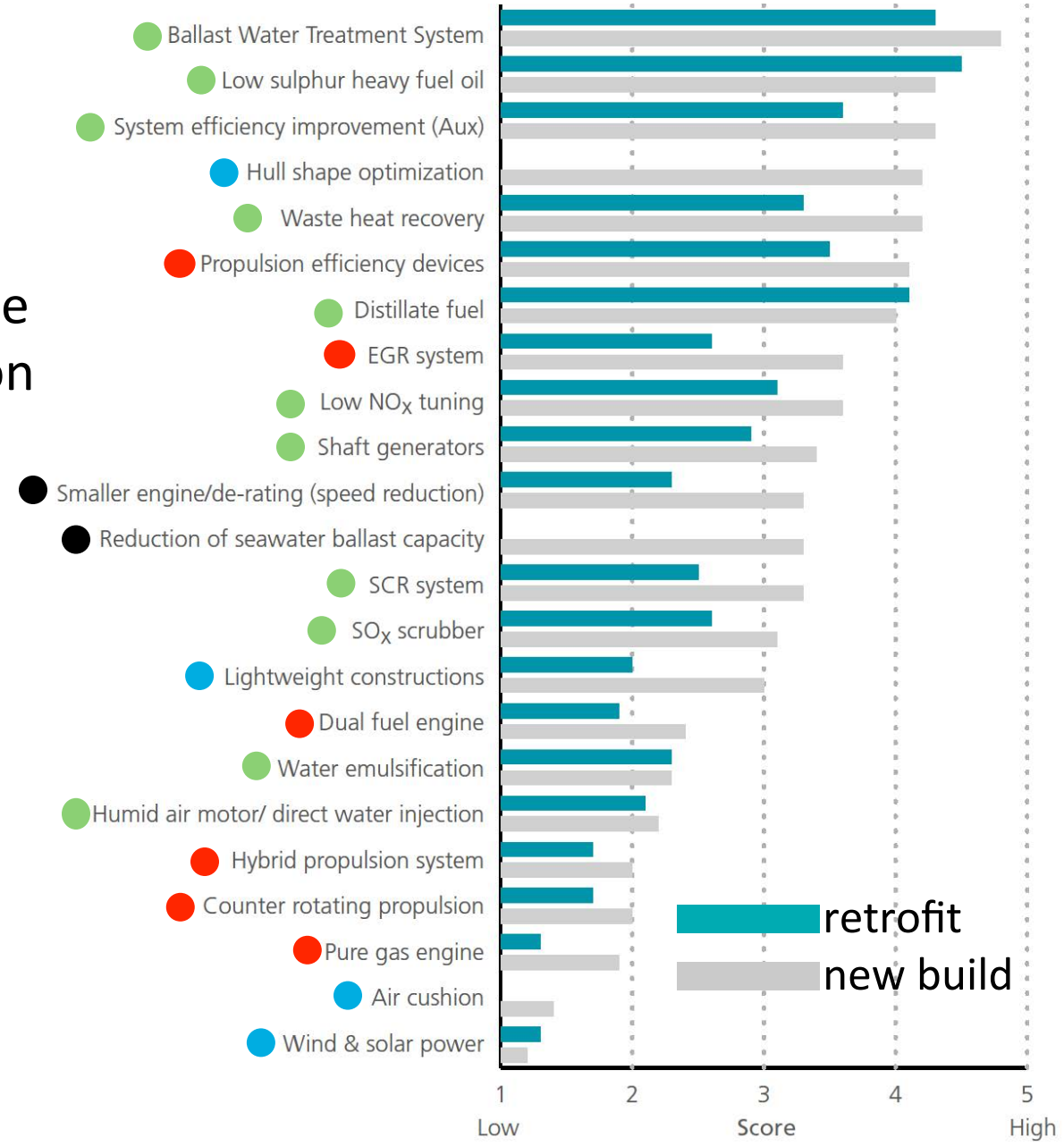
Which Technology Areas?

What's Driving Innovation

- Drive to reduce costs acute now:
  - Low economic growth
    - Uncertainty
    - Demographics trends
  - Low oil prices
  - Excess ship and offshore building capacity
- Innovation also driven by
  - Change – conflict, politics, climate change ….
  - Regulatory changes
    - Environmental
    - Safety
  - Lack of qualified personnel
    - Increasing reliance on automation

What's Driving Innovation

- Technologies likely to be implemented – based on survey of ship owners
- Green shipping/energy efficiency
- Marine engg./Propulsion
- Nav arch/engineering
- Operational



Source: DNV Report Shipping 2020, 2012

Technology Themes

- Several organizations attempt to predict technology needs for the future:
  - Various international and national agencies
  - Classification societies
- A general consensus (?) has emerged in some areas
- Selected technologies highlighted in following slides

Technology Themes

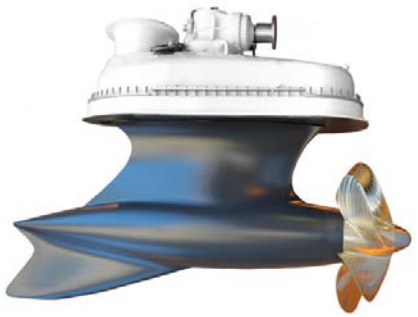
- Some key themes:
  - Advanced materials
  - Information technology and communications
  - Automation & robotics
  - Sustainable shipping
  - Safety
- Some specific aspects
  - Engineering simulation
  - Propulsion
  - Asset integrity management
  - Aquaculture
  - Naval technology
  - Seabed mining
  - Floating infrastructure
  - Marine habitation

Advanced Materials

- Steel is by far the most common material in ships (hull, equipment…)
- Aluminum hull confined to smaller faster ships
- Advanced composites have technical advantages over metals but are expensive
- But as costs come down …

Norwegian ferry – Lightweight carbon-fibre hull. Hybrid power – diesel/battery

Source: "Composites Today" website



Lightweight steerable thruster from Rolls Royce makes extensive use of carbon fibre materials

Source: Rolls Royce website

Information Technology & Communications

Outdated software leaves tanker owners vulnerable to cyber attack

Wed 01 Jun 2016 by Edwin Lampert

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Draft IMO guidelines on maritime cyber risk management

In SMART4SEA 14 June 2016

- Cyber attacks are expected to grow

10th Annual API Cybersecurity Conference & Expo, 2015

Information Technology & Communications

- In common with other industries both marine and offshore industries rely increasingly on sophisticated software systems
  - Fewer crew, greater reliance on computer-based technologies such as:
    - ECDIS (Electronic Chart Display and Information System)
    - DGPS/GPS
    - AIS (Automated Identification System)
    - GMDSS (Global Maritime Distress and Safety System)
  - Navies – cyber and electronic warfare
  - Ports – cyber-security, smuggling
  - Oil and gas installations

Automation & Robotics

- *Unmanned ships*

- Unmanned ships are being proposed primarily for two reasons:
  - Safety
  - Economy

Source: Rolls Royce plc

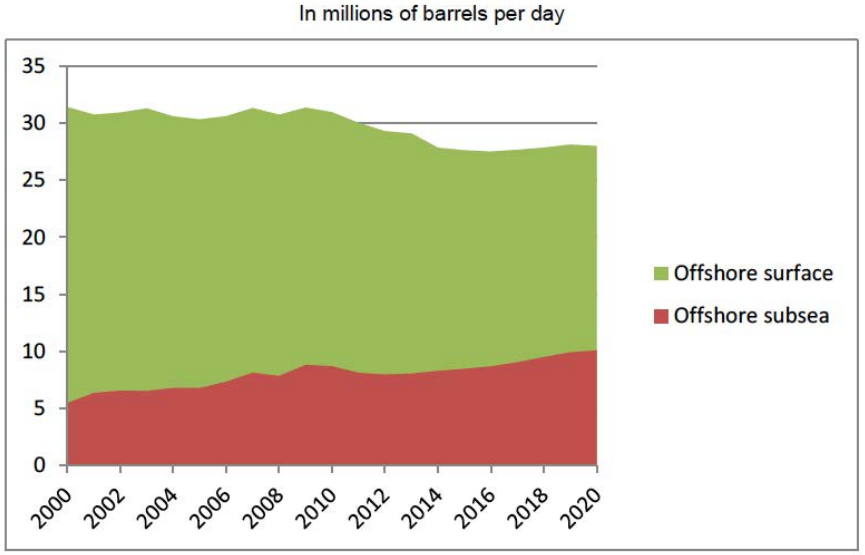
- Sensors and computer systems to replace less reliable humans
- Hybrid systems proposed
  - Convoys – unmanned ships led by conventionally manned ship
  - Hybrid scheme – ship is manned in coastal regions and ports

Automation & Robotics

- AUVs and UUVs

Important for subsea operations

- Unmanned Undersea Vehicles important for inspection and repair of ships & offshore assets
  - Remotely operated underwater vehicles (ROVs)
  - Autonomous underwater vehicles (UUVs)
- Challenges
  - Communications
  - Range

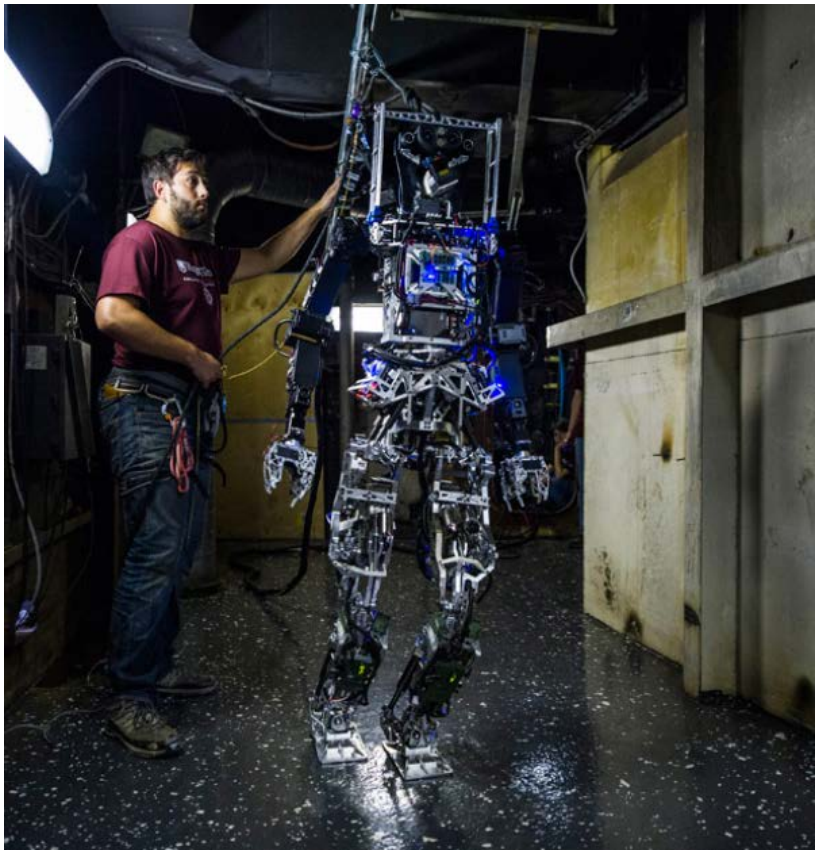


Source: Douglas-Westwood; quoted in OECD Report C/WP6(2015)5/FINAL, 2015

Automation & Robotics

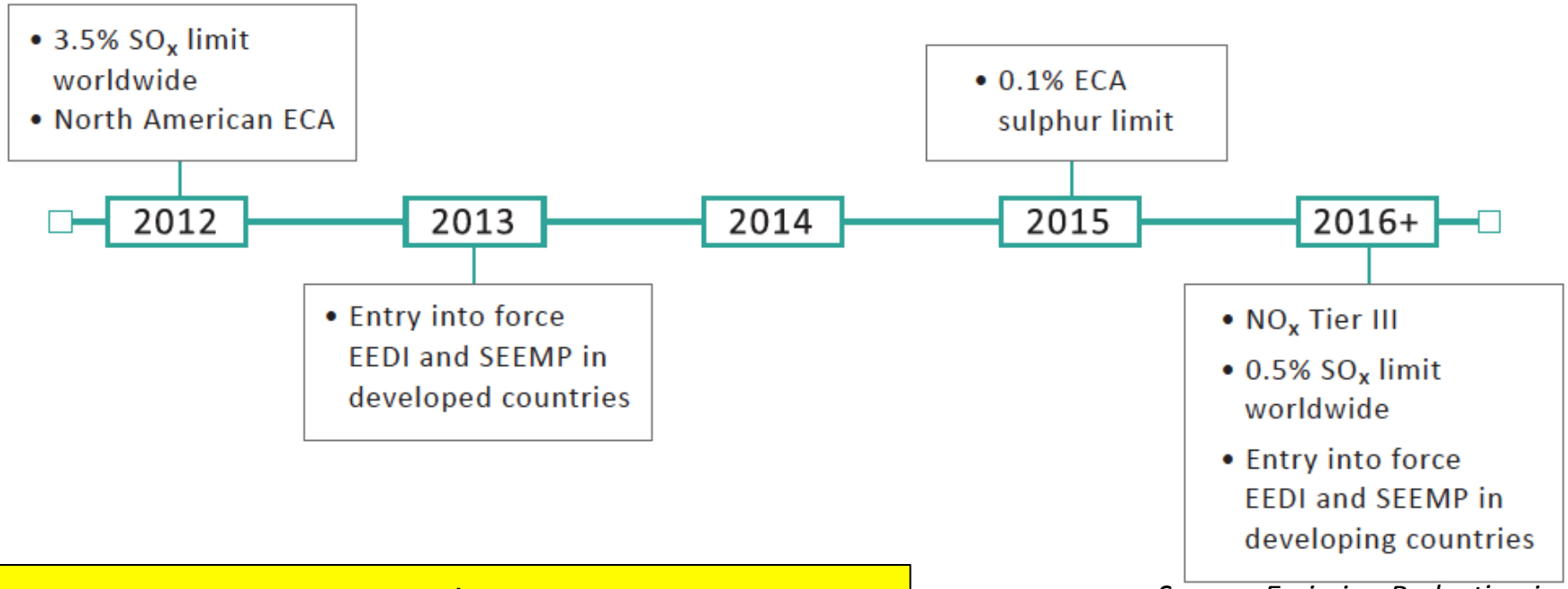
- Robotics

- Some activities might be better performed using robots
  - Inspections and repair in hazardous areas
    - Corrosion
    - Cracks
  - Firefighting
- Shipbuilding
  - Profile cutting
  - Panel welding
  - Pipework
  - Etc.



Sustainable Shipping

- Climate change impetus for new IMO regulations



ECA	Emission Control Area
EEDI	Energy-Efficiency Design Index
SEEMP	Ship Energy Efficiency Management Plan

Source: Emission Reduction in the Shipping Industry, July 2013, Sustainalytics

Sustainable Shipping

- *Driver for several technology developments*

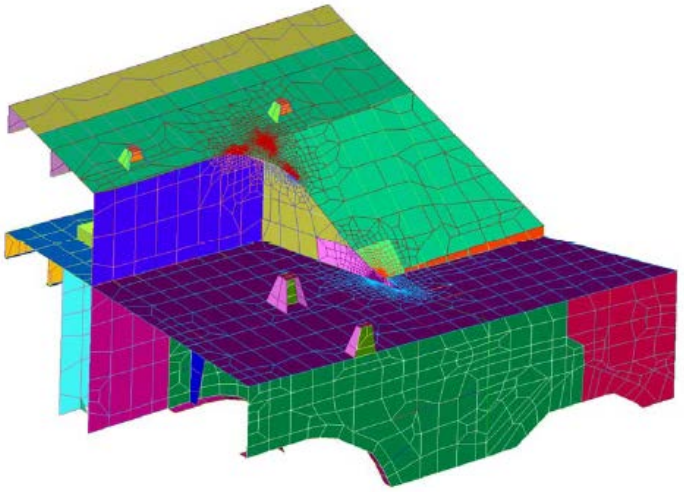
- Lighter materials
- Improved hull forms
- More efficient propulsion systems
- Battery technologies

Safety

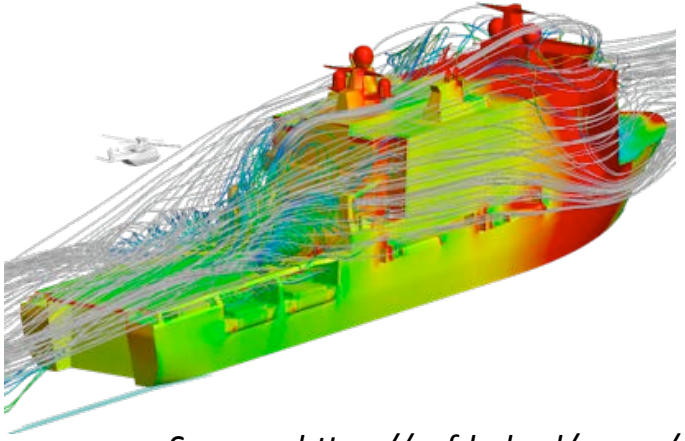
- Marine and offshore industries are among the riskiest
- These industries continually seek ways to improve safety and reduce accidents
- High accident rates in marine and offshore operations
  - Inherently risky
  - Systems increasingly complex
- Several areas require attention
  - Multiple alarms on offshore installations
  - Cruise ships in the Arctic
  - Etc.

Engineering Simulation

- Rapid increase in use of computer-based simulation for engineering analysis
  - Structural finite element analysis well established
  - Computational fluid mechanics less so
- Design methodologies and acceptance criteria are evolving less rapidly
- Some issues:
  - Validation of analysis methodologies
  - Skills of users
  - Uncertainties in analysis



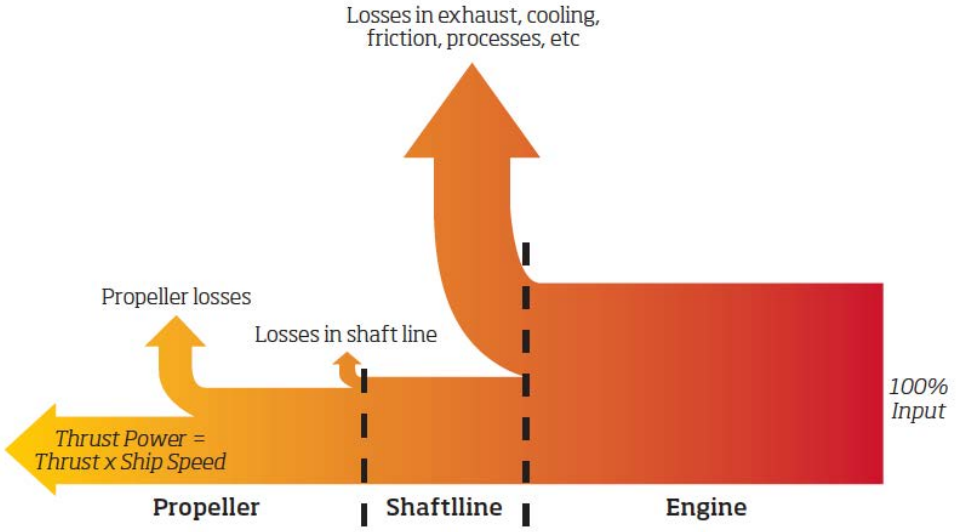
Source: Viking Systems, Annapolis, USA



Source: https://ecfd.nlr.nl/scope/

Propulsion

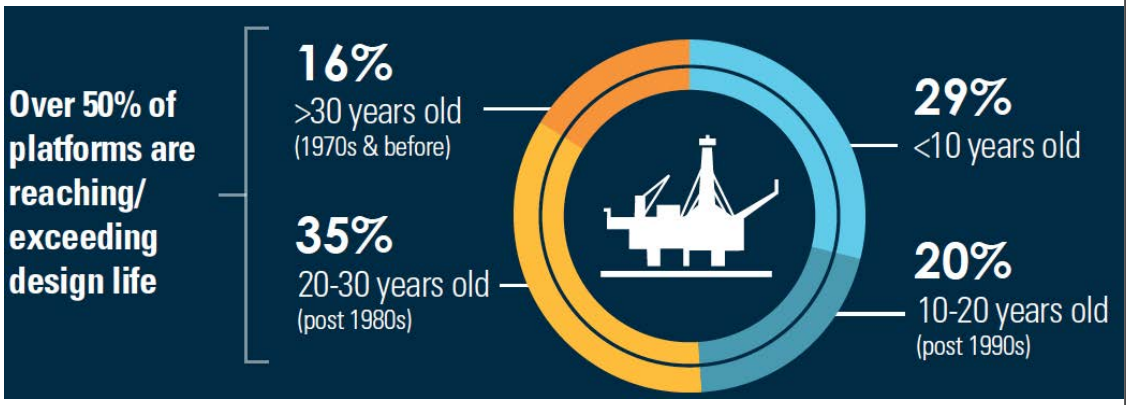
- Diesel engines dominate the marine market but ..
- LNG use increasing is
  - Lower emissions
  - Need for LNG bunkering infrastructure
- Use of biofuels and synthetic fuels hold promise
- Hybrid solutions attractive in some circumstances
  - Diesel/battery



Source: Future Ship Powering Options, Royal Academy of Engineering Report, 2013

Asset Integrity Management
- Aging platforms

- The problem
  - No appetite for expensive new platforms
  - Interest in extending life of fields
- Challenge
  - Establishing state of asset
    - Sensors
    - Big data: extracting meaningful information
    - Integrating measurements
  - Cost-effective inspection and repair strategies
  - Assessment methodologies – risk-based methods



Source: Bentley Systems Infographic on Structural Integrity, 2016

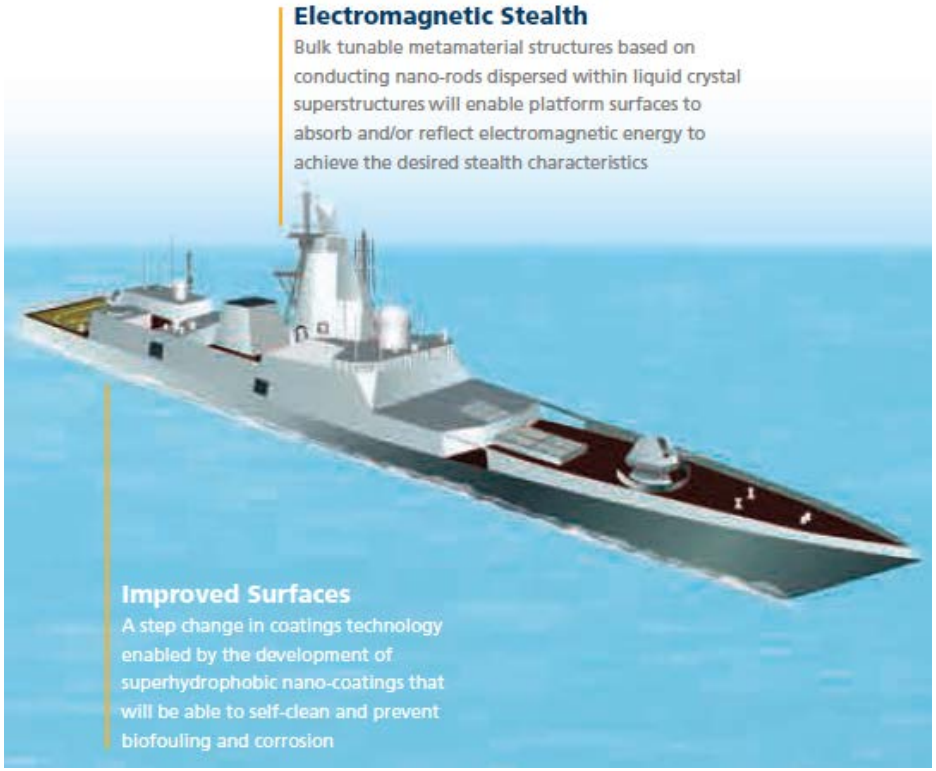
Aquaculture
- Offshore fish farming

- Advantages over close-to--shore farming
  - Exposed to steady currents
  - Reduced diseases
  - Smaller environmental impact due to a changing column of water around the cages
  - Fewer space constraints
  - Low operating costs because of high automation (but higher CAPEX)

Source: SalMar Group, Norway

Naval Technology

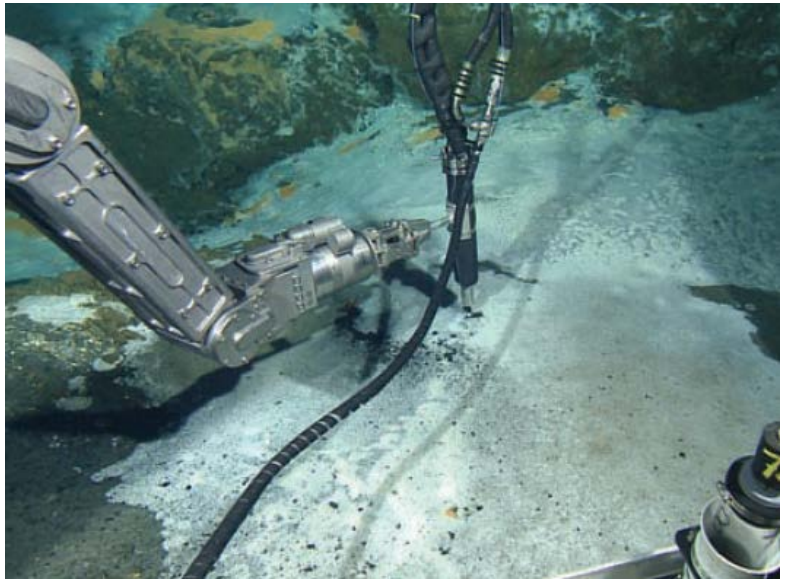
- A joint team of Lloyds Register, QinetiQ and the University of Southampton identified several technologies relevant for naval platforms:
  - Big data analytics
  - Advanced materials
  - Autonomous systems
  - Advanced manufacturing
  - Energy management
  - Cyber and electronic warfare
  - Human-computer interface
  - Human augmentation technologies



Source: LR/QinetiQ/UofSouthampton, Global Marine Technology Trends 2030, 2015

Seabed Mining

- The seabed has for many years held promise as a source of energy and minerals
- Among the most promising:
  - Methane hydrates
  - Seafloor Massive Sulphides
  - Polymetallic Nodules/Manganese Nodules
  - Cobalt-rich Crusts

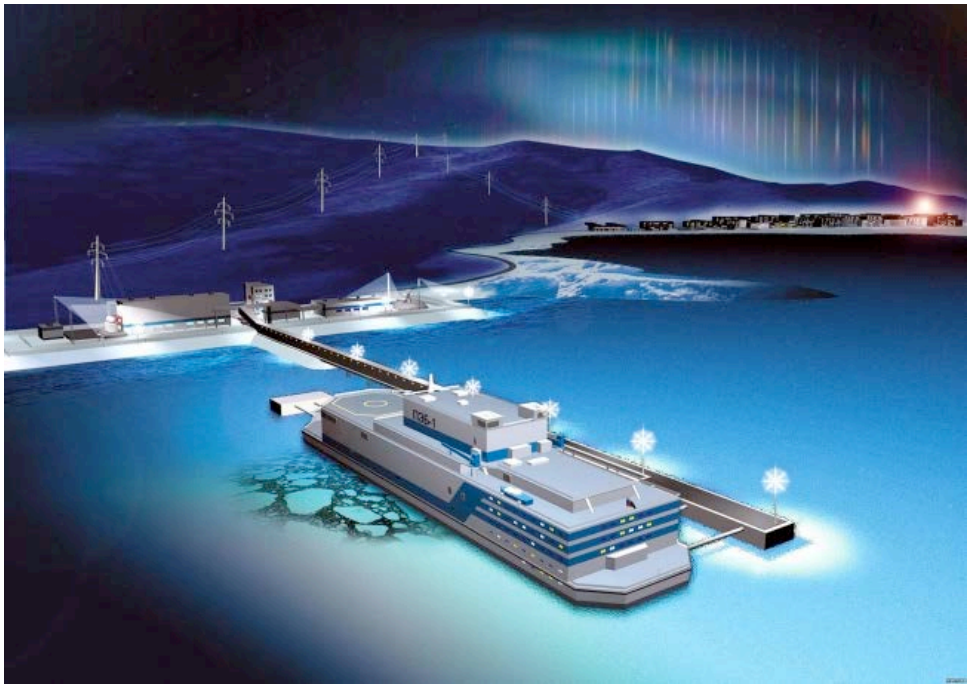


Source: Scientific American

- Various schemes for mining - ROVs and AUVs, pumps, risers
- Primary challenge is cost-effective recovery
- Several pilot schemes underway

Floating Energy Infrastructure

- Large floating systems to support power stations
- Can be relocated
- Graphic shows Russian concept for floating nuclear power station in the Arctic



Source: Radio Canada 23 Apr 2015; Graphic: Rosatom.ru

- FLNG embodies similar elements

Marine Habitation

- While concepts for marine habitation have existed for many years no large scale installations have been built
- With population pressures and climate change (rising sea levels) might the concepts go beyond the thinking phase?

Source: Dezeen magazine, 13 May 2014

Concluding Remarks

- Challenging times for marine & offshore industry
  - Low growth, low oil prices
  - Uncertainties
  - Over supply in some sectors
- Opportunities for research especially if solution-focused
  - Reducing costs
  - Regulatory changes
  - Implementing new technologies