

INSTITUTION OF MECHANICAL ENGINEERS HONG KONG BRANCH
EVENING LECTURE “GLOBAL MARINE TRENDS 2030” ON 15/11/2017



The speaker, Mr. Douglas Raitt of Lloyd's Register (LR) (middle), and his LR colleague, Mr. Bin Tian (right), received the certificate of appreciation after the above evening lecture delivered in The Hong Kong Polytechnic University on 15/11/2017

Since the Millennium, 95 % of global goods and commodities were transported by sea, leaving the remaining 5 % by all other means. Global trade, facilitated by shipping, has had profound impact to people's daily life. To position the shipping industry in preparation for the future, the mega-trends, political, economic and environmental landscapes are to be carefully evaluated.

Global Economic Scenario

The global economic development may have three (3) possibilities.

Status Quo

Status Quo characters reactive and short-term solutions, rapid regulatory changes and overlapping jurisdictions and conflicting laws lead to checks and controls, and inward-looking and protectionism. In Status Quo, no single trade power dominates and the heightened tensions between the major powers result in other countries to hedge their security needs. The shipping industry pursues superior risk management and maximum flexibility in order to respond to all possible abrupt changes.

In other words, the world in the Status Quo scenario is not yet truly a “global village”.

Global Commons

Global Commons characters built-in security and compliance certification, regulatory harmonisation and thriving mutual recognition and voluntary best practice codes. Major agreements on international trade and environmental protection are entered and enacted, resulting in the acceleration of the expansion of globalisation and world economy, as well as rise in living standards. Networking skills and superior reputation management become essential to the shipping community.

In simple terms, Global Commons means true globalisation is achieved.

Competing Nations

Competing Nations characters fragmentation in regulations, priority given to the national interests, rising protectionism, encouragement in local production and consumption and gate communities. These result in the shrinkage of globalisation and the reduction in demands, as well as the disappearance of a level playing field. Local presence becomes essential to the shipping industry in order to sufficiently serve the individual countries.

The “Donald Trump trend” in the U.S. is a good illustration of Competing Nations.

Population Demography

Populations and Age Distributions

While the global population was 6.9 billion in 2010, it is forecasted that reaching 8.3 billion is on the horizon of 2030. From which, 3 billion additional population will be added from the developing nations, while China and India will contribute 17 % and 18 % of the world population respectively. In particular, India will have the largest and youngest population in 2030, endowing the country with a dynamic and plentiful workforce. Simultaneously, however, the population of the major economies will age. In particular, while 34 % of the Japanese population was supported by the other 66 % in 2010, it is forecasted that the ratio will become 50:50 in 2030, imposing a burden on the young working population heavier than ever.

Rising Middle Class

The middle-class population is expected to expand significantly. China and India are the major developing countries which contribute to the expansion of the global middle-class population which is currently dominated by the developed countries. The rate of expansion is equivalent to that 283 men per minute are joining the middle-class club from now to 2030. The impact of such explosive growth of the middle-class population is that the demand on utilities and consumable goods will surge, and it is forecasted that in 2030, the consequential global demand of raw materials will double of the current level. If the existing American lifestyle is to be accessible to all middle-class club members in 2030, the demand will be seven (7) times of the current level.

The resources on Earth will, be subject to unprecedented level of stress, and following the huge resources consumptions is the increase of greenhouse gas, principally carbon dioxide, emissions. Global warming will exacerbate, and more extreme weather conditions will be expected.

Commodities Demography

Oil

While both China and India will be the two (2) primary importers of all commodities, in 2030, India and South East Asia are predicted to surpass China in the volume of importing oil. The major source of oil supply may shift from currently the member countries of Commonwealth of Independent States to the Middle East and Africa.

Natural Gas

In 2030, the Middle East and Europe are forecasted to consume more natural gas than oil, while Australia may replace currently Qatar and become the largest natural gas exporter. Simultaneously, Nigeria and Mozambique in Africa may also become the major natural gas exporting countries.

Coal

While China may remain the largest consumer of coal and consume three (3) times of the 2010 level in 2030, India is predicted to exceed the U.S. in coal consumption by 2030, importing coal from predominately Australia. It is interesting to note that, notwithstanding the endowment with large reserve of coal, China is likely to import coal to fill its energy hunger. This is due to the majority of its domestic coal is low grade and the land transportation of coal is less cost competitive than sea.

Steel

Following the steep economic growths, China and India are predicted to see colossal demands on steel for supporting their infrastructure and become the major consumers and importers of iron ore. It is worth nothing that, in spite of being also an iron ore producer, China is importing iron ore from Australia for its own needs. This is due to the not only does the Chinese ores can fulfil only 34 % of its needs, leaving 66 % to be met by import, the iron content in the Chinese ores is less competitive than the Australia ones. On average, the Chinese ores carry 34 % of iron, versus the Australian ores 60 %.

Container Trades

As analysed above, the increase in wealth of China and India, primarily the middle-class of these countries, imposes huge demands on the consumer goods. Container trades are expected to be benefited from the demand growths driven by Asia, and double the 2010 levels in 2030 is envisaged.

Shipping Demography

Tonnages

In response to the above increasing demands of commodities and consumer goods in Asia, the shipping industry is predicted to expand its carrying capacity to meet them in the following magnitudes by 2030:-

Vessel	Increased tonnage by number of times of 2010 level
Bulk Carrier	1.7 to 2.2
Container Carrier	1.4 [less than 7,600 twenty-foot-equivalent (TEU) size] to 6.5 (over 7,600 TEU size)
Liquefied Natural Gas Carrier	1.8 to 2.5
Oil Tanker	1.7 to 1.8

At the moment, the oil tankers are in steady business and the container carriers are enjoying increasing demand. However, the bulk carrier market has been sluggish, and the ship-builders have run after the new-built orders hard. It has been reported that 70 % of the shipyards in China have received no order.

Ownerships

In 2010, Europe excluding Greece was the largest ship-owners, which was followed by Greece, China and Japan. It is forecasted that in the *Status Quo* scenario in 2030, China may become the dominant ship-owning country. On the other hand, Japan may shrink its share from 12 % in 2010 to only 6 % in 2030, while Greece may also shrink substantially from the 2010 level.

Opportunities and Challenges

It is certain that the demand on the shipping industry is a function of the population growth. The higher the population growth, the greater the demand on shipping. The rising demands, shift of wealth from the west to the east, and rise of innovations in the maritime sector are all opportunities, while the impacts on the environment are a major challenge to the shipping industry.

Although in 2010 shipping was responsible for 2.8 % of the global emissions, which was equivalent to the total emissions of Germany in the same period, in response to the higher demands on transporting commodities and consumer goods as outlined above, the maritime traffic is going to increase and so is its associated pollution. However, while the ship-owners are struggled in complying with the ever-tightening environmental legislations, the conservative nature of the shipping industry has hindered its embracement of the new technologies and achievement of higher efficiency and less pollutions.

Recalling the history of maritime technology, the ocean-going vessels were propelled by sails in 1870. About 40 years later, in 1900 propulsion by coal came into the stream. Another 40 years later, in about 1940 the shipping industry leaped into diesel-propulsion. The means of propulsion, however, has not advanced beyond 1940 despite after over 70 years, and the overall current shipping technologies have continued which in the 1960s. Simultaneously, the emissions of land transportation have improved over the years, reflecting the shipping industry is lagging behind in the reduction of emissions and use of new technologies.

Transformation: First Arena

The shipping industry has two (2) fronts of developments in the transformational technologies, namely internal developments and external developments, or the First and Second Arena respectively.

The First Arena emphasises improvement of efficiencies. Both the haul and engine designs are to be improved to reduce fuel consumption and emissions respectively. An example of the resulted operating cost reduction is the route between Singapore to Rotterdam in the Netherlands, which covers about 3,500 knots of voyage. In 2012, the operating cost was about USD600 per tonne. In 2015, it has reduced by two-third to only USD200 per tonne.

In parallel, both the expected rise of oil price and the enactment of the legislation of requiring the use of cleaner fuel are on the 2020 horizon. In particular, the sulphur content in the fuel oil for shipping is to be reduced from currently 3.5 % to 0.5 % by 2020, whereas the latter fuel costs two (2) times of the former fuel, which has constituted 60 % of the total cost of shipping. The resulted rising fuel cost has prompted the shipping industry to explore using natural gas and methanol to substitute oil.

Nuclear propulsion for the merchant vessels has been under exploration, and it has been estimated that the fuel consumption of the voyage from Singapore to Rotterdam is about 3.2 grams of uranium. Although its inherits safety and security concerns will result them in being banned from entering the U.S. ports, one day it may become an option for the shipping industry if it is globally received.

Transformation: Second Arena

The external developments involve the introduction of new technologies outside the shipping industry into it. The following new technologies are a few possibilities.

Smart Materials

Advanced materials, often at micro- or nano-scale and in composites, are sophisticated and high performance. Their formation into the required shapes and functions can be achieved by three-dimensional (3D) printing. This means that in future, a ship equipped with a 3D printer installed with a stock of printing ingredients in powder can print small size components, such as bolts, for its own reparation and maintenance, resulting in a significant reduction of the stock of spare parts in the vessel. While the original equipment manufacturer possesses the intellectual property of the components concerned, this will help reducing the capital cost on stocking spare parts and the operating cost on weight and space.

Big Data Analytics

While the land and aviation transport have embarked the use of data, the shipping industry has not started with it because the data involved is too large in volume and there has not been a strategy of utilising it. The algorithm of making good use of the data received from vast sources suitable for shipping is still under development.

Robotics

Robotics for the application in the shipping industry is still in its infancy. Nevertheless, inspection is identified potential for robotics to be called upon. Sending a drone to inspect is far safer and more cost effective than erecting scaffolds and send a man to inspect at height. On the other hand, the rules for drone inspection have not been in place and are subject to establishment.

Sensors and Autonomous Ships

Sensors are the backbone of big data and prerequisite to autonomous ships, which is the ultimate dream of the shipping industry. The advantages of autonomous ships are obvious. Firstly, as said, while 60 % of the total cost of shipping is on fuel, half of the remaining 40 % of the total cost is contributed by the crew salaries and the occupation of the space on ship for crew accommodation, which otherwise could have been converted into carrying goods. Secondly, according to statistics, 96 % of all recorded accidents on ships are caused by human mistakes. Autonomous ships can eliminate all men on board and maximise the capacity of the vessel, as well as improve the safety performances of the shipping industry.

Autonomous shipping is not novel and the first vessel for transporting fertiliser between its production site and delivery port in Norway is expected to start sailing in 2018. However, International Maritime Organisation has not developed industry rules to govern autonomous ships to date.

Man In Future

In the future, enabled by big data analytics, robotics and autonomous shipping, man may no longer be needed to be on the deck and in the engine room. Deck officers and engineers on board may become obsolete one day; yet it does not mean that marine engineers will be of no value. Instead of working inside the vessels, they will work behind computers and analyse data transmitted from the vessels and the inspection drones, identifying problems and provide solutions with their expert knowledge and experiences which automation cannot perform. Their contributions to the shipping industry will still be valued, only their role is changed.

Nevertheless, following the advancement of automation, the crew size is likely to be reduced from the current level. Simultaneously, the bridge may still be manned in order to make real-time decisions in the adverse and quick-changing weather conditions, which sensors, data transmission and algorithms may not be able to function and give the correct instructions timely.

Remarks

Although no one has a crystal ball, the above trends and analysis have projected some possibilities of the future shipping industry to the members of Institution of Mechanical Engineers Hong Kong Branch (IMechE-HKB), Mechanical, Marine, Naval Architecture and Chemical Division of The Hong Kong Institution of Engineers (HKIE-MMNC), Hong Kong Joint Branch of The Royal Institution of Naval Architects and The Institute of Marine Engineering, Science and Technology (HKJB) and Hong Kong Institute of Marine Technology (HKIMT). Threats and opportunities are the two sides of a coin, and the mechanical and marine engineers can stand on the opportunities side in the ever changing world with the right knowledge and skills.

IMechE-HKB, HKIE-MMNC, HKJB and HKIMT thank Mr. Douglas Raitt and Mr. Bin Tian of Lloyd's Register for their sharing.

The original "Global Marine Trends 2030" of LR, which is available on the LR website <https://www.lr.org/en/insights/global-marine-trends-2030/>, is attached for reference.

*** END ***

Encl.
WHT



The future marine global landscape


IMechE lecture Hong Kong – 15 November 2017

Douglas Raitt – Regional Consultancy Manager Asia

 Lloyd's Register Marine


Working together
for a safer world

Agenda



- Introduction
- The World in 2030
- The Impact on SEA

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Introduction

These publications are freely available on our website






Global Marine
Fuel Trends
2030



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Introduction – Scenario Planning

Scenario	Characteristics	Impact
Status Quo	 <p>Reactive and short-term solutions Absence of market solutions to the crisis of security and trust Rapid regulatory changes Overlapping jurisdictions and conflicting laws lead to checks and controls All recognise a reversal to inward looking and protectionism is detrimental to all parties</p>	<p>No single trade power dominates Heightened tensions between major powers causes other countries to hedge their security needs Short-term portfolio optimisation and vertical integration Superior risk management is essential and maximum flexibility is called for in the shipping community Naval power grows with economic power</p>
Global Commons	 <p>Built-in security and compliance certification Regulatory harmonisation Mutual recognition Independent media Voluntary best-practice codes Close links between investors and civil society Major agreement on international trade and environmental protection</p>	<p>Accelerated expansion of globalisation Strong international institutions regulate and arbitrate international affairs fairly and transparently A win-win world with rising living standards and an expanding world economy Networking skills and superior reputation management are essential for the shipping community Naval power increases</p>
Competing Nations	 <p>Dogmatic approaches Regulatory fragmentation National preference, conflicts over values and religion give insiders an advantage A brake on globalisation Rise in protectionism, encouraging local production and consumption Gate communities Patronage and national standards exacerbate fragmentation Self-interest and zero-sum games</p>	<p>Reduction in demand Disappearance of a level playing field Competing demands from national interests make life complicated Shipping community will suffer with the roll-back of globalisation Local presence for shipping is necessary Naval power increases</p>

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The World in 2030 Population Growth



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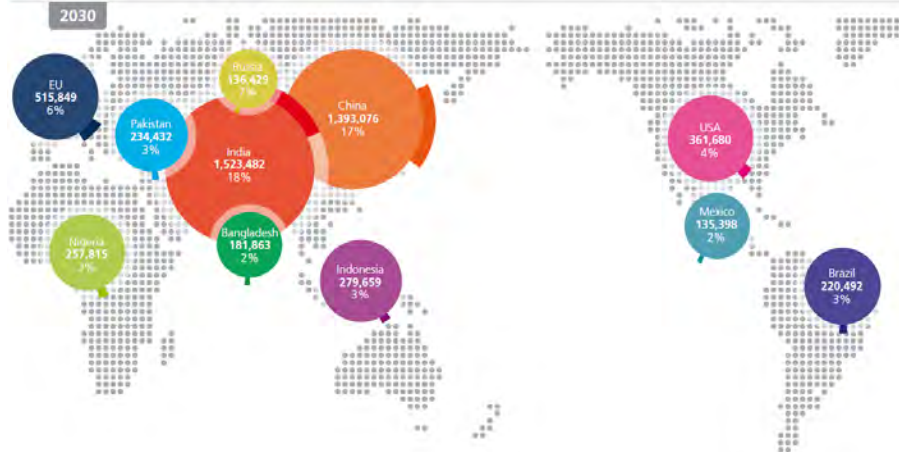
The World in 2030 Population Growth – 6.9 Billion in 2010



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The World in 2030 Population Growth – 8.3 Billion in 2030?

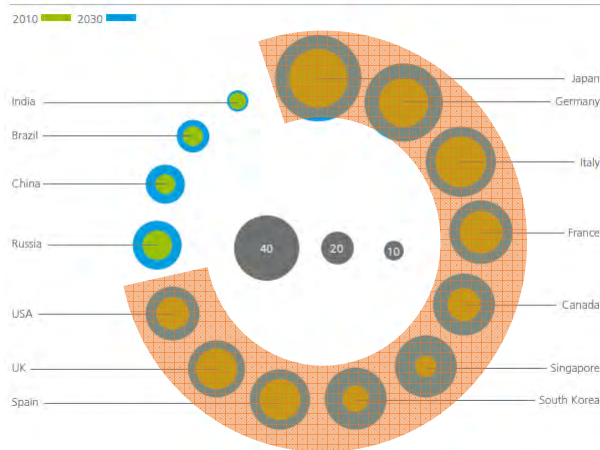


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The World in 2030 Population Growth – Aging Populations

Fig. 7 Aged dependency ratio: people over 65 per 100 people aged between 15 and 64 (%)
Source: UN F.U.R.

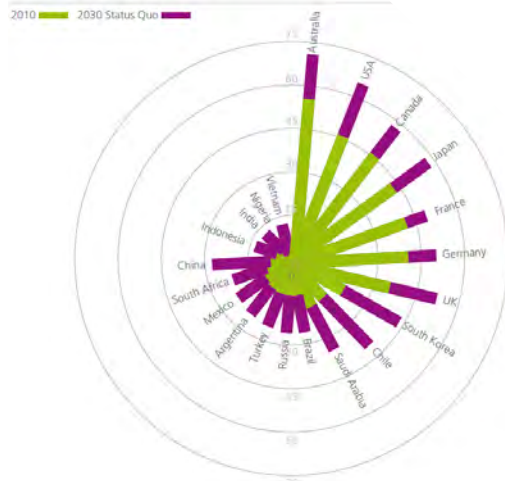


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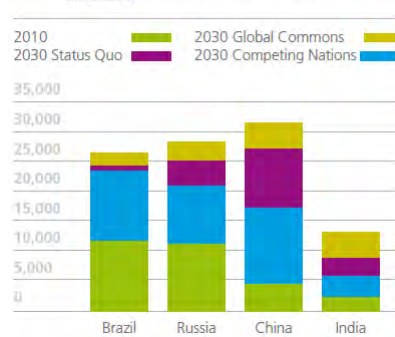
The World in 2030 Global Trade – GDP Per Capita

Fig. 14 Real GDP per capita (thousand \$2010)
Source: IMF / LR



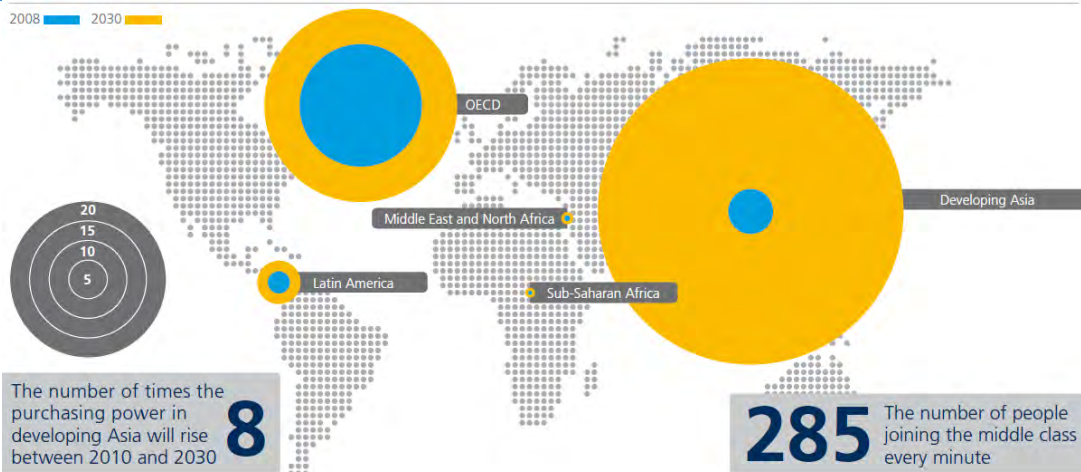
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Fig. 15 Status Quo - Real GDP per capita (\$2010)
Source: IMF / LR



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The World in 2030 Global Trade – Total Annual Expenditure (Trillion USD)



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Marine

The World in 2030

Climate Change – Precipitation and Coastal Flooding



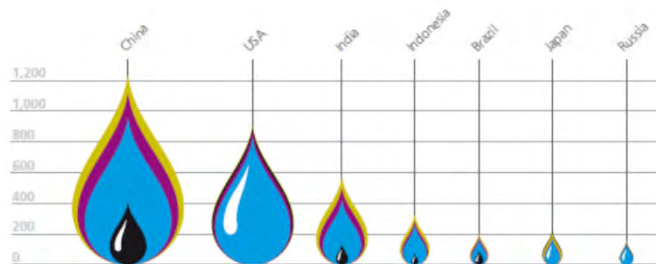
The impact on oil consumption

Fig. 22 Oil consumption (million tonnes)

Source: M&P/LR

- 2010
- 2030 Competing Nations
- 2030 Status Quo
- 2030 Global Commons

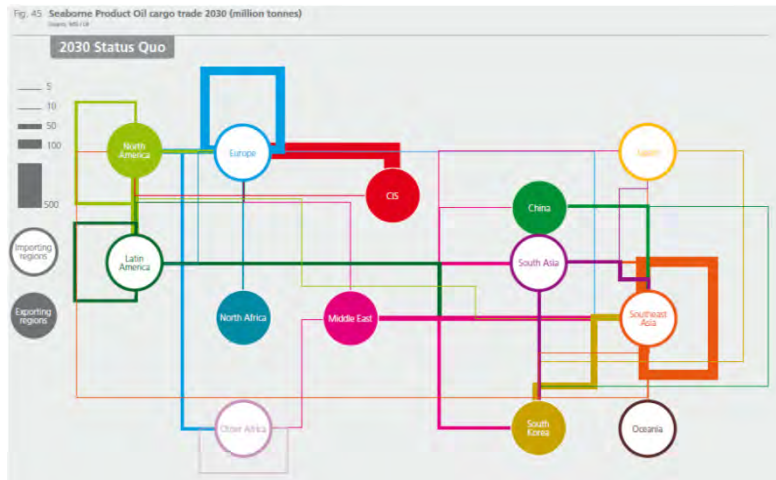
40% higher energy forecast demand in 2030



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Product Oil Trade 2030

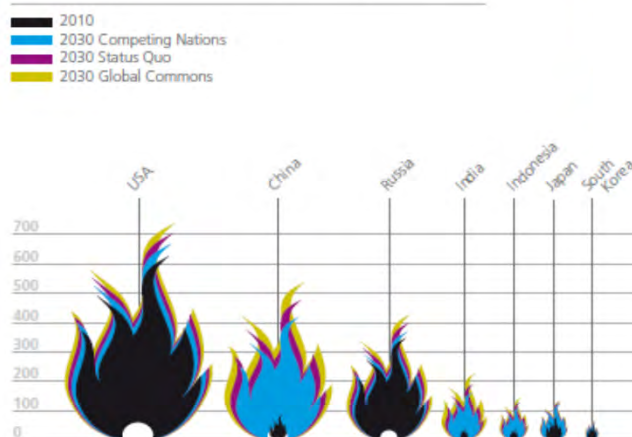


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The impact on natural gas consumption

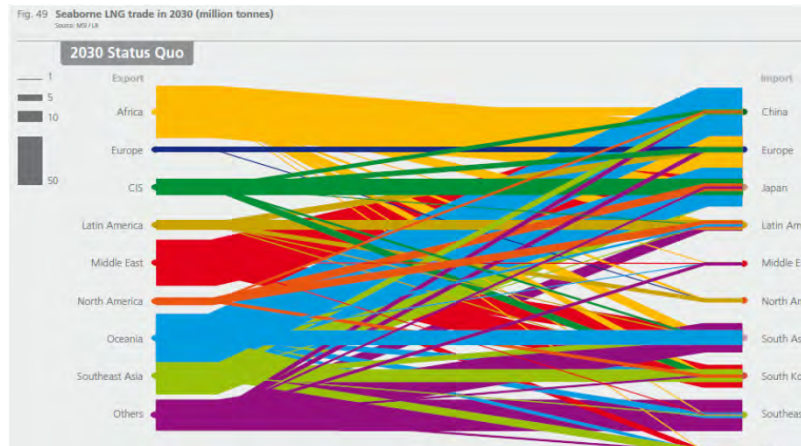
Fig. 23 Natural Gas consumption (million tonnes of oil equivalent)
Source: IEA / LR



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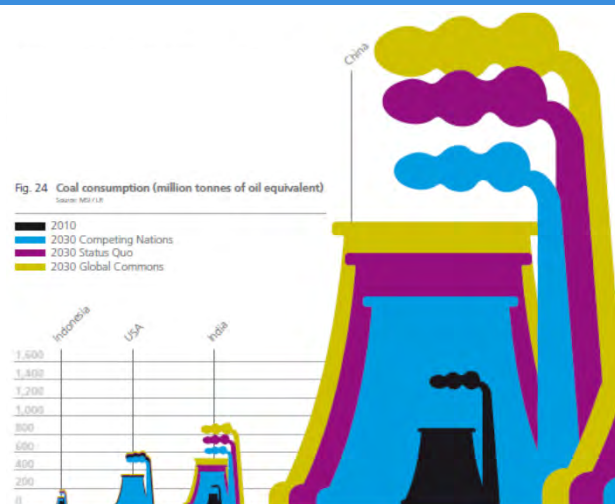
LNG trade 2030



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The impact on coal consumption



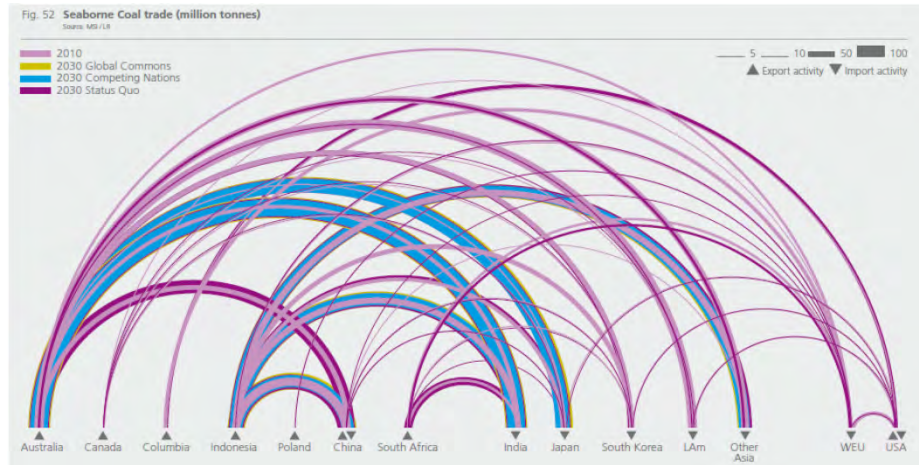
China 60% of world coal consumption in 2030

India's coal consumption will double between 2010 to 2030

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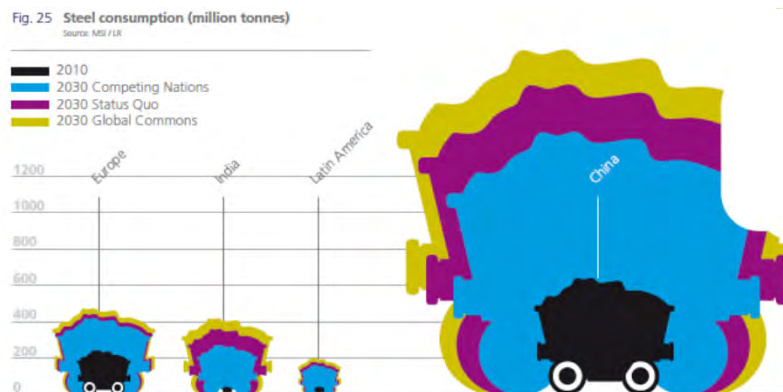
Coal trade 2030



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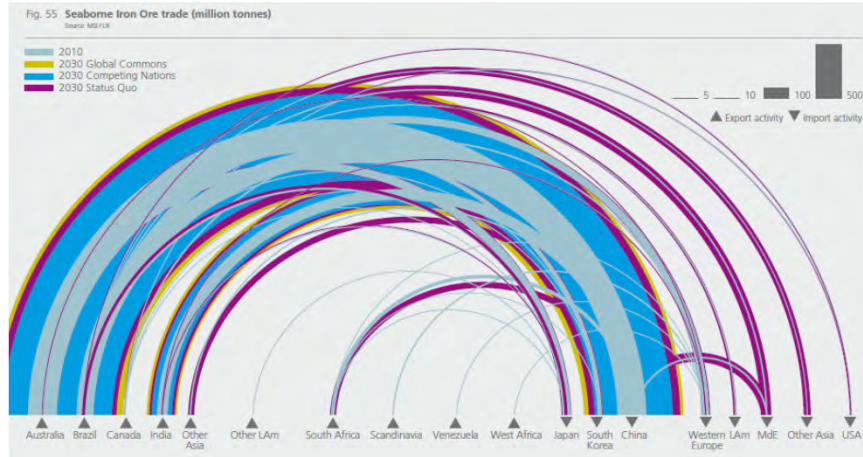
The impact on steel consumption



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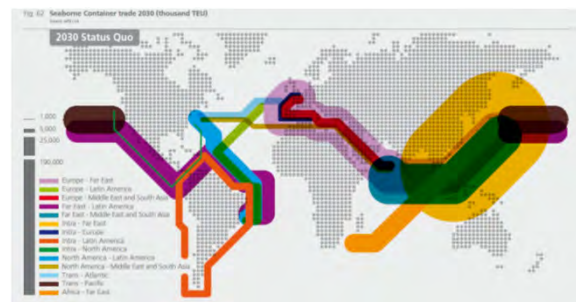
Iron ore trade 2030



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Container trade 2030



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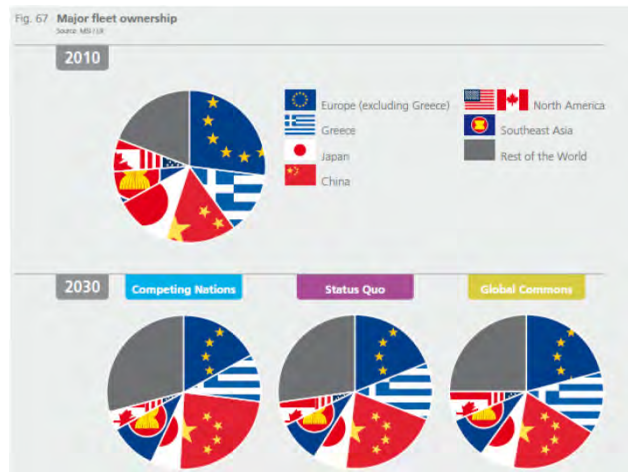
Fleet Size 2030



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Ownership 2030

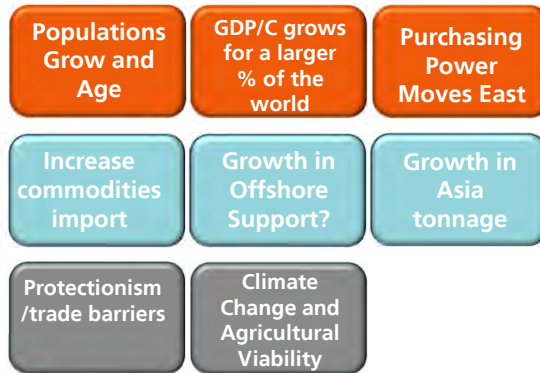


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The 2030 Global Landscape

Conclusions – **Situational** / Opportunities / Threats?



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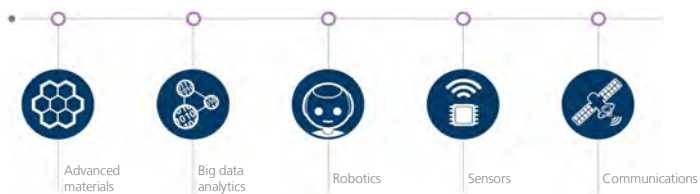


8 Transformational Technologies

First arena:
Internal developments



Second arena:
External developments



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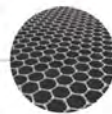
Advanced Materials

- Materials fine-tuned at micro- or nano-scale
- Thriving Composite Materials
- Bio-inspired and bio-based materials

High strength, toughness, malleability, corrosion resistance and self-healing structural material



Self-cleaning and self-repairing finishes



Graphene-doped anti-corrosion coating

Drivers of advanced materials include:

Protection of People, Assets, and the Environment

- Higher structural and fire protection performance to safeguard people and assets
- Improved ship stability by lowering the centre of gravity
- Ergonomics and comfort
- Sustainable sourcing
- Design for end-of-life

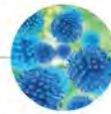


Energy Consumption

- Reduce lightweight
- Reduce energy consumption of heating, ventilating, and air conditioning (HVAC) system
- Offer a surface that improves hydrodynamic efficiency

Improve Operational and Maintenance Efficiency

- Higher cargo-handling capacity
- Reduced maintenance costs

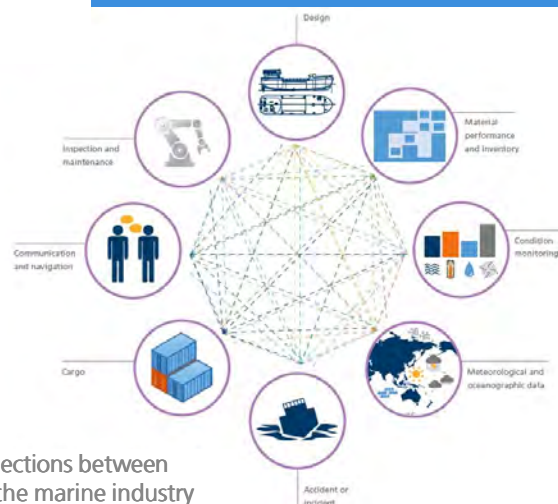


Bio-based materials made from sustainable resources, such as bacteria, waste plants, or fast-growing and non-food feedstock

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Big Data Analytics



Data's multiple connections between different sources in the marine industry

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Robotics

Cognition

Robots will have cognitive capabilities in terms of attention, dialogue, perception, memory and decision making.

Versatile

Swim, fly and climb functions will provide a multitude of resources to researchers and engineers both onboard and ashore.

Imitation

The re-creation of animal-human actions, like soft arms inspired by an octopus or articulations inspired by human fingers, will provide a full range of capabilities.

Senses

Speaking, touching, seeing, listening senses will enhance robots' capabilities.

Adaptability

Ability to carry out specific tasks autonomously, ability to operate in subtropical and Arctic areas, battery-powered, wireless communication with other networks: these features will be of paramount importance for the shipping industry over the decades to come.



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Robotics

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Unmanned Aircraft

How is LR supporting Systems (UAS)?

LR has an active research program in technology, design codes, policies. We see UAS as part of the unmanned systems ecosystem, alongside underwater and ground-based systems.

There is no doubt that these technologies and Energy industry – and across sectors – will leverage the opportunities.

Guidance Notes for Inspection using Unmanned Aircraft Systems

March 2016



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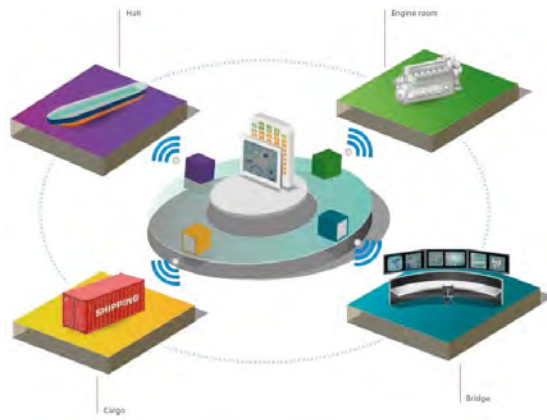
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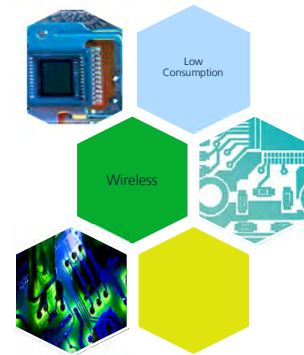
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Sensors



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Global Marine Trends 2030

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Global Marine Trends 2030

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Fig. 1 Top sea bilateral trade in 2010 (Western centric)

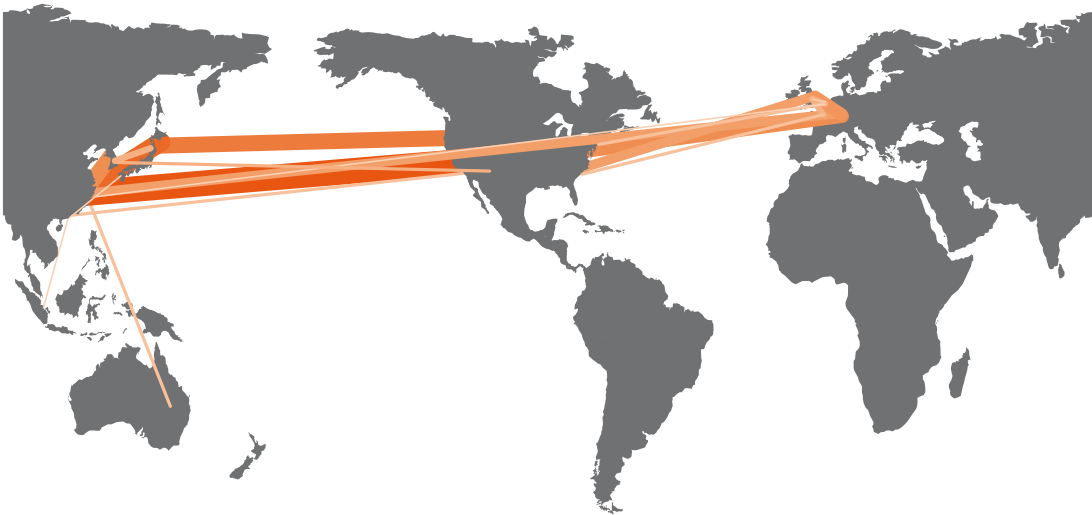


Fig. 2 Top sea bilateral trade in 2030 (Sino centric)



Foreword

Welcome to Global Marine Trends 2030



We thought the world would not change much between the last decade of the twentieth century and the first decade of the twenty-first. As events unfolded in the financial world, the Middle East and emerging countries, we were shocked by what happened. It has had dramatic impact on geopolitics, international security, world trade and business.

As we enter the second decade of the twenty-first century, our business environment is becoming more complex, global and multi-polar. This development is driven by many factors, some of them easily discernible and others more subtle. One of the principal driving forces is the aspirations of people in developing nations. These are behind massive dislocations and upheavals in the BRIC countries, in the Middle East and elsewhere around the globe. We are seeing a new, multi-polar, world economic configuration emerging (in terms of resource demand and allocation, trade and consumption patterns and a shift in the centre of economic activities from west to east). It poses many challenges but also opens many new opportunities for the marine industries. These will have profound impacts on commercial shipping requirements and natural resource exploitation; an emerging shift of geopolitical configurations where future competitions and conflicts between nations is more likely to involve future competition at sea.

This will pose threats to peace and stability. Coupled with these threats, new business opportunities are opening up for naval suppliers as a result of the increased demand for naval systems of all sorts.

Increasing demand for sustainable energy sources also seems to be driving the search offshore.

The central question is: What will 2030 look like for the marine industry as these forces gather their momentum, accelerating changes around us? Global Marine Trends 2030 has been prepared by a team from Lloyd's Register, QinetiQ and University of Strathclyde, using publicly available and proprietary information, and a scenario development methodology. The team has shed some light on a few variables that they judge will have a disproportionate influence on future events and possibilities. It will help you to recognise signposts indicating where events are headed, and to identify opportunities for policy intervention and formulation.

We share this publicly to encourage broader understanding of global issues that affect the marine industry and their impact in the form of scenarios, but not projections. I hope you find the Global Marine Trends 2030 useful, informative and interesting; and that it helps to stimulate debate and thinking of the realities and challenges - and solutions - that will shape the future of the marine industry.

Richard Sadler
Chief Executive Officer
Lloyd's Register Group Limited





Executive summary

We started the twenty-first century with great optimism. “The world is flat” and “the end of history” proclaimed by great thinkers such as Friedman and Fukuyama. They believe historical and geographical divisions are becoming increasingly irrelevant and free market capitalism of the West and its lifestyle may signal the end point of humanity’s sociocultural evolution. And calamity unfolds before our very eyes: the financial crisis, the failure of the Copenhagen Climate Change Conference, the pace of WTO negotiations and the threat of pandemic.

With astonishing events unfolding in the financial world in 2008 and in the Arab world in the early part of 2011, giant forces are at play that seem beyond the control of even leaders of powerful countries, let alone business executives who traditionally see their abilities to shape the big picture future limited. They are right in that there is little they can do in affecting these giant forces such as technology, demographics or the movement of capital and manufacturing around the world seeking best investment returns. But they do have a choice: they can either react passively to such forces or anticipate them to their advantage. Either way they ignore these forces at their peril.

It seems obvious now: the voluntary opening up of China in 1978 and India in 1990 and their eventual accessions to the WTO in 2001 and 1995 respectively have had an enormous implications to the world, which should not surprise anyone, as they together consist of nearly 40% of humanity. Their impacts have been magnified by other countries like Brazil which also rushes into development. The plug-in of more than 2.4 billion people to the world economic power grids, and their dreams of achieving a lifestyle and earnings similar to the developed world, are bound to have gigantic impacts on world trade and the environment. These in turn change social attitudes, drive supply and demand in resources, technologies, goods and services. The effects have been particularly felt in the marine world: demands for additional new tonnage for container ships for transporting manufactured goods, bulkers and tankers for commodity trades; the demands for drilling for oil and gases into ever greater depth offshore, for example.

Were these events predictable? If they were predictable could the major disruptions and discord they caused be foreseen? Could their effects be smoothed or these events be avoided altogether?

“ The opening up of China in 1978 and India in 1990 and their eventual accessions to the WTO have had an enormous impact to the world, as they together consist of nearly 40% of humanity. ”

For much of the past two years, Lloyd’s Register, QinetiQ and University of Strathclyde have worked together as a team to prepare this Global Marine Trends 2030 report. It aims to define key global trends using demography, economy, resources and environment. We explore the underlying factors which drive them; where they seem headed; and how they might interact to affect the marine world in 2030. Our thinking is exploratory rather than definitive; our discussion is descriptive rather than predictive. It is not a prediction of the world in 2030, but rather a description of what these giant forces are and how they might interact. It is a work in progress and the trends are at best indicative in nature based on existing works in the public domain and our own research. Nevertheless by examining a small number of the giant forces that we consider most influential, the trends presented should provide a good basis for framing strategy formulation discussions, and identifying policy options for threats and opportunities that arise from them.

The marine world in 2030 will be almost unrecognisable owing to the rise of emerging countries, new consumer classes and resource demand.

“The marine world in 2030 will be almost unrecognisable owing to the rise of emerging countries, new consumer classes and resource demand.”

We are telling a story with no clear or definitive outcome. But, by examining different scenarios based on major global drivers (such as economic and population growth, resource demand, accelerated technological advances, rise of consumers and cities in large emerging countries), we can map out divergent futures. By bringing together trends and their interactions, industry-specific insights, and using simple problem-solving techniques, we have been able to create three possible outcomes in a quantitative, actionable and unbiased way, namely the “Status Quo”, “Competing Nations” and “Global Commons” scenarios. These principally separate out the possible actions of society in terms of international politics. The propensity to compete or cooperate depends on human nature.

In the “Status Quo” scenario, we expect long term economic growth and an increase in global challenges. Reactive and short-term solutions are found to address many issues that affect trade and commerce, which in turn affects shipping. Absence of market solutions to the crisis of security and trust, rapid regulatory change, overlapping jurisdictions and conflicting laws lead to checks and controls, encouraging short-term portfolio optimisation and vertical integration, creating risk to the shipping world. There will be no single dominant trade power, but a collection of powers trying to support current world orders and systems to advance their interests. All recognise that a reversal to insularity and protectionism is detrimental to all parties.

Superior risk management is essential and maximum flexibility is called for from the shipping community. Naval power continues to grow around the world. Energy demands increase offshore investment.

In the “Global Commons” scenario, we see even more economic growth. Cross-border integration (e.g. non-custom trading) and virtual value chains are encouraged by built-in security and compliance certification, regulatory harmonisation, mutual recognition, independent media, voluntary best practice codes and close links between investors and civil society. Networking skills and superior reputation management are essential. We envisage major agreements on international trade, climate change and environmental protection.

We can see accelerated expansion of globalisation with strong international institutions regulating international affairs and arbitrating disputes in a transparent and fair manner. This is a win-win world for all participants and shipping will expand in line with rising living standards and an expanding world economy. Although there will be less need for naval power, investment will continue as economies grow. Offshore energy demand will increase more rapidly.

In the “Competing Nations” scenario, dogmatic approaches, regulatory fragmentation, national preference and conflicts over values and religion gives insiders an advantage and put a brake on globalisation. Gate communities (e.g. trade blocks),

patronage and national standards exacerbate fragmentation and call for careful country-risk management.

In this scenario, we can see the shipping community will suffer with the potential roll-back of globalisation and a rise in protectionism, encouraging local production and consumption.

At best regional blocks are formed with barriers erected and a preference for intra-regional trade, resulting in a reduction in demand for international shipping and the disappearance of a level playing field. This is a world of self-interest and zero-sum games. Local presence for shipping is necessary and competing demands from national interests make life complicated. The naval sector will see greater demand, but suffer from lower economic growth.

In between these three scenarios, there will be disruptive events that introduce step changes to the world. We have constructed a few potential disruptive events to see how they might change the future. It is not possible to know which scenario will prevail; however the trends presented can help readers to challenge conventional wisdom, pressure-test existing business models, identify market opportunities, and develop more innovative products and services.

At the very least we hope it will generate debate and discussions about what the future might hold for us all.

The GMT 2030 Project Team



Using scenarios

The Global Marine Trends 2030 project uses a scenario planning methodology that is primarily qualitative in nature.

Scenarios are stories about the future. Good scenarios are plausible, challenging and rigorously constructed to address the most critical questions that decision-makers need to face. One cannot expect any given scenario to come true as it stands. They are not predictions, preferences or forecasts. Rather, the process of developing and using scenarios is intended to help us learn and generate insights, both from exploring each scenario individually and from comparing and contrasting them.

Scenarios can enrich learning as well as decision-making at both the organisational and individual level. They enhance a strategy’s robustness by identifying and challenging underlying assumptions and established wisdom. We make better strategic decisions by discovering and framing uncertainties, leading to a more informed understanding of the risks involved with substantial and irreversible commitments.

Scenarios improve awareness of change by shedding light on the complex interplay of underlying drivers and critical uncertainties, and enhancing sensitivity to weak and early signals of significant changes ahead.

They increase preparedness and agility for coping with the unexpected by making it possible to visualise possible futures and mentally rehearse responses.

They facilitate mutual understanding and collaborative action by providing different stakeholders with common languages and concepts in a non-threatening context, thereby opening the space for creating robust, effective and innovative multi-stakeholder strategic options.

We used the following five steps to develop Global Marine Trends 2030:

- | | |
|----------------------|---|
| Step 1 | Formulating the central question |
| Steps 2 and 3 | Identifying driving forces and determining critical uncertainties |
| Step 4 | Constructing scenario frameworks |
| Step 5 | Developing scenario stories |

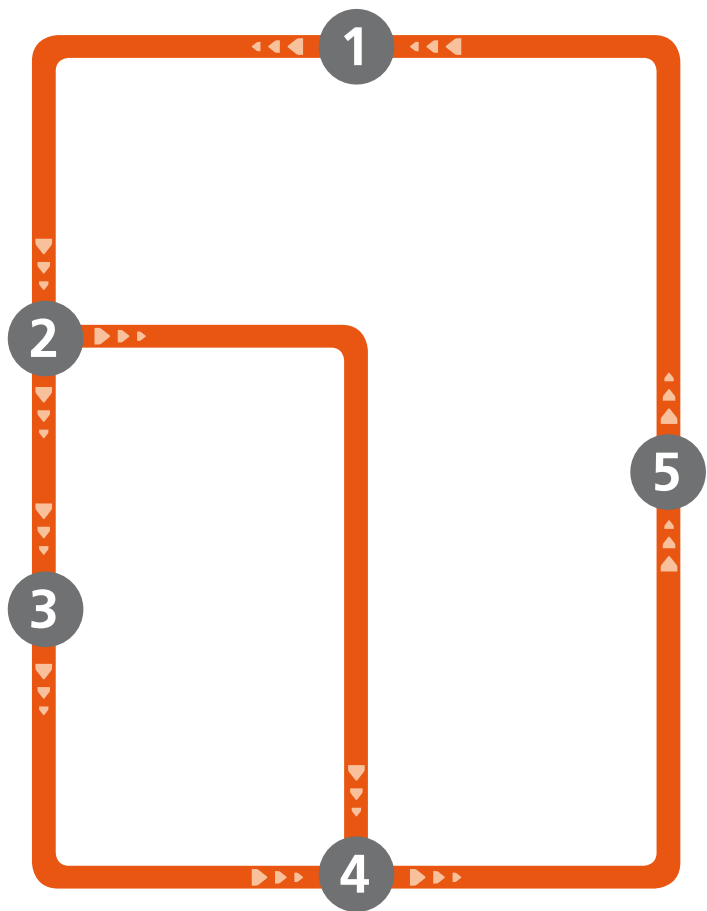
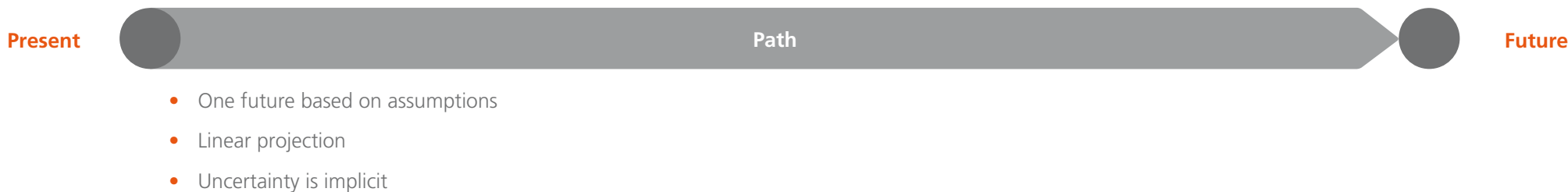


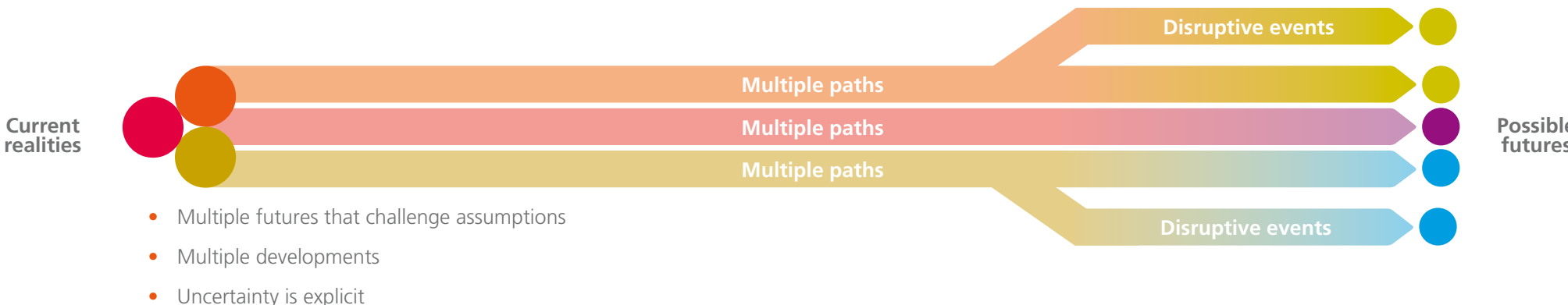
Fig. 3 Forecasting versus scenario thinking

Forecasting



Scenario thinking

Global Commons  Status Quo  Competing Nations 



Marine world in 2030 - three scenarios

The marine world in 2030 will be almost unrecognisable owing to the rise of emerging countries, new consumer classes and resource demand. The central question is what it will be like? Will it be a world with multiple players or will one dominate? Will it be a world full of conflicts or in harmony? In qualitative terms, the shape of the marine world in 2030 will depend on tri-polar interactions between people, economies and natural resources. Our future will depend on their relative pulls towards a certain destination. Here, we consider three possible scenarios.

In the first world of 2030, where people’s primary interest is biased towards social development (especially living standards and jobs), we envisage business as usual with occasional disruptions along the way. Government will strive to satisfy people’s needs with short term fixes. We expect the world will continue its current growth momentum with some booms and busts over the next twenty years. We call this the “Status Quo” scenario.

In another world, where primary interests shift to concern over resource limitation and environmental degradation, we will see a desire for a more sustainable world being developed, and fairness in wealth distribution. Government will act to forge agreement for common goods. We call this the “Global Commons” scenario.

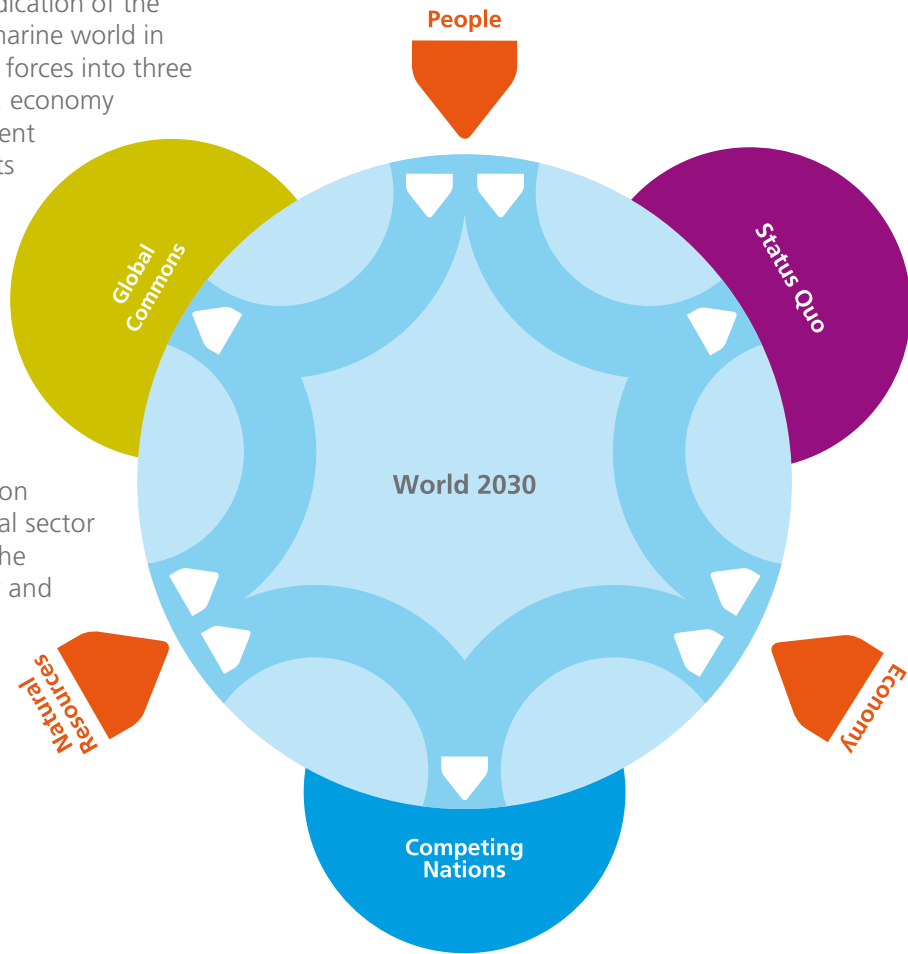
In a further world, where the voice of the people is not heard (or not expressed), the state will mainly act in its own national interest. There will be little effort to forge agreement amongst governments for sustainable development and international norms.

This is a zero sum world and we call this future a “Competing Nations” scenario.

In order to provide some quantitative indication of the effects of these three scenarios on the marine world in 2030, we have translated these tri-polar forces into three quantitative global drivers; demography, economy and natural resources, for the development of scenarios to demonstrate their impacts downstream. We have also considered the environment as one of the global drivers, but it will have smaller impact on the marine world in our time horizon. The influence of politics is of course an important consideration but it is implicit in our scenario formation.

These scenarios have different impacts on different marine sectors. The commercial sector is influenced by all three forces, while the energy sector is influenced by economy and natural resources. In the naval sector, we find that the primary driver is economic power.

Fig. 4 Tri-polar interactions give rise to different scenarios



Scenario	Characteristics	Impact
Status Quo	<div></div> <div>Reactive and short-term solutions Absence of market solutions to the crisis of security and trust Rapid regulatory changes Overlapping jurisdictions and conflicting laws lead to checks and controls All recognise a reversal to inward looking and protectionism is detrimental to all parties</div>	<div>No single trade power dominates Heightened tensions between major powers causes other countries to hedge their security needs Short-term portfolio optimisation and vertical integration Superior risk management is essential and maximum flexibility is called for in the shipping community Naval power grows with economic power</div>
Global Commons	<div></div> <div>Built-in security and compliance certification Regulatory harmonisation Mutual recognition Independent media Voluntary best-practice codes Close links between investors and civil society Major agreement on international trade and environmental protection</div>	<div>Accelerated expansion of globalisation Strong international institutions regulate and arbitrate international affairs fairly and transparently A win-win world with rising living standards and an expanding world economy Networking skills and superior reputation management are essential for the shipping community Naval power increases</div>
Competing Nations	<div></div> <div>Dogmatic approaches Regulatory fragmentation National preference, conflicts over values and religion give insiders an advantage A brake on globalisation Rise in protectionism, encouraging local production and consumption Gate communities Patronage and national standards exacerbate fragmentation Self-interest and zero-sum games</div>	<div>Reduction in demand Disappearance of a level playing field Competing demands from national interests make life complicated Shipping community will suffer with the roll-back of globalisation Local presence for shipping is necessary Naval power increases</div>

Global drivers

Population



Demographics

The world is getting more crowded with global population reaching 6.9 billion in 2010. China and India are the two most populous countries in the world and together account for 37% of the world population.

Population “only”
6.9 billion
in 2010

2010

2030

India becomes
Number 1
in total population

The population may reach 8 billion by 2030, with 96% of growth coming from developing countries. India will overtake China with the largest population and the largest labour force in the world. Mexico will replace Japan in the top 10.

Fig. 5 The 10 most populous countries/regions in 2010 (thousands)

Source: UN / LR

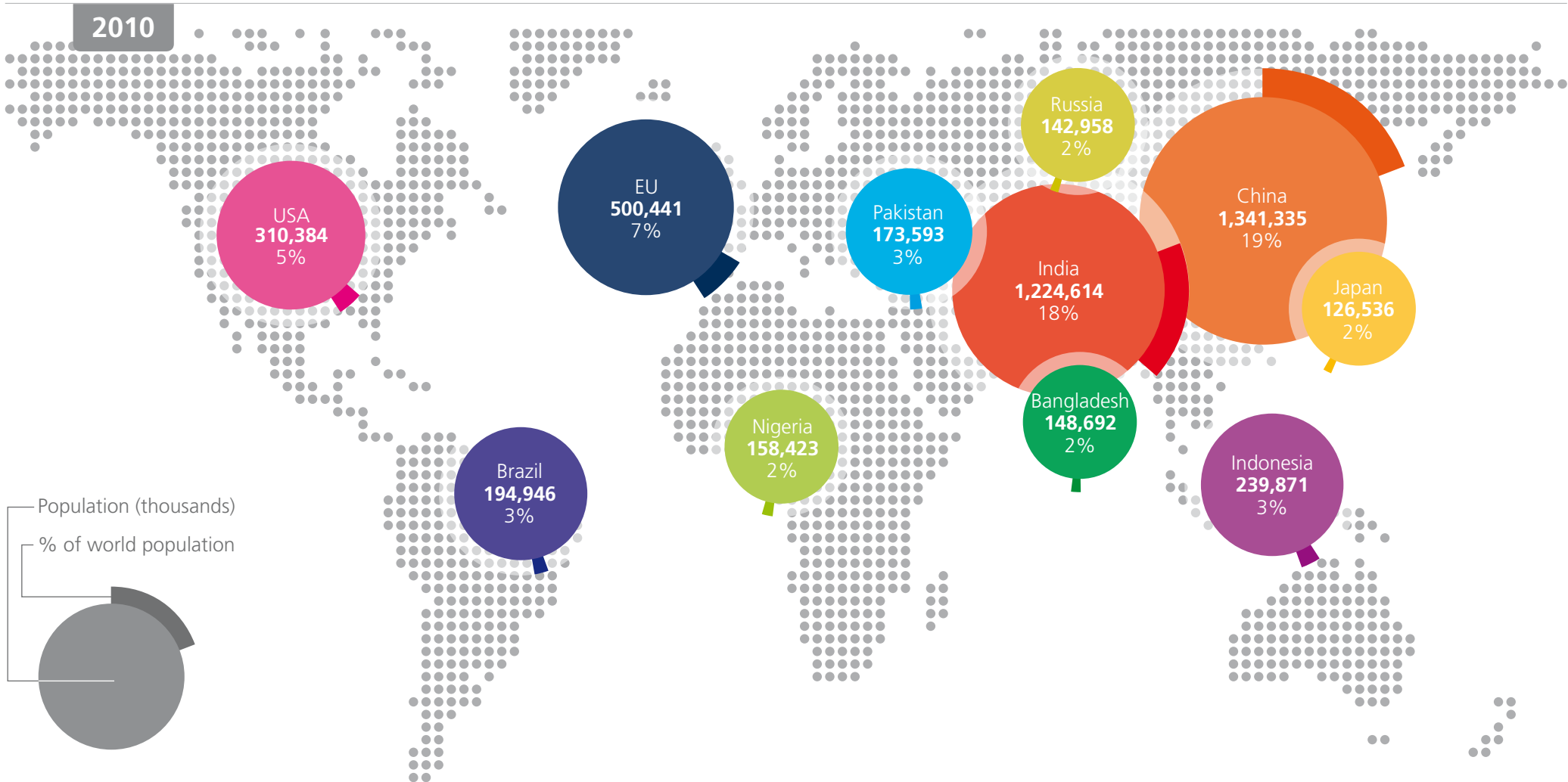
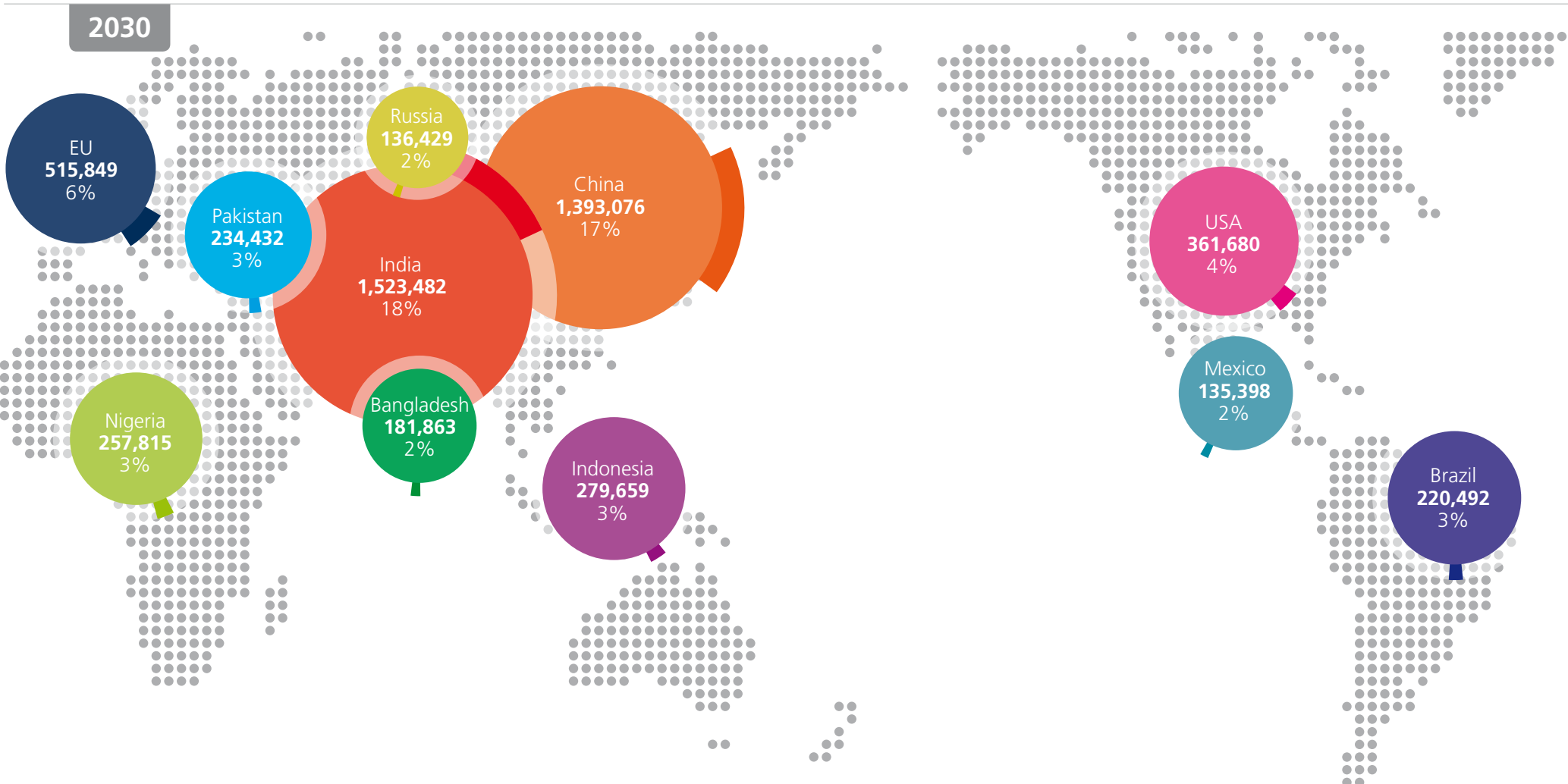


Fig. 6 The 10 most populous countries/regions in 2030 (thousands)

Source: UN / LR



Double challenge

An ageing population

As a society becomes richer, couples tend to raise fewer children and people tend to live longer. This has led to an ageing population, escalating social pressure on the work force (eg. via pensions and healthcare) and impeding economic growth.

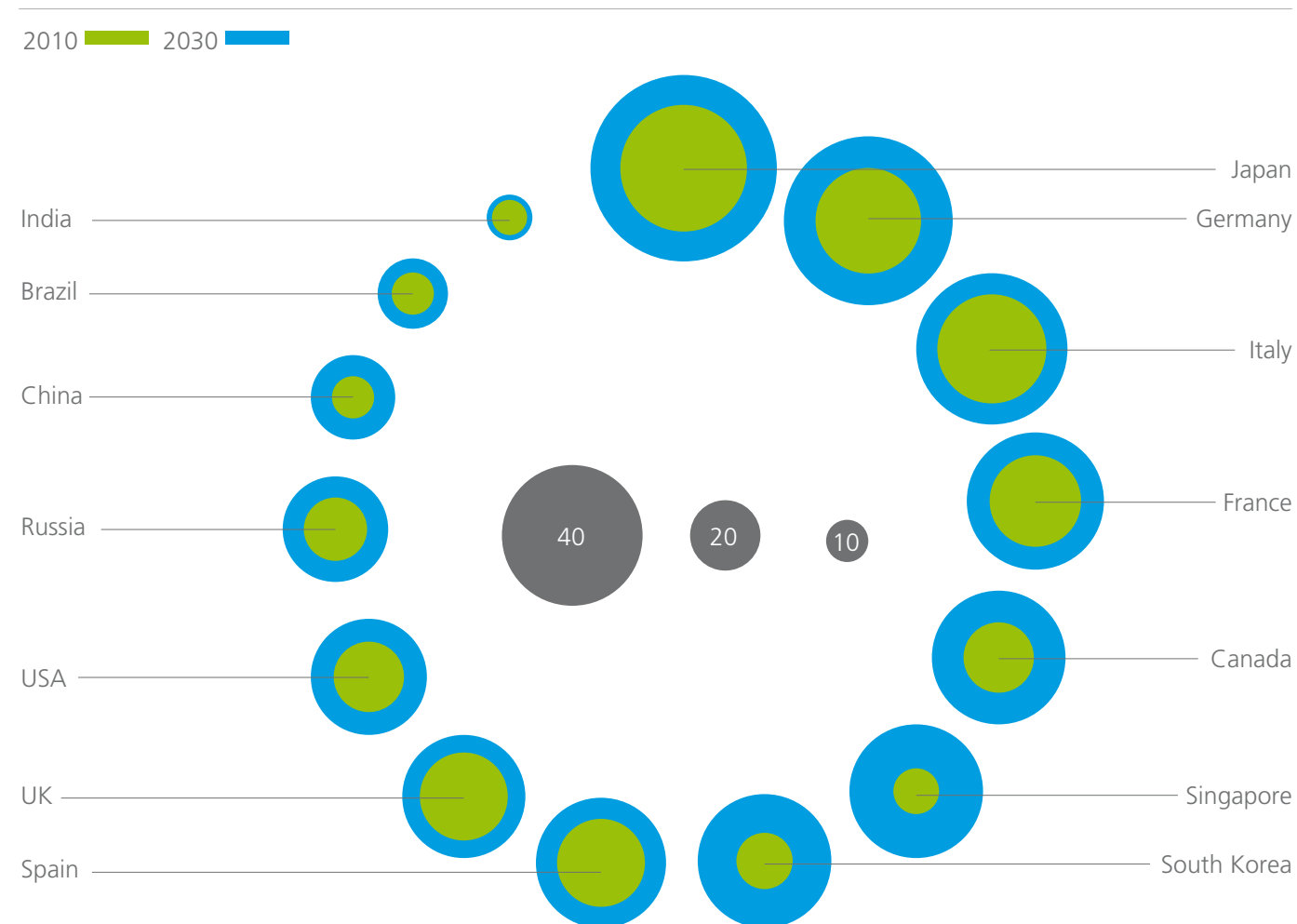
Japan's population is currently the oldest in the world. 38% of its population will be over 65 years old in 2030, meaning that 53 (from 35 in 2010) Japanese aged over 65 need to be supported by 100 Japanese aged between 15 and 64 years old. Germany and Italy are in similar situations.

Meanwhile, countries including China and Russia are also ageing. In 2030, the aged dependency ratio of China will be at a similar level to that of Spain today. India, on the other hand, will enjoy being as young as China in the 2000s by 2030. A younger population is a favourable demographic asset for a country's development, assuming India is able to provide education and jobs.

53 The number of Japanese pensioners will require support from every **100** workers by 2030.

Fig. 7 **Aged dependency ratio: people over 65 per 100 people aged between 15 and 64 (%)**

Source: UN / LR



Double challenge

Declining population

Human beings' global population expansion is regarded to be exceeding the Earth's carrying capacity. A few countries, led by Japan, Germany, and Russia, will confront an unprecedented shrinking population. This could be good news for some overcrowded regions and could also contradict a country's social and political preference in population level. For instance, experts predict that without sufficient population density, Russia with such a massive territory could become politically unstable and no longer be viable as a nation. In order to solve this issue, Russia has begun taking migrants from Central Asia and the Caucasus area to prop up its declining population. However, the increasing immigration could contribute to social instability such as ethnic conflict. China's population will reach its peak around 2030 and will start to decline unless its one child policy is relaxed or abandoned.

Fig. 8 **Population change between 2010 and 2030 (%)**

Source: UN/LR



Urbanisation

Urbanisation is inevitable in the modern world. People leave rural areas for cities in search of better job opportunities. An expansion of urban living is taking place in every continent.

However, the majority of people in some of the most populous countries still live in rural areas. South Asia was, in 2010, the most rural region, with 71.9% in Bangladesh, 70.0% in India, and 64.1% in Pakistan.

The largest percentage growth in urbanisation will take place in China, Southeast Asian countries, Bangladesh, Nigeria and Turkey over the next 20 years.

City - Population

Most major cities are usually sea ports or inland ports, with easy access to waterborne transport. For the next 20 years, the earth's urban landscape is going to continue shifting towards the emerging nations. Most of the populous cities are located in Asia, Latin America and Africa.



Fig. 9 **Urban population percentage in 2010 and 2030 (%)**

Source: UN / LR

2010 ■ 2030 ■

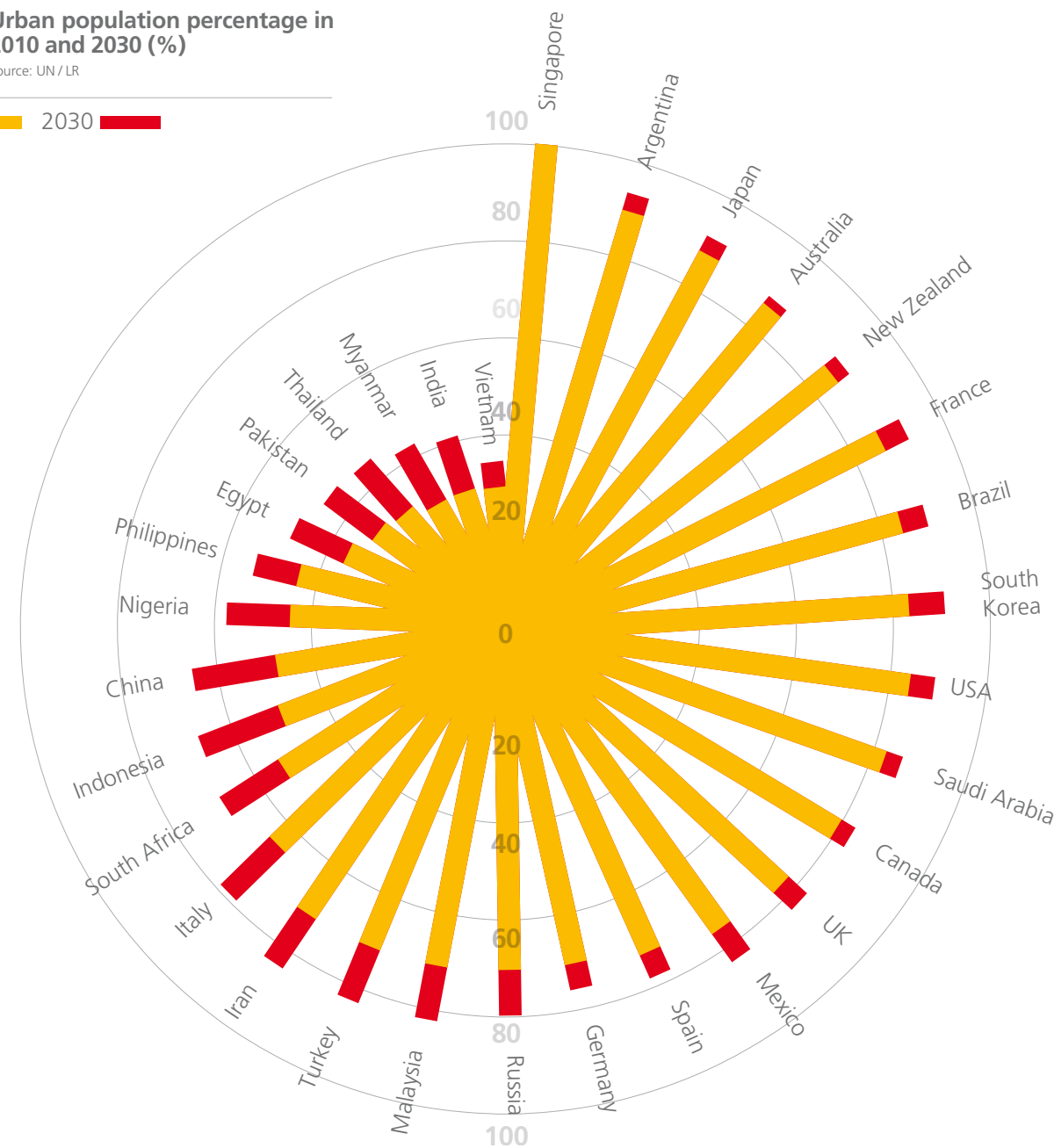
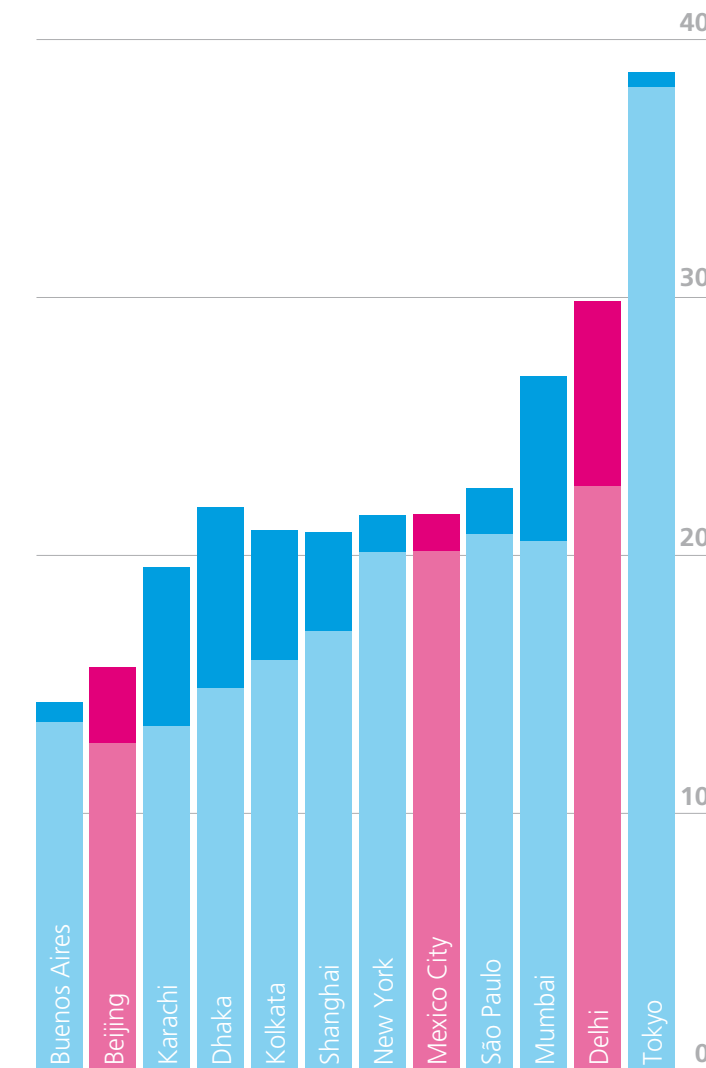


Fig. 10 **Population of top urban agglomerations in 2010 and 2030 (million people)**

Source: UN / LR

Non-port cities 2010 ■ 2030 ■
Port cities 2010 ■ 2030 ■



Global drivers

Economy

Economy

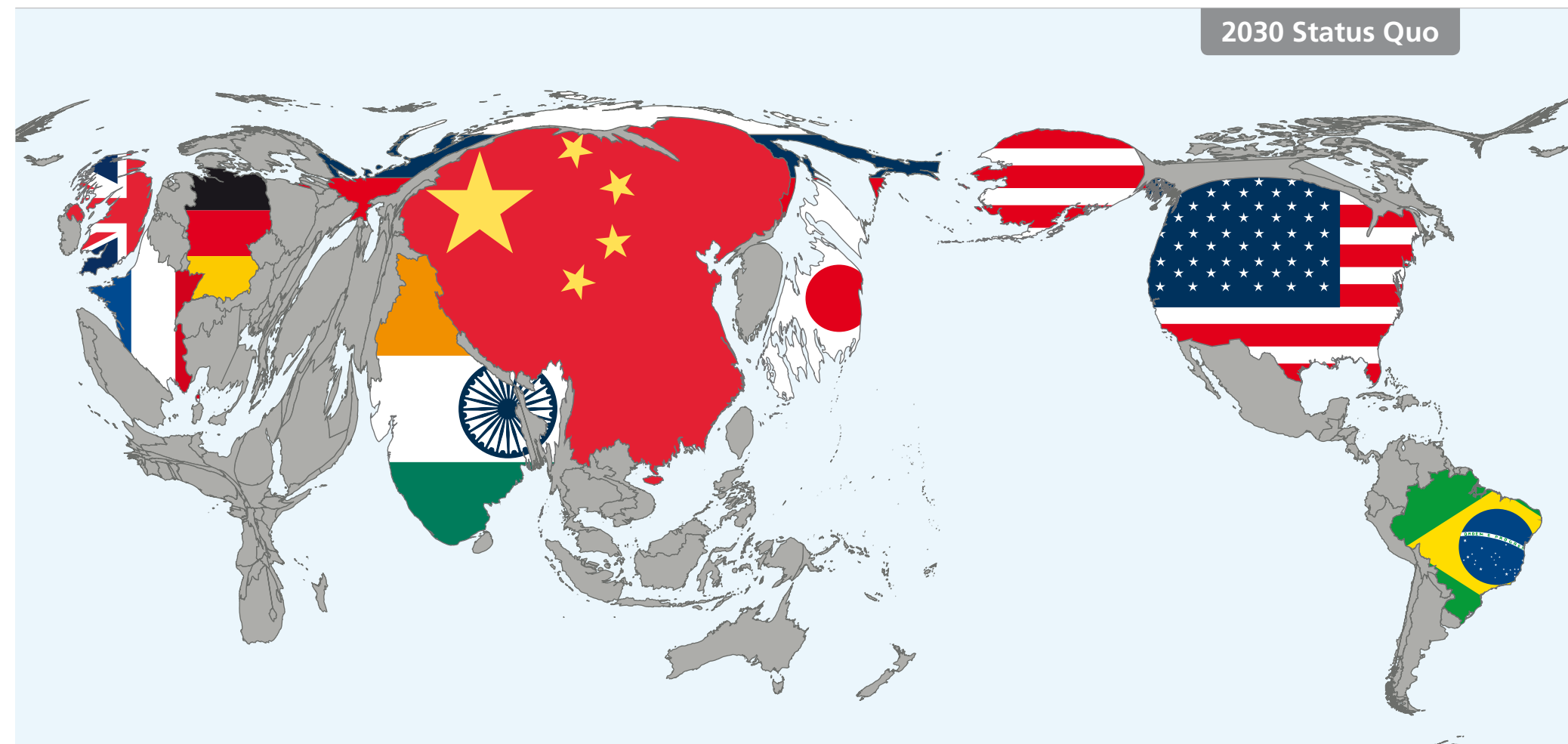
In every scenario, countries and regions will continue to compete in the global market. The world's 2010 economic power will be rebalanced by a new league of economies. They have brandished their strength during the financial crisis, regarded as a safer place for investment and growth.

China, India and Brazil will sit in the top 5 list in terms of GDP ranking. China alone will contribute about 20% of the global GDP. The traditional developed countries, such as USA, Japan and Western European Countries, will gradually lose their economic dominance in the next two decades.

20% China's contribution to world GDP in 2030

Fig. 11 Global economic focus moves East (relative real GDP size in \$2010)

Source: IMF / LR





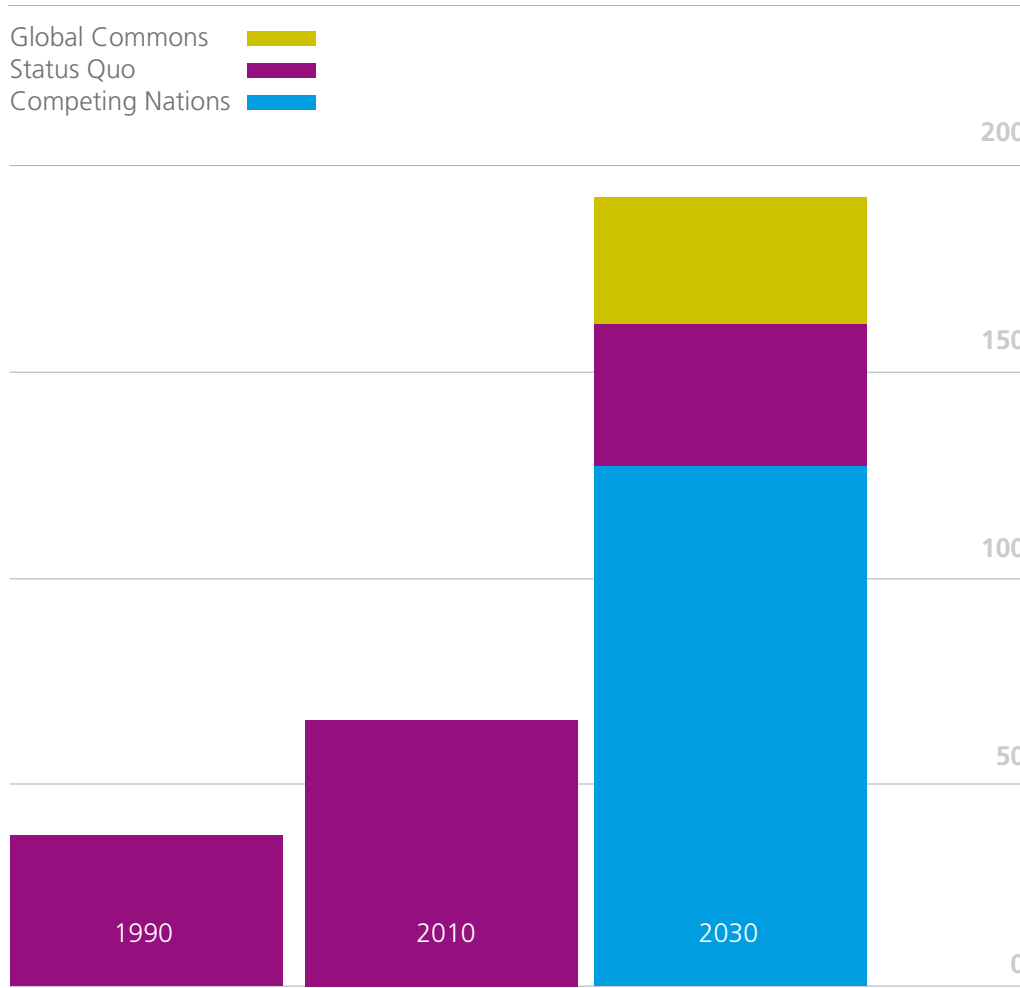
3x Growth in world GDP which could be achieved in the next 20 years

The 3 biggest economies in 2030 in all three scenarios

**China
USA
India**

Fig. 12 Global real GDP increase (trillion \$2010)

Source: IMF / LR



Competing Nations

Protectionism and localisation are the main features, which dampen the global economic growth and trade. The world is balanced between two super powers: China and USA. China will grow more slowly, rivaling USA by 2030. India's GDP will be 13% more than that in Japan, and will be about one-third of that of the USA. The global economy will still grow to nearly twice the size of that in 2010.

Status Quo

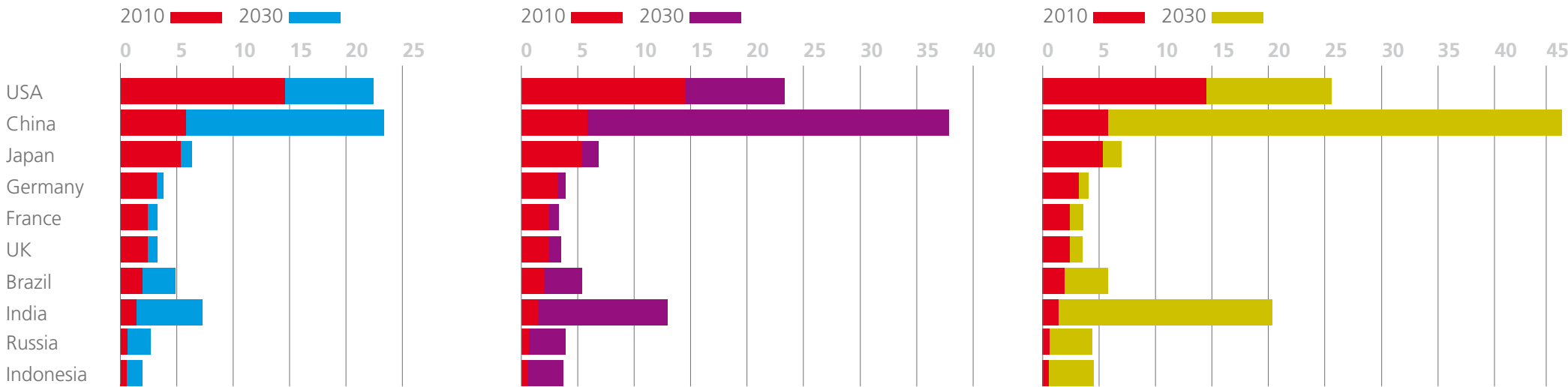
Reactive and short-term solutions are the main features in this scenario. In 2030, the world's economy will be led by China and USA, with India also on the rise. China will edge out the USA in terms of GDP rank in the 2020s. However the most remarkable rise in the world's economic power will take place in India. India will leap from ninth in 2010 to the top three in the 2020s. India's GDP will be nearly twice the size of Japan and more than half of the USA by 2030. Meanwhile, Brazil will join the top 5 and Russia the top 10 in the 2020s. Indonesia could also achieve immense growth and become top 10 by 2030. The global economy will be 2.6 times the size of that in 2010.

Global Commons

Global trade liberalisation and integration will accelerate economic growth. This is a world dominated by three countries: China, USA and India. China will still catch up on the USA faster than the Status Quo scenario and accelerate in the 2020s. India will be an even bigger player in the global economy. India will join the top three in the 2020s, growing to nearly three times the size of Japan and around 80% of the size of USA by 2030. The economic size of the South Asia region will compete with Europe by 2030. Traditional European economic powers such as the UK and France will be overshadowed, but still much larger than in 2010.

Fig. 13 A list of countries ranked by real GDP (trillion \$2010)

Source: IMF / LR

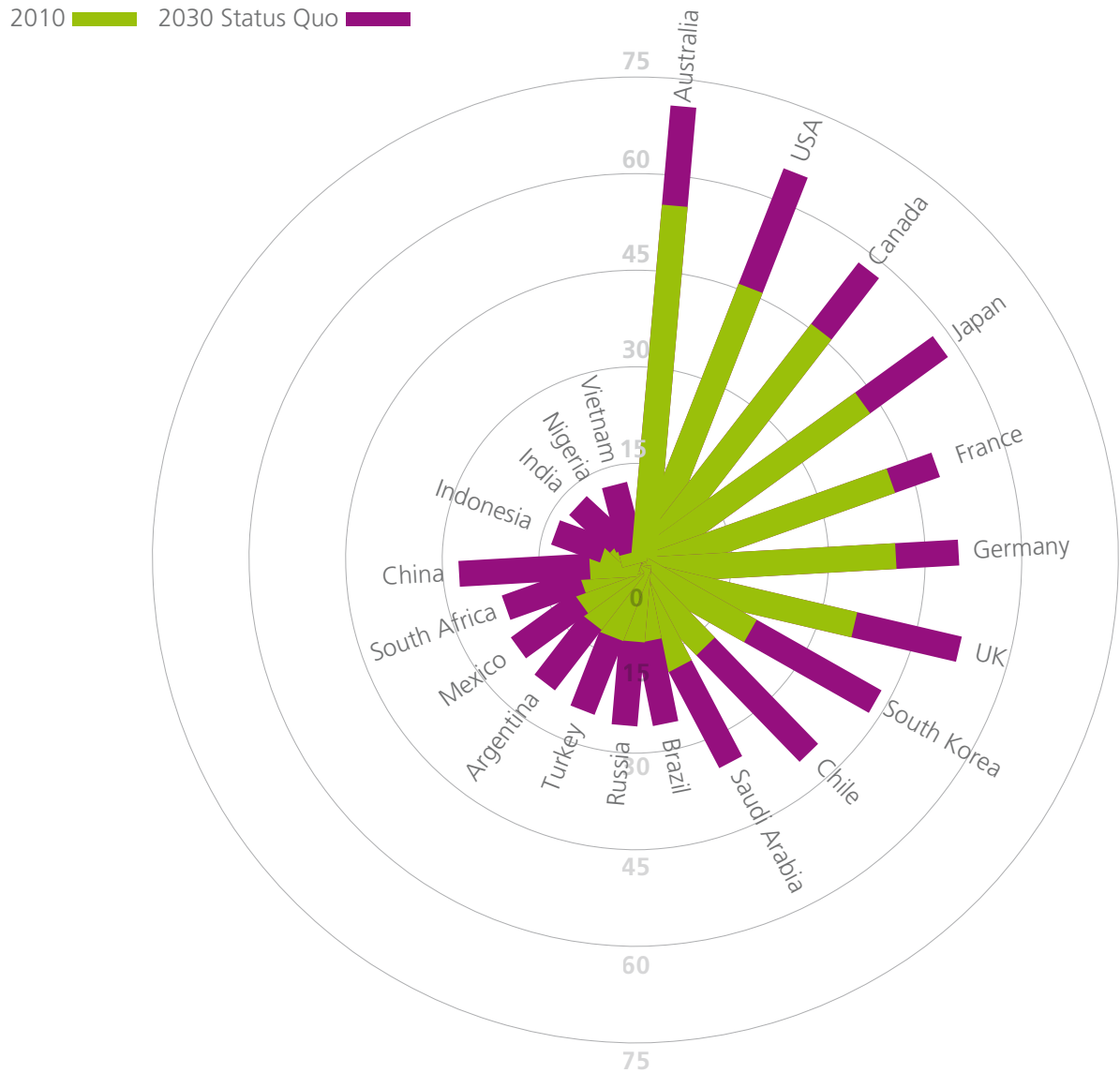


China, Vietnam India, Indonesia

The countries with the largest growth in per capita GDP

Fig. 14 Real GDP per capita (thousand \$2010)

Source: IMF / LR



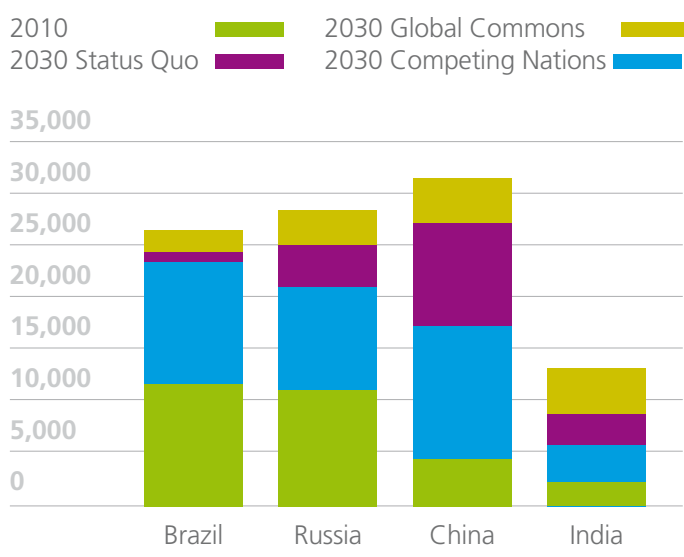
BRIC triple GDP per capita

The world's GDP per capita will rise faster than in the last 20 years. The top per capita GDP ranks will still be filled with highly urbanised developed nations. However, the largest percentage growth in per capita GDP will take place in the medium or low-income countries, particularly China, India, Vietnam and Indonesia. The increased income will boost their appetite for food, energy, infrastructures and all sorts of consumer goods, expanding demands for trade and shipping activities.

China's manufacturing sector will be under pressure to transform from labour-intensive to higher productivity business. This requires innovative technology development to upgrade China's competitiveness. In 2030 its labour cost may soar over South Korea's 2010 level.

Fig. 15 Status Quo - Real GDP per capita (\$2010)

Source: IMF / LR



Consumers' expanding purchasing power

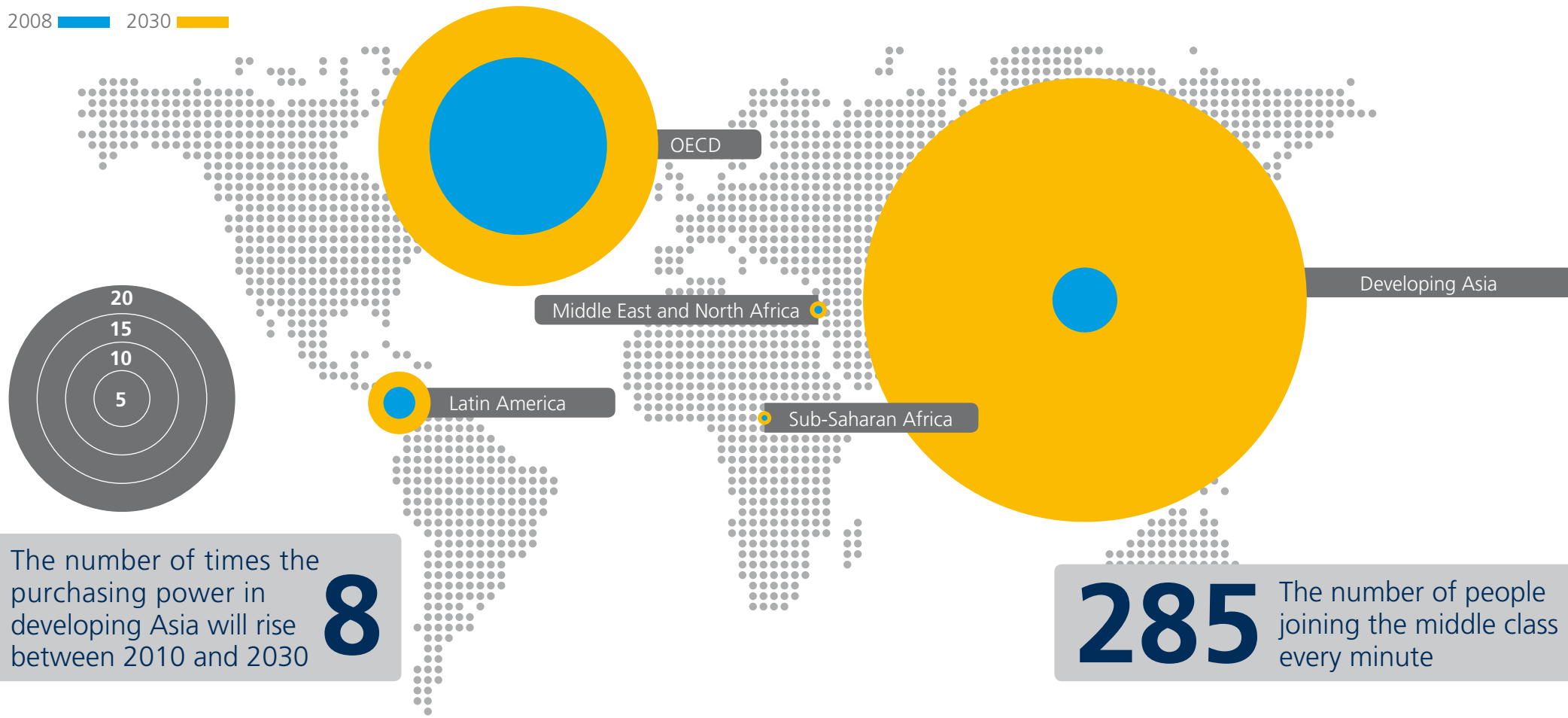
A region's consuming power is one important factor that drives shipping demand. Due to robust purchasing power growth in developing countries, the world's economy is no longer driven by the first-tier income-ranking countries.

The world's middle class in 2030 is likely to grow 40-50% from today's level. China and India will attribute nearly two-thirds of such growth. China has the second largest middle class, following USA. India may soon join, and some even predict that India will overtake China, with the biggest middle class population by 2025.

As a whole, the purchasing power in developing Asia will rise 8 times between 2010 and 2030, whereas OECD's spending power will only grow 3 times. For the next 20 years, inequalities between developed and developing economies will be narrowed. Nevertheless, about 45% of the total population in Sub-Saharan Africa will still be in poverty in 2030.

Fig. 16 Total annual expenditure (trillion \$2010 PPP)

Source: ADB / LR



Trade expansion

Intra-regional trade nearly doubles by 2030

Today, intra-regional merchandise trade is greater than trade between different regions. For instance, intra-Europe trade accounted for 71% of total European trade in 2011. Intra-Asia trade contributes 53% of the total Asia trade. 49% of North America's exports remain in the region. Such a phenomenon is less evident in Latin America, Commonwealth of Independent States (CIS) and the Middle East.

The rise of trade blocks within more regions may continue to promote intra-regional trade for the next 20 years. Global seaborne trade will be dominated by Intra-Far East, between Oceania and Far East, Far East and Latin America, and Far East and the Middle East. We will also see the strongest growth within these trade routes with Asia taking centre stage in the global seaborne trade.

Fig. 17 Major seaborne trade routes in 2010 and 2030 Status Quo (million tonnes)

Source: MSI / LR

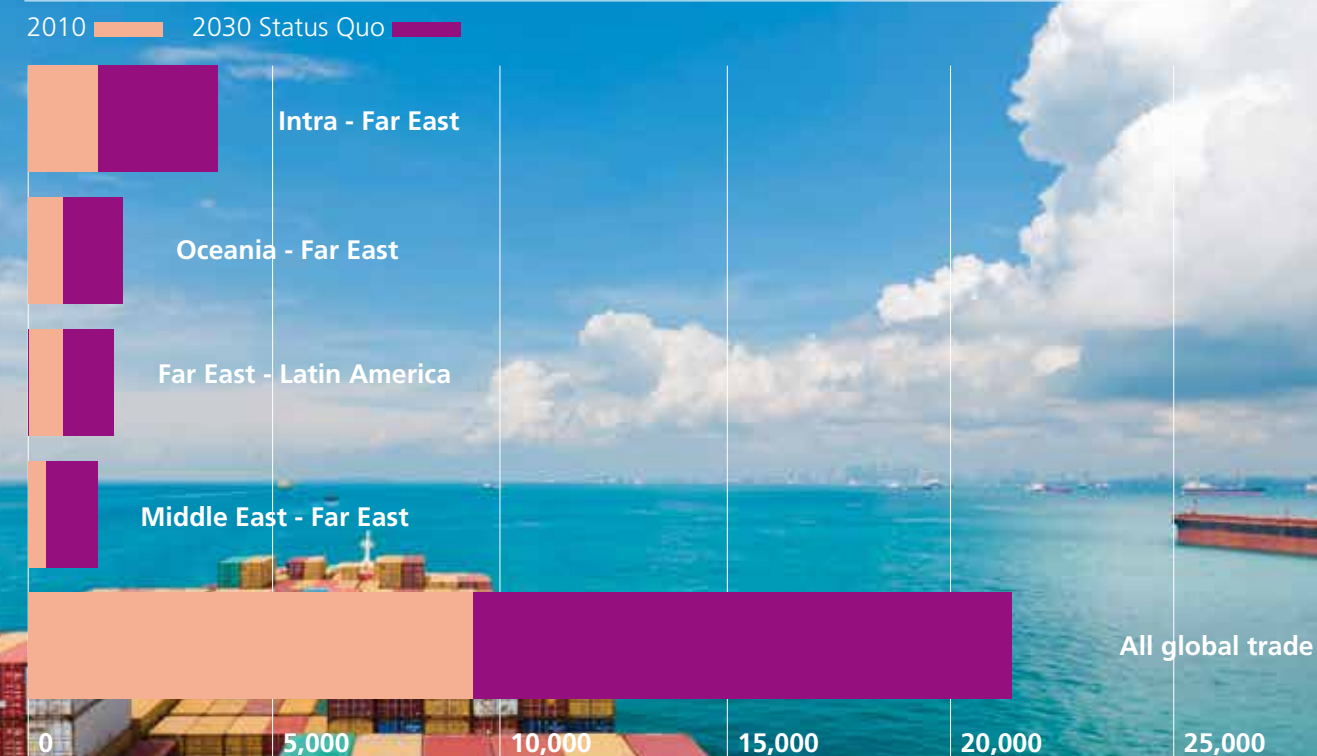
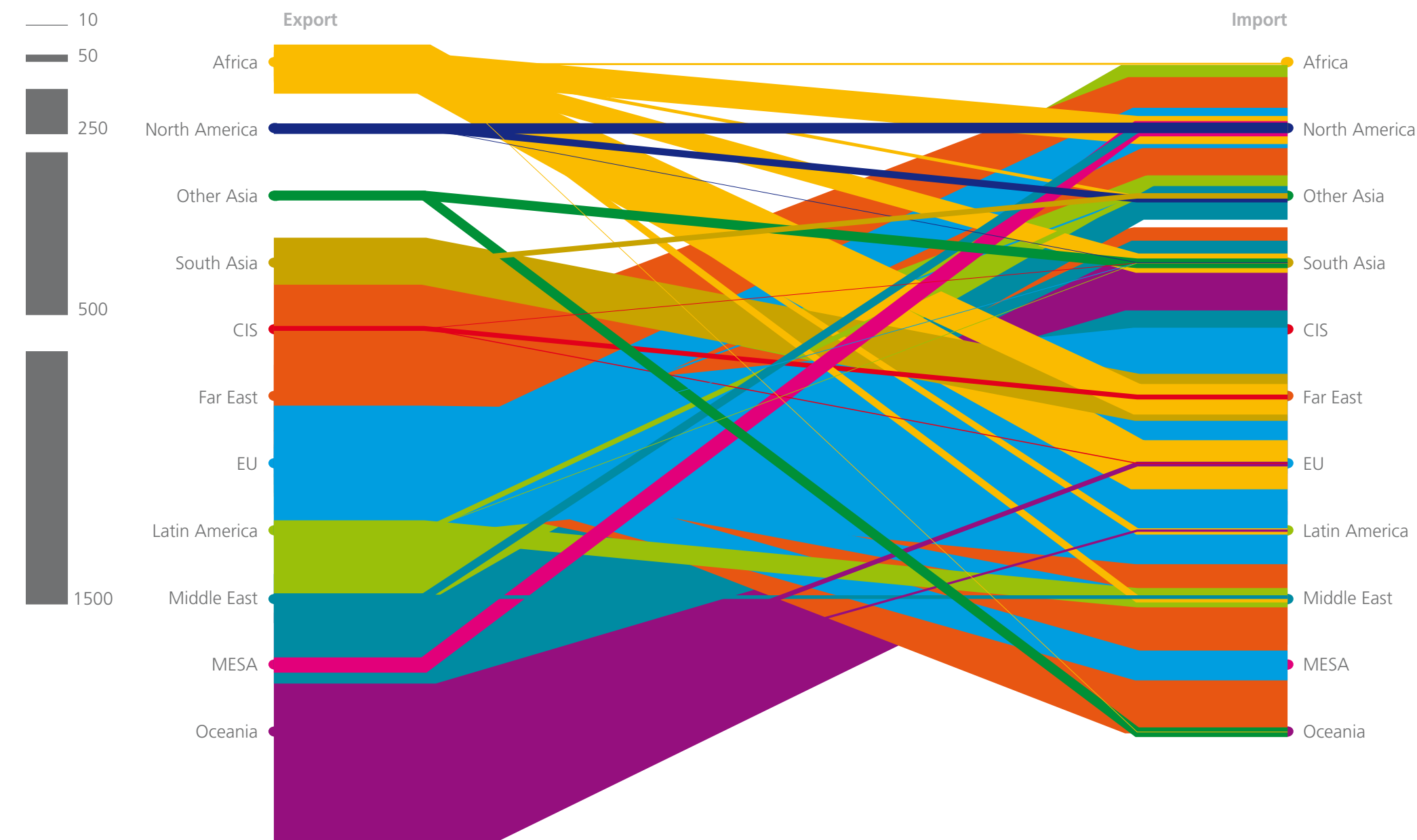


Fig. 18 Major seaborne trade routes and volumes in 2030 Status Quo (million tonnes)

Source: MSI / LR

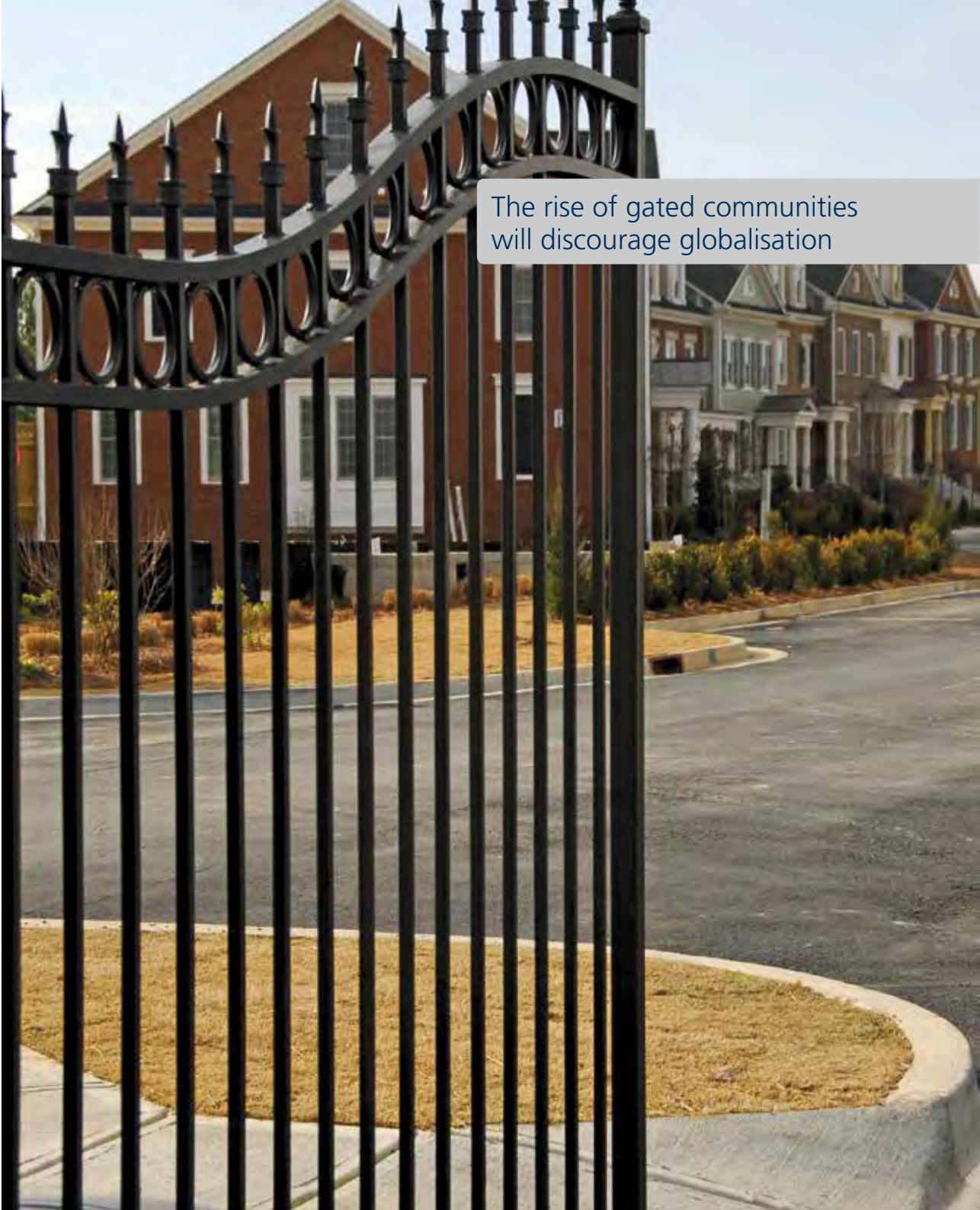


Regional trade blocks

The main purpose is to reduce or eliminate regional trade barriers (such as customs and trade quotas) across borders.

What lies ahead for regional trade agreements in 2030? In a “global commons” scenario, there is less need for regional trade blocks. In the “status quo” scenario, regional trade blocks should perform a positive role in stimulating more trade and growth, particularly important because of the slow growth envisaged for developed economies and because of the lack of progress in the Doha round of trade negotiations within the WTO framework. Regional trade blocks work better and display their full potential when conditions allow companies to integrate with others in the region, in production and distribution networks. When this happens, a built-in pressure for better coordination at the supranational level will emerge. Eventually, supranational institutions will define rules of exchange for the future.

Regional trade blocks may not perform well under the “competing nations” scenario. The main constraints faced are usually of a political or ideological nature. They range from governments suspicious of the benefits of free trade and globalisation to under-the-surface hegemonic disputes in key regions.



The rise of gated communities will discourage globalisation

NAFTA (North American Free Trade Agreement)
Consists of USA, Canada and Mexico.

EU (European Union)
Consists of 27 member states.

EAEC (Eurasian Economic Community)
Consists of Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan and Russia.

DR-CAFTA (Dominican Republic - Central America Free Trade Agreement) Consists of Dominican Republic, Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua.

UNASUR (Union of South American Nations)
Consists of 12 South American countries.

ASEAN (Association of Southeast Asian Nations) Consists of Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.
ASEAN+3 (ASEAN + China, Japan, South Korea)
AANZFTA (ASEAN + Australia, New Zealand)

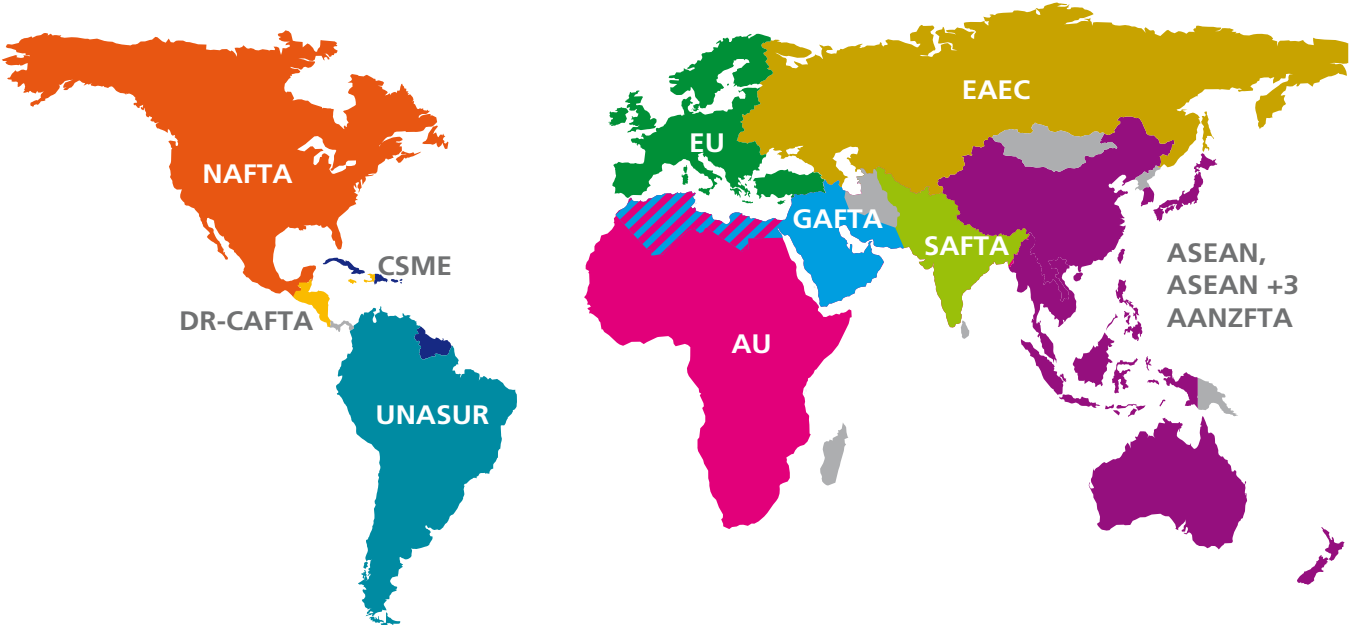
CSME (Caribbean Community Single Market and Economy) Consists of 15 Caribbean region countries.

GAFTA (Greater Arab Free Trade Area) Consists of 18 Arabic countries in the Middle East and North Africa.

SAFTA (South Asia Free Trade Agreement)
Consists of Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

AU (African Union) Consists of 54 African states.

Fig. 19 Selected current free trade areas around the world
Source: LR



Cities rule

Cities’ economic power has been immense since industrialisation, and served as magnet for talent, capital and trade. Bulk materials are needed for building modern infrastructure and facilities. Urbanisation also brings lifestyle and consumption pattern changes.

New York and Tokyo will still dominate the world’s city GDP output in 2030. Other American, Japanese and European cities will be overtaken by China and Latin America’s fast growing cities in the next two decades.

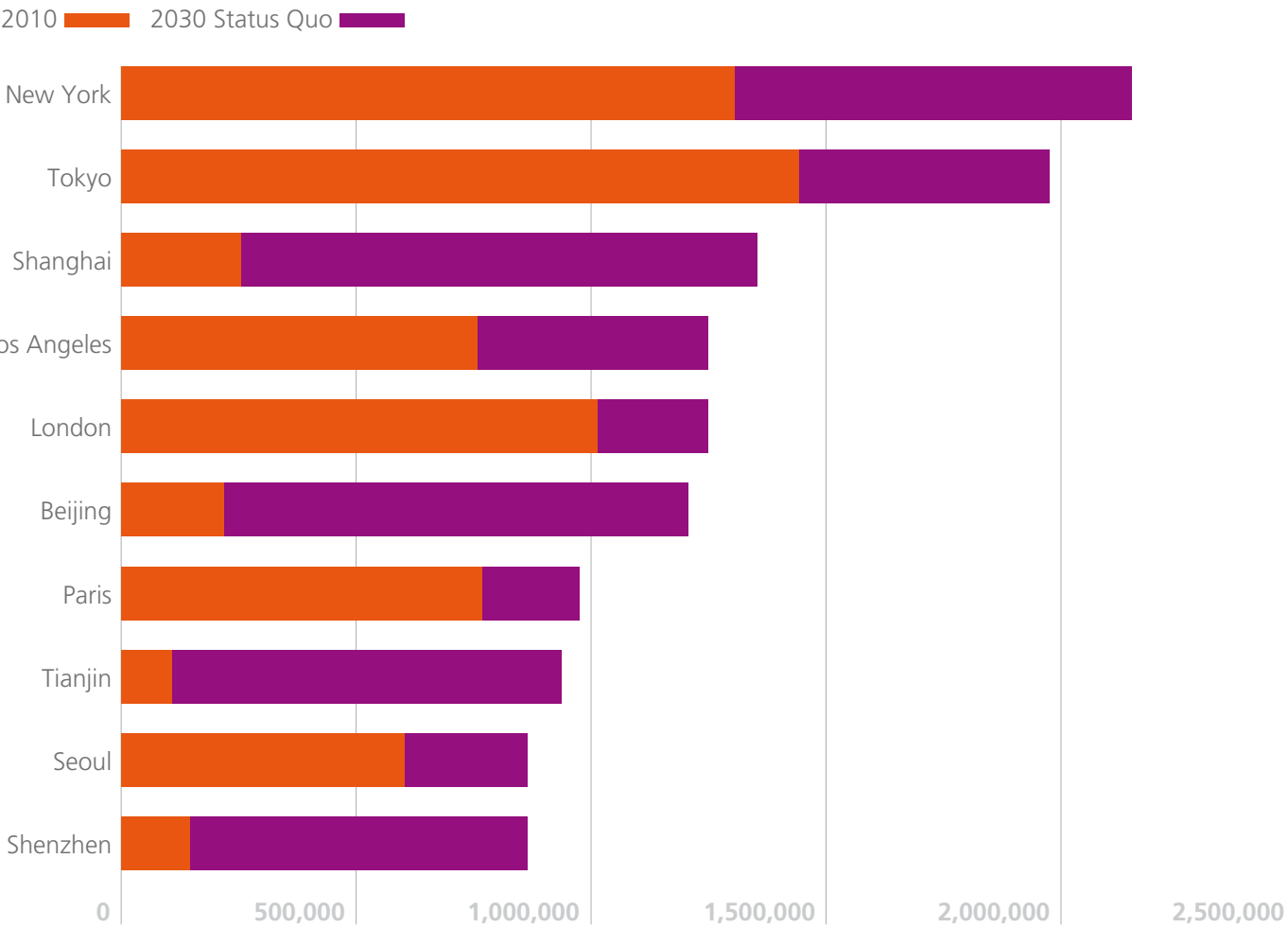
Port cities are special

Globalisation in shipping transport has brought the emergence of hub/nodal port cities. These cities compete with each other under a border-less battlefield of shipping markets. Over half the wealthiest cities are ports today, and such trend will continue in all three scenarios in 2030.

Rise and fall of city pecking order depending on scenarios

Fig. 20 Major cities’ real GDP in 2010 and 2030 Status Quo (million \$2010)

Source: OECD / UN / NS / LR



Competing Nations

The traditional wealthy cities from USA, Japan, and Europe will still occupy the top 5 in GDP ranking. Only three Chinese cities: Beijing, Shenzhen and Tianjin, will be the newcomers in the world’s top 20 city list. The two major Indian cities, Delhi and Mumbai, will still be not developed/ rich enough to join the top 20.

Status Quo

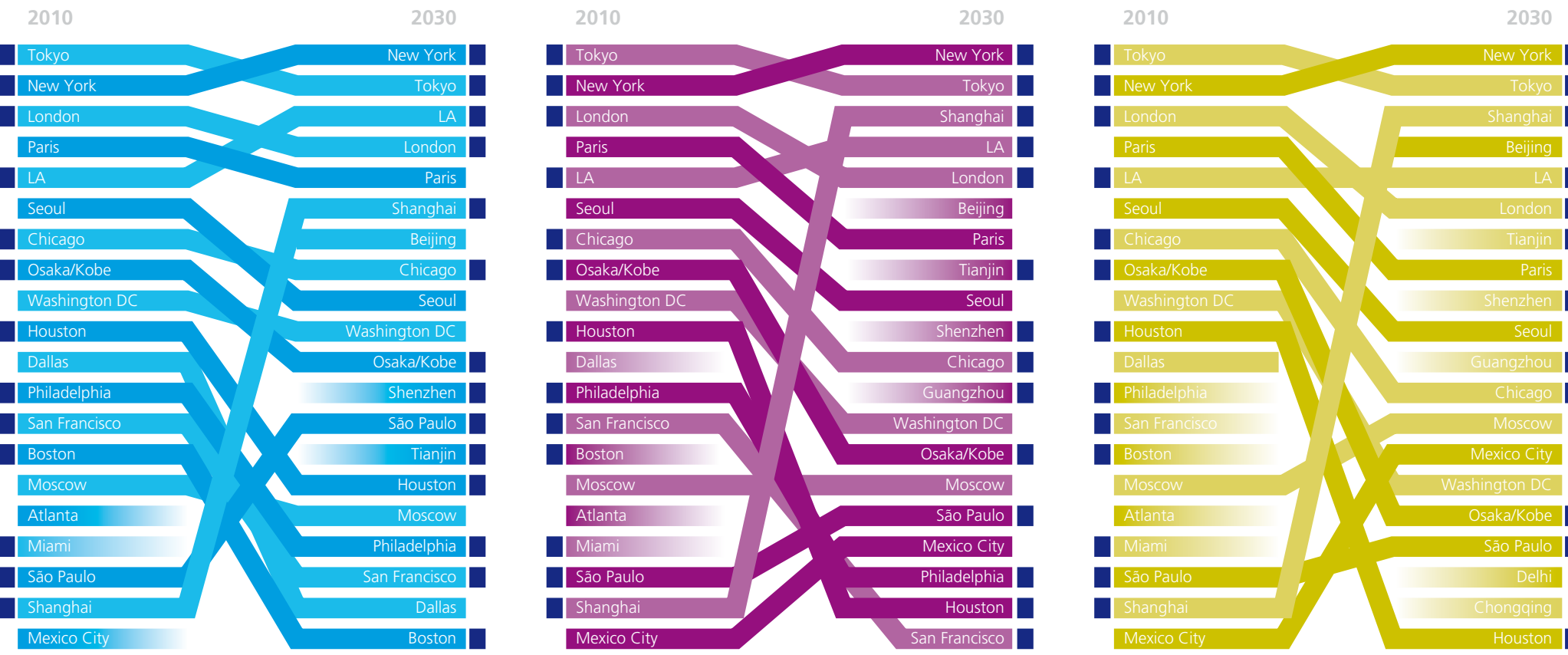
Shanghai will jump from the 19th to the 3rd in the world’s city economic ranking. Four Chinese cities, Beijing, Tianjin, Shenzhen and Guangzhou, will be the newcomers in the top 20 list. Outside the top 20 list, Delhi could be as big as Miami in 2030.

Global Commons

With China’s incredible economic growth, Shanghai and Beijing will become part of the top 5 elite in 2030. Other newcomers, including Tianjin, Shenzhen, Guangzhou and Chongqing, will enter the top 20. Indian cities will emerge, economically speaking, Delhi could become as big as São Paulo in 2030. Mumbai could be as big as Singapore in 2030.

Fig. 21 The GDP ranking in different cities in 2010 and 2030 based on three scenarios (top 20 cities ranked in real GDP in \$2010)

Source: OECD / UN / NS / LR. Note: Sea port cities are indicated by ■



Global drivers

Resources



Resources demand

As the population, economy and prosperity increase so will the demand for oil and gas. United Nations' projections suggest a total world population of 6.9 billion in 2010 to expand to 8 billion in 2030. The world's real GDP per capita is likely to rise more than 100% over the next 20 years - more people with more income indicate that demand for resources will rise.

40% Higher energy forecast demand in 2030

The number of times China could increase its oil consumption by 2030 **x3**

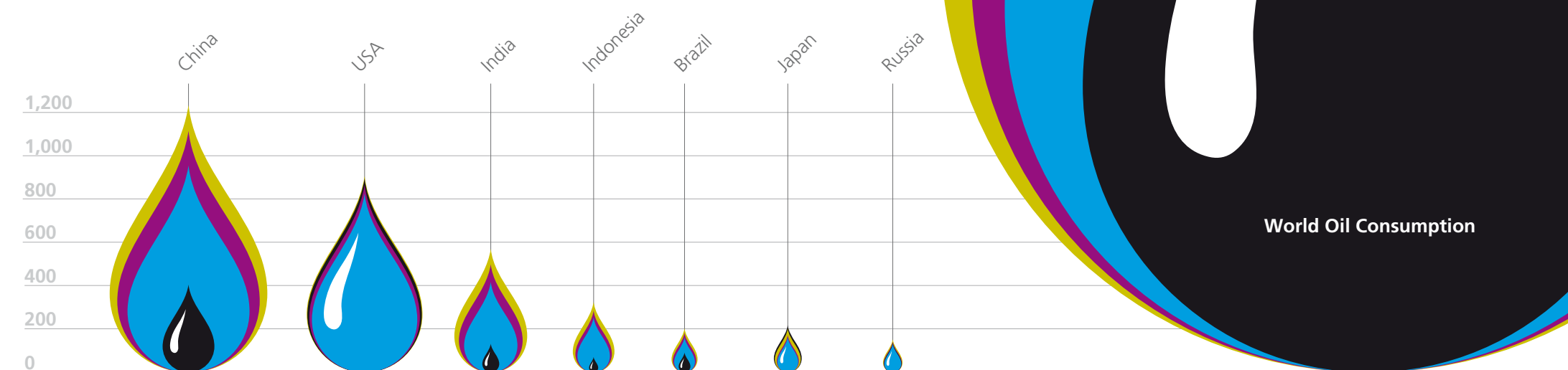
Oil consumption

China will overtake North America to become the largest oil consumer by 2030, nearly triple the level of 2011 and moving from about half of North America in 2011 to 35% more than North America in 2030.

Fig. 22 Oil consumption (million tonnes)

Source: MSI / LR

- 2010
- 2030 Competing Nations
- 2030 Status Quo
- 2030 Global Commons

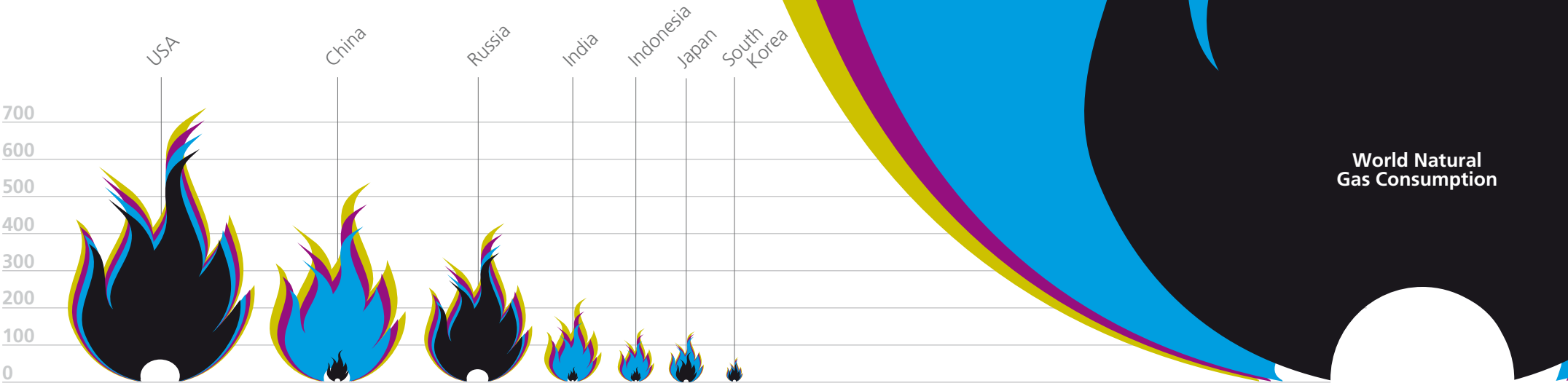


Natural Gas consumption

USA will remain the biggest natural gas consumer in 2030, while China will see the largest growth in natural gas consumption in the next two decades. Russia's energy consumption continues to be dominated by natural gas over the next 20 years. Natural gas consumption in the Middle East and Europe will overtake oil consumption by 2030.

Fig. 23 Natural Gas consumption (million tonnes of oil equivalent)
Source: EIA / LR

- 2010
- 2030 Competing Nations
- 2030 Status Quo
- 2030 Global Commons



Coal consumption

China and India will be the two giants in the world's coal consumption. Around 60% of coal consumption will come from China in 2030. Coal will continue to dominate India's energy outlook in the next 20 years. As India's economy modernises, India's coal consumption will more than double between 2010 and 2030, surpassing the USA's consumption and making her the second largest coal consumer in 2030.

Fig. 24 Coal consumption (million tonnes of oil equivalent)
Source: MSI / LR

- 2010
- 2030 Competing Nations
- 2030 Status Quo
- 2030 Global Commons



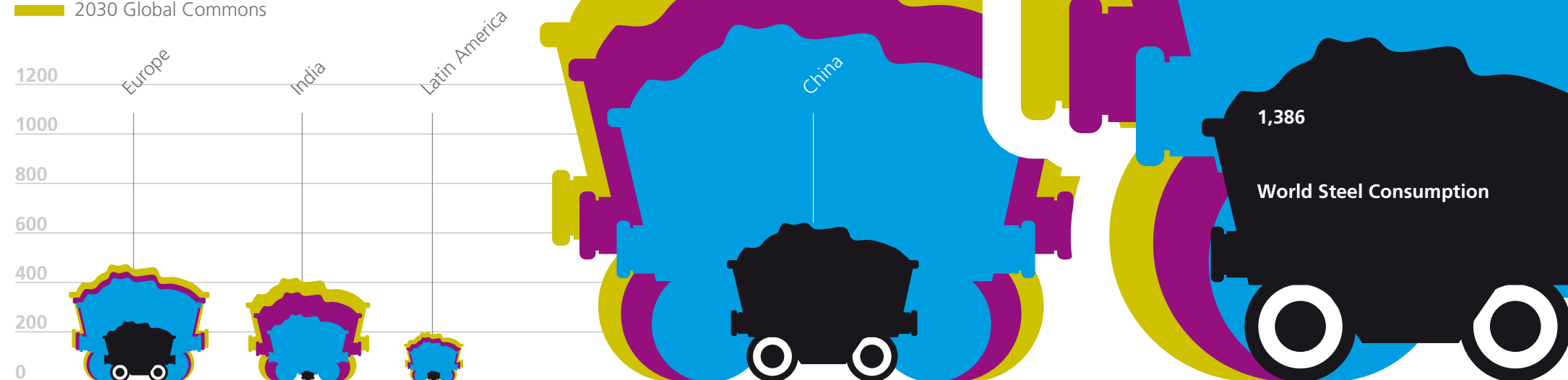
Steel consumption

Due to its special combination of strength and formability, steel plays an important part in building modern infrastructure. As the main raw material of producing steel is iron ore, iron ore is also an important seaborne cargo shipped around the world. Because of the massive demand in the construction sector, India will see the largest growth in steel consumption. China's steel consumption growth will slow down, but she will still remain the biggest steel consumer in 2030.

Fig. 25 **Steel consumption (million tonnes)**

Source: MSI / LR

- 2010
- 2030 Competing Nations
- 2030 Status Quo
- 2030 Global Commons



5x

The growth in India's steel consumption reached in two decades



Global drivers Environment

Climate Change Poor will suffer more

In 2030 there will be
people on the planet

8.3 billion

Together we will consume
worth of resources per year
at the current rate

2 Earths

If everyone consumed like
the Americans we will need
to sustain us

7 Earths

The change in precipitation pattern is projected to pose water security issues in some areas. About 75 to 250 million of people in Africa, i.e. 6-20% of the total population in Africa, are predicted to suffer the effects of drought by 2020. Water stress will also be intensified in southern and eastern Australia, New Zealand's Northland and some eastern areas by 2030.

Secondly, the coastal areas will be more vulnerable to the ocean climate in 2030. With a global mean temperature increase reaching 1°C relative to 1980-1999, most of the temperature and acidification-sensitive corals, which help break the surf and on which many marine species depend, will bleach and die out. Together with other anthropological activities, such as water dam construction that decreases river sediments, more aggressive coastal erosion will deteriorate local resources. Coastal areas will also be attacked by flooding due to sea-level rise and more frequent storm surges. 75% of the mega-cities with populations over ten million, or 45% of the world populations, are already living in coastal zones. Indonesia, Thailand, and Bangladesh are anticipated to experience

above-average sea level rise. Countries with large populations living in low-lying areas (such as Bangladesh and Vietnam, as well as some island nations including the Maldives) are all under threat of inundation. These will bring environmental migration, refugees, damage to infrastructure, and salt in the soil, devastating crops. The adaptation of infrastructure at ports and in coastal areas will be essential.

The absolute costs of climate change adaptation as a whole could be massive, and will increase over time. The World Bank estimates that East Asia and the Pacific will top the list in terms of the total environmental adaptation cost. However, Sub-Saharan Africa is projected to suffer the most, spending 52-70% of its GDP on environmental adaptation across various sectors for the next 20 years.

As countries industrialise, urbanise and consume, our environment is under greater stress bringing along with it climate change and pollution.

Potential impacts of Climate Change on human health

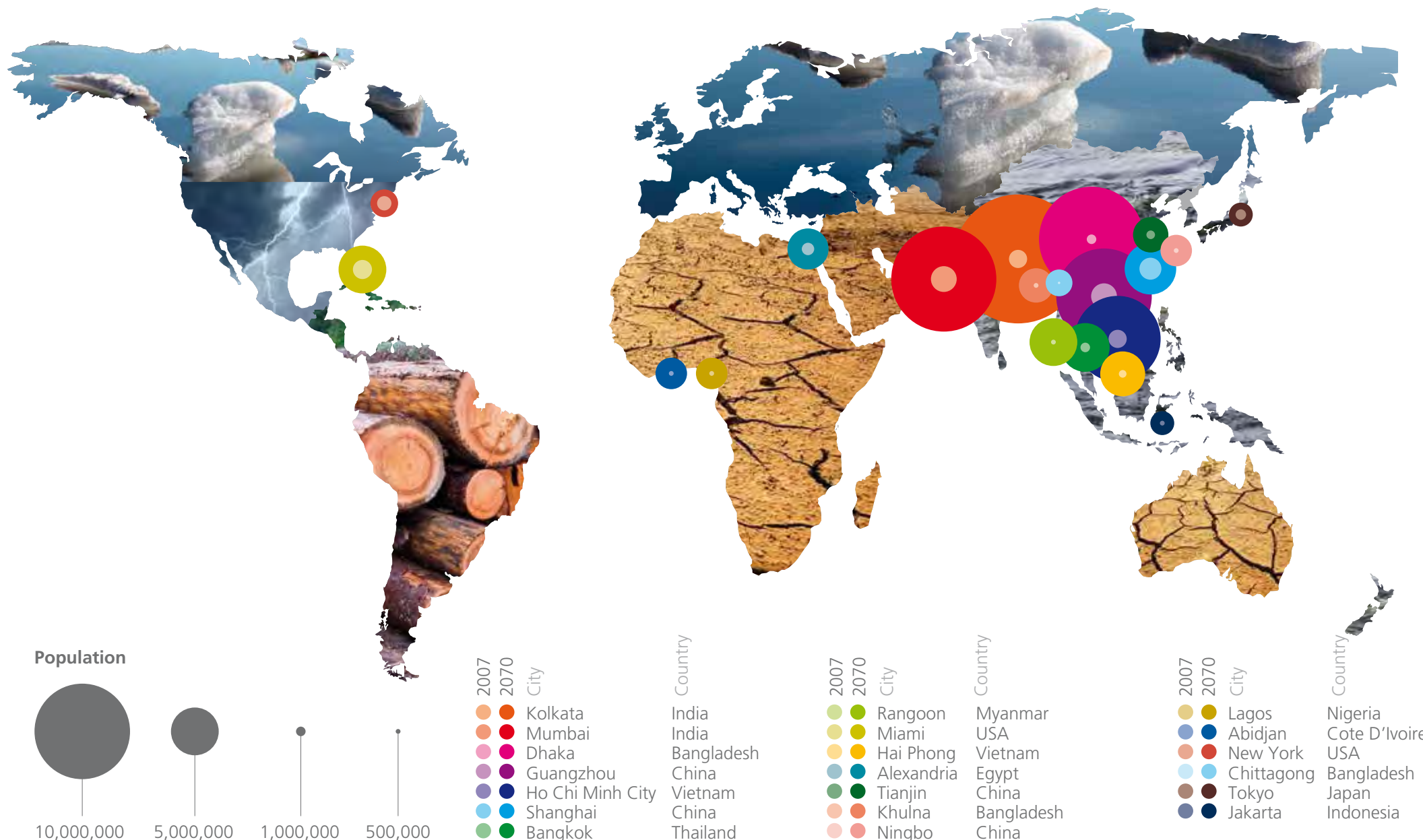


70%

Percentage of Sub-Saharan Africa
GDP spend on environmental
adaptation for the next 20 years

Fig. 26 Top 20 cities ranked by population exposed to coastal flooding in 2007 and 2070

Source: OECD / LR



Climate Change

The melting North offers new opportunities



The Arctic is warming twice as fast as the rest of the planet. The retreating ice offers access to precious minerals and new shipping routes, but also carries grave dangers and immense challenges.

The Arctic region holds potentially as much as 25% of remaining undiscovered oil and gas reserves, with the largest reserves expected to be found north of Russia, along with an abundance of other minerals and metals. Marine life is extremely bountiful in the open areas of the Arctic Ocean close to the ice ridge and the zone where warm and cold water meet. The Arctic is a major fishing area, and has great potential for carrying out research on unique genetic resources that can be commercially exploited. It is one of the few remaining unspoiled areas of pristine wilderness. Should global warming continue, the possibility of trans-Arctic shipping for at least several months per year cannot be discounted. Such routes might become competitive, since they could cut distances between Asia and Europe by at least a third to 12,000 km.

The technical, economic and environmental challenges remain formidable as temperatures can drop below -50°C. The water surface is covered by hard multi-year ice as thick as 3 metres on even stretches and many times that on the ridges that form where ice floes collide. In open water, storms can be very rough and unpredictable, and atmospheric icing from sea spray can destabilise a ship. Massive investment is also required for building infrastructure essential along the transit locations and for rescue and search. The Arctic Ocean environment is fragile and vulnerable. Pollution caused by spills and emissions is difficult to clean up. However as long as the world continues to industrialise, which is certain to be irreversible, then additional new resources will have to be found.

Fig. 27 Resources and shipping routes in the Arctic

Source: LR

Resources

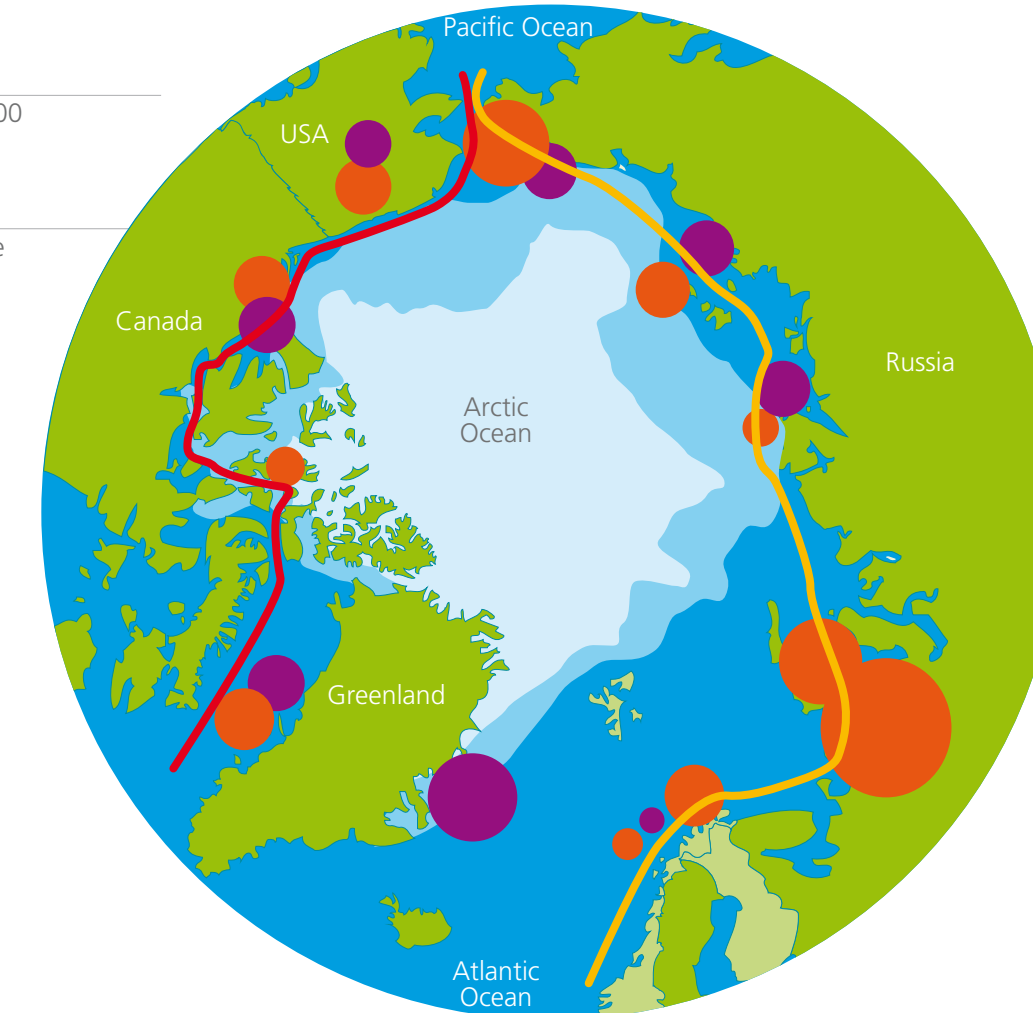
- Gas
- Oil

Summer ice extent

- Average 1979 - 2000
- Summer 2011

Possible shipping routes

- North-west passage
- North-east passage



Commercial sector



Foreword



World trade relies on ships and the cargoes they carry, and the service industries that support them, as well as the security provided by navies.

Without ships and navigable seas there is no globalisation. Shipping, as the enabler of trade, will be shaped by the major economic and social forces described in this report. By developing and modelling a future based on the scenarios chosen in this significant piece of work, the GMT 2030 team hopes to provide all who are interested in the future of maritime trade with some useful insights into where our world might be going - and how the marine industries will be affected.

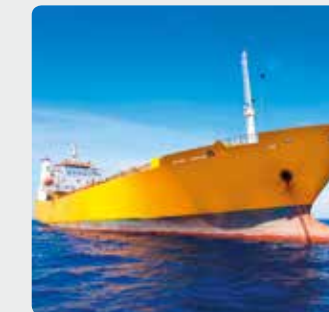
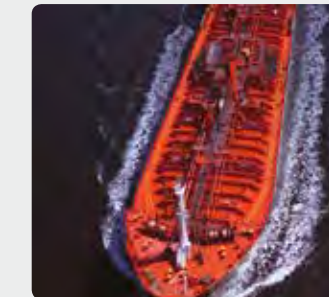
As the world faces more uncertainty and the potential for highly disruptive change, perhaps, more than at any time in most memories, the report shows that there are justifiable grounds for optimism about the future of our maritime activities.

Maritime trade will be needed more than ever if we are to prosper. This valuable report provides useful insight into the future of shipping and naval power.

Tom Boardley

Marine Director

Lloyd's Register Group Limited



Scenario and global driver impacts on the commercial sector

The ocean is the highway for international trade, with 90% being seaborne. The global fleet of ships (self-propelled merchant vessels above 99 gross tonnes), numbered over 103,000 in 2011. These consist principally of bulk carriers, tankers and container ships, which are the vital arteries of international commerce, and thus key to understanding global marine trends. Bulk carriers carry raw materials such as iron ore; tankers carry crude oil and liquefied natural gas and container ships move manufactured goods from manufacturing centres to consuming countries.

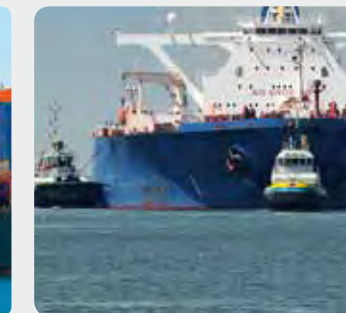
The shipping business cycle of boom and bust is subject to the economic fundamentals of supply and demand, satisfying the basic human desire to improve living standards. About 88% of the world's 6 billion people live in relatively poor countries, suffering from the effects of poverty such as malnutrition and poor health. Luckily most poor people have an opportunity to join the quest for improved living standards, led by China and India.

Global Marine Trends 2030 recognises four global drivers affecting the commercial shipping sector: demography, economy, resources and environment. Among these, we have found that the economy has the largest measurable impact on the commercial sector, and we have used this to characterise our understanding of future trade and shipping requirements. We have modeled the effects of all four drivers, to generate shipping trends for the commercial sector in 2030. National economics is a reflection of a country's productivity and technology levels, which in turn reflects the extent of urbanisation and industrialisation. The rise in living standards increases the middle classes and generates demand for resources, consumer goods and service. The cost is intense competition for a limited supply of resources, and environmental degradation.

Of course politics - the process by which groups of people make collective decisions - plays a significant part in driving the commercial sector. Politics can create conditions for significantly greater or lesser commercial intercourse and therefore affects seaborne trade. The three scenarios developed have implicit political dimensions. Technological development plays a very important part, as an enabler, rather than a driver, of the commercial sector. The environment and resources are constraints that have been taken into account implicitly in the scenarios themselves.

Past experience suggests that the quest for social development will necessitate urbanisation and industrialisation on a gigantic scale not seen in human history. Urbanisation means building cities with much denser populations, and infrastructure to connect them. This generates demand for raw materials such as iron ore which may not be available locally. Bulk carriers are required to ship the raw materials across the oceans from producing countries to consuming countries. In the meantime industrialisation generates demand for electricity to power industrial growth. This generates demand for fossil fuels such as coal, crude oil and oil products which are carried by tankers. As countries develop their industrial capacity, they start to export manufactured goods to consumers around the world. This generates demand for container ships to carry manufactured goods from production centres to consumers around the globe. As countries industrialise and people's living standards improve, they consume more and place heavy demand on resources - causing environmental degradation if not carefully managed. Key threats are climate change and pollution, while opportunities lie in new trade routes and resource exploitation as ice in the Arctic region melts.

90% of international trade is seaborne



Crude Oil

Crude Oil reserves

The crude oil’s reserves-to-production ratio of the world is reported to be about 55 years. It is suggested that there should be sufficient oil to match the demand after 20 years. Globally, crude oil production is expected to increase to meet the growth in consumption. The world’s crude oil supply is set to rise between 38-63% by 2030.

Crude Oil production

The largest growth in crude oil production will still come from the Middle East. The recent oil bonanza in Latin America (Brazil) and North America (Canada and USA) will also give the two regions a competitive edge. North America’s robust growth is mainly from its unconventional oil resources.

Russia’s current core oil fields in Western Siberia will decline. Nevertheless higher-cost fields in Western Siberia, Eastern Siberia and the Arctic could be expected to take up the slack.

Uncertainties in oil production may lie in Africa. Africa's oil production growth could face challenges in its civil conflicts, the lack of infrastructure, and it's poor quality of schooling.

63% The rise in oil supply by 2030

Fig. 28 Crude Oil proven reserves (billion tonnes)

Source: EIA / LR

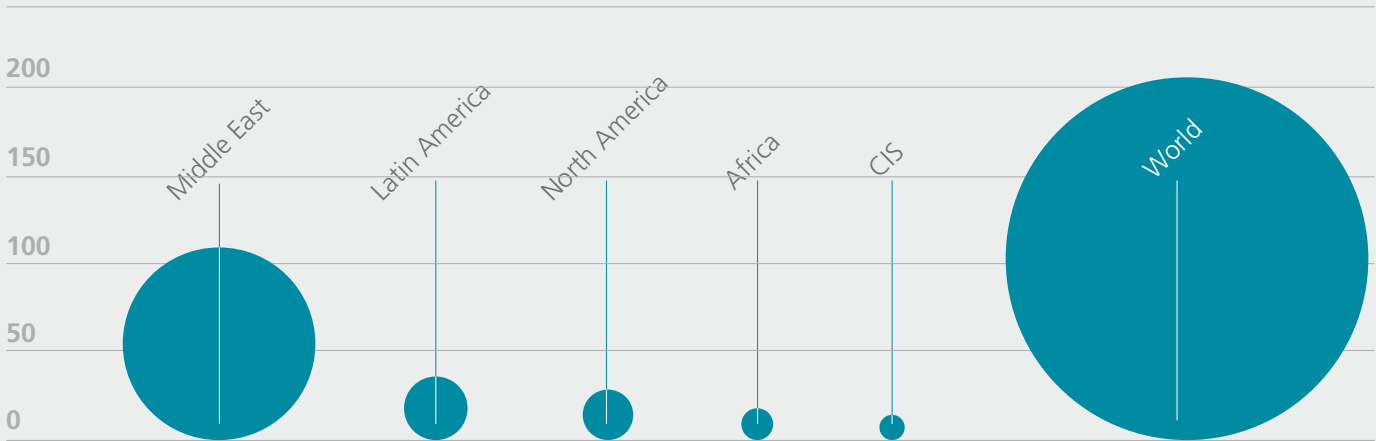
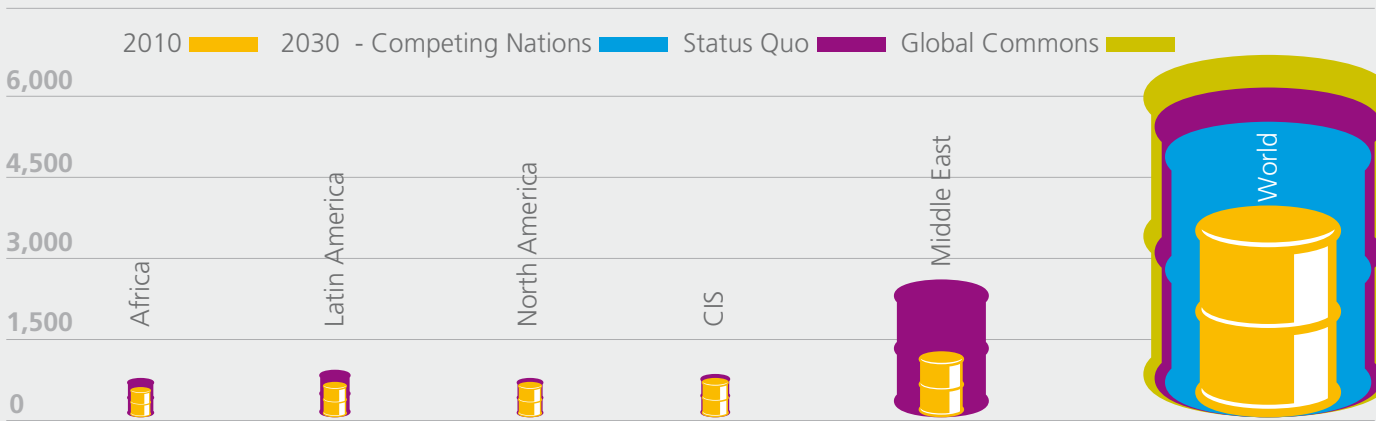


Fig. 29 Crude Oil production (million tonnes)

Source: MSI / LR



Natural Gas

Natural Gas reserves

The estimated proven reserves-to-production ratio of natural gas is about 60-65 years. With recent development in horizontal drilling and hydraulic fracturing (fracking) that unlocks shale gas reserves and other new discoveries, some research estimates the technical recoverable resources-to-production ratio could reach more than 230 years at current level. But there are concerns in the gas development. The cost of accessing all the gas bounty is unknown. Safety and environmental issues raised from implementing new technologies could restrain the shale gas production growth. If these barriers are surmountable, the global energy market could enter an era of gas.

Natural Gas production

CIS (mostly Russia) and USA remain the major natural gas producers in 2030. Similar to oil, Russia’s natural gas production will gradually shift from Western Siberia to Eastern Siberia and the Arctic. USA’s main natural gas production growth will come from shale gas fields.

The Middle East’s natural gas production could be constrained by the lack of export infrastructure, technical and economical challenges in the production field as well as domestic policy.

USA Russia The largest gas producers in 2030

Fig. 30 Natural Gas reserves (billion tonnes of oil equivalent)

Source: IEA / LR

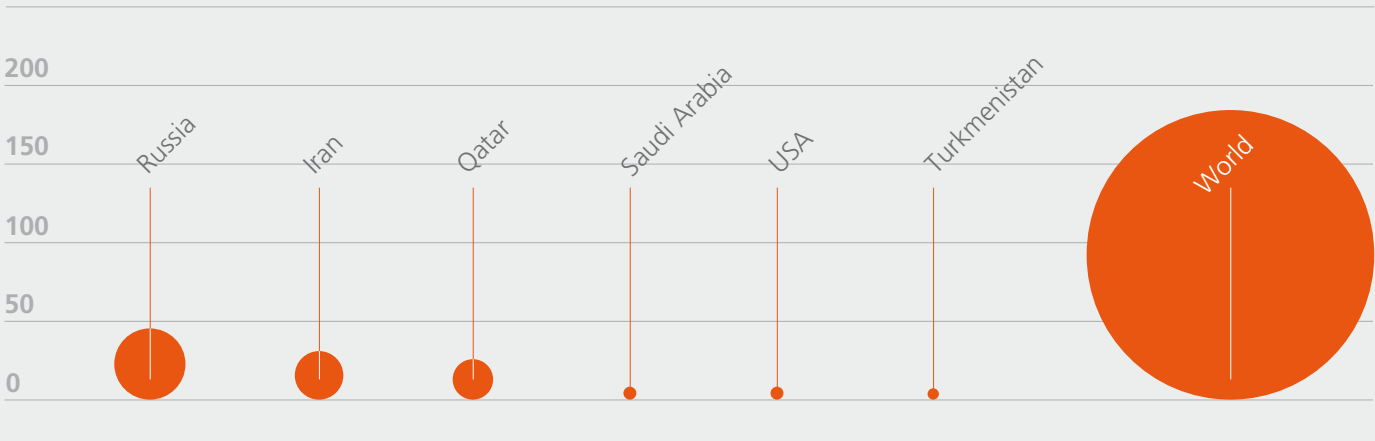
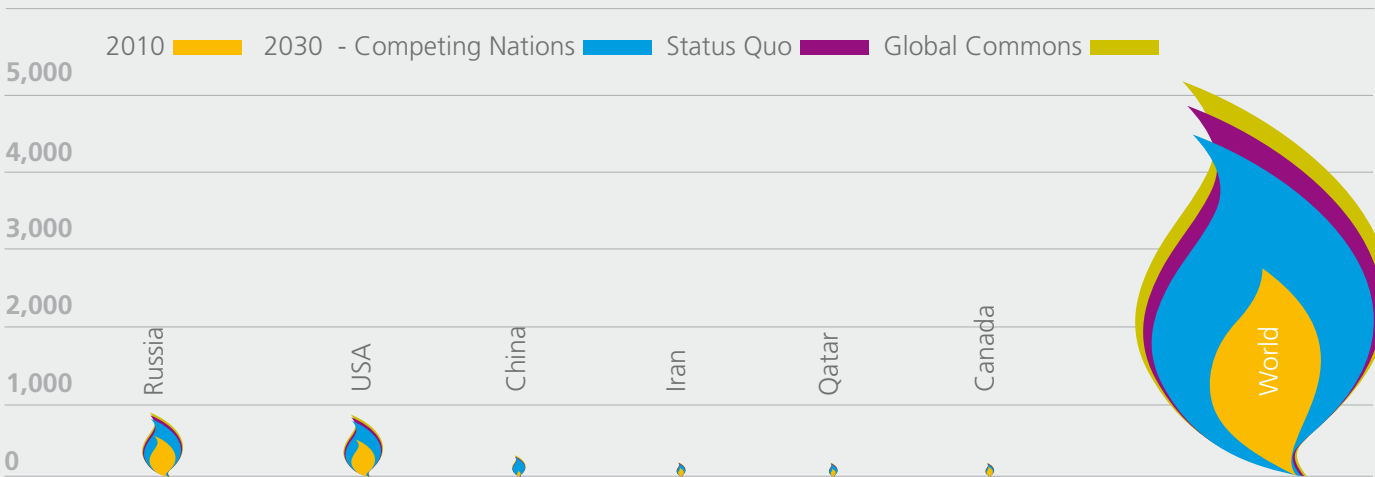


Fig. 31 Natural Gas production (million tonnes of oil equivalent)

Source: IEA / LR



Coal

Coal reserves

Proven coal reserves represent around 140 times the 2011 annual world coal production. Hard coal is the most widely used coal grade today, contributing 86% of the world's coal demand. 76% of the hard coal reserves, essential for the steel/metallurgy industry, come from USA, China, India, and Russia.

Coal production

The world's coal production will more than double by 2030. Among all major producers, China will achieve the largest coal production and production growth. Most of the world's coal production is for domestic markets. Nevertheless, coal is one of the most important bulk cargoes in international shipping.

Fig. 32 Proven recoverable Coal reserves at end-2008 (million tonnes)

Source: WEC / LR

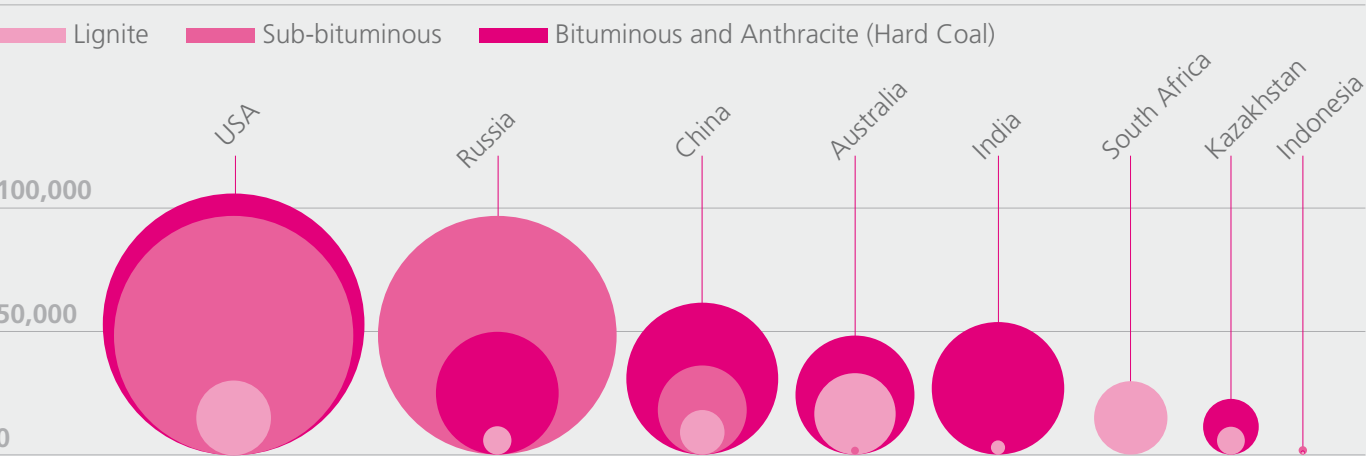
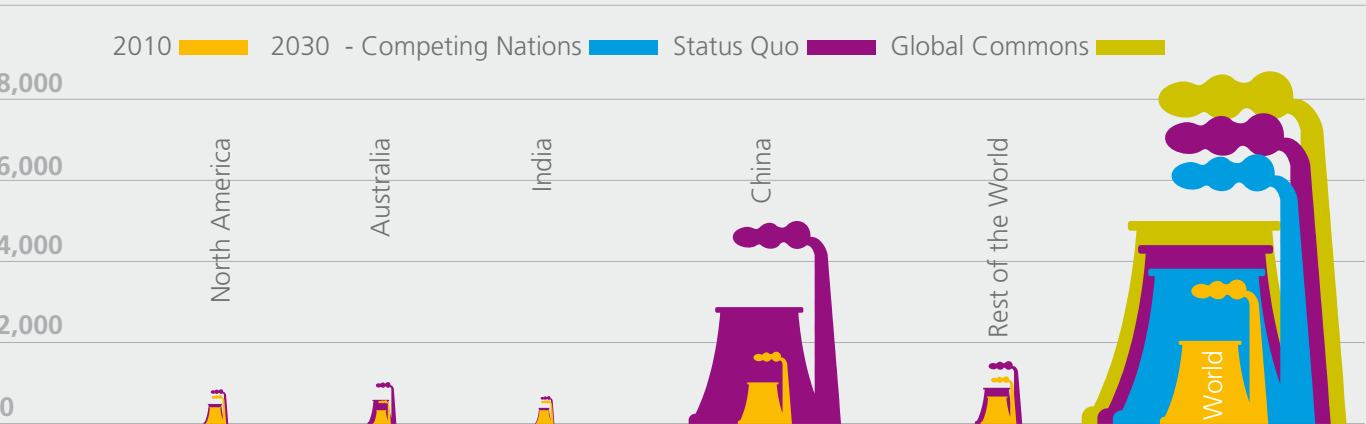


Fig. 33 Coal production (million tonnes of oil equivalent)

Source: MSI / LR



China

The dominant country in coal production in 2030

Iron Ore

Iron Ore reserves

Iron ore is the key raw material for manufacturing steel, which is used to build infrastructure in the modern society. Australia and Brazil together own 41% of the world's iron ore reserves.

Iron Ore Production

The largest iron ore production will still come from Latin America and Oceania. India may see the largest iron ore production growth, between 3 to 5 times, over the next 20 years.

Fig. 34 Iron Ore reserves (million tonnes)

Source: USGS / LR

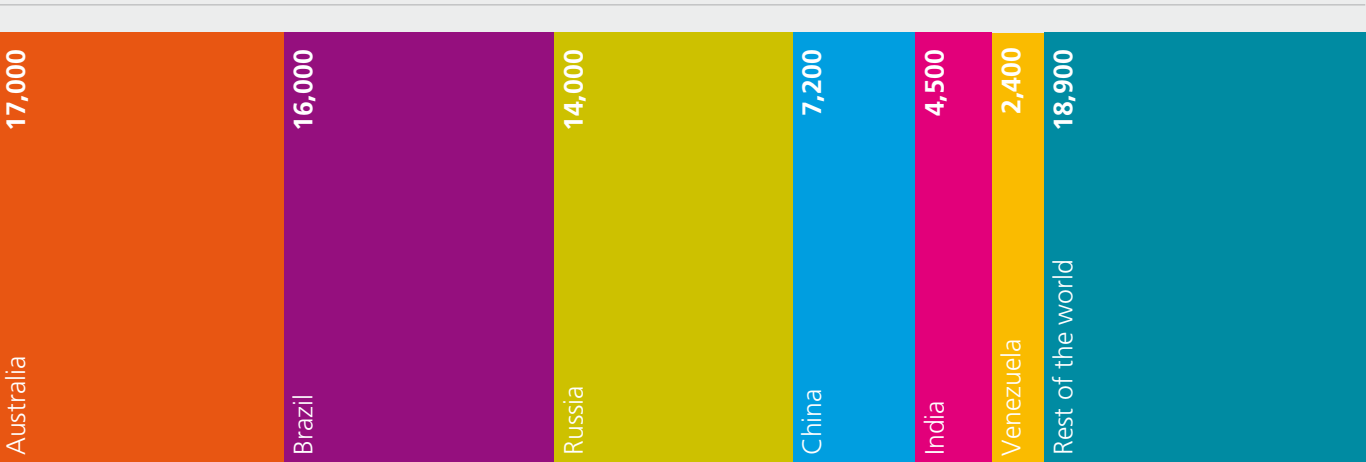
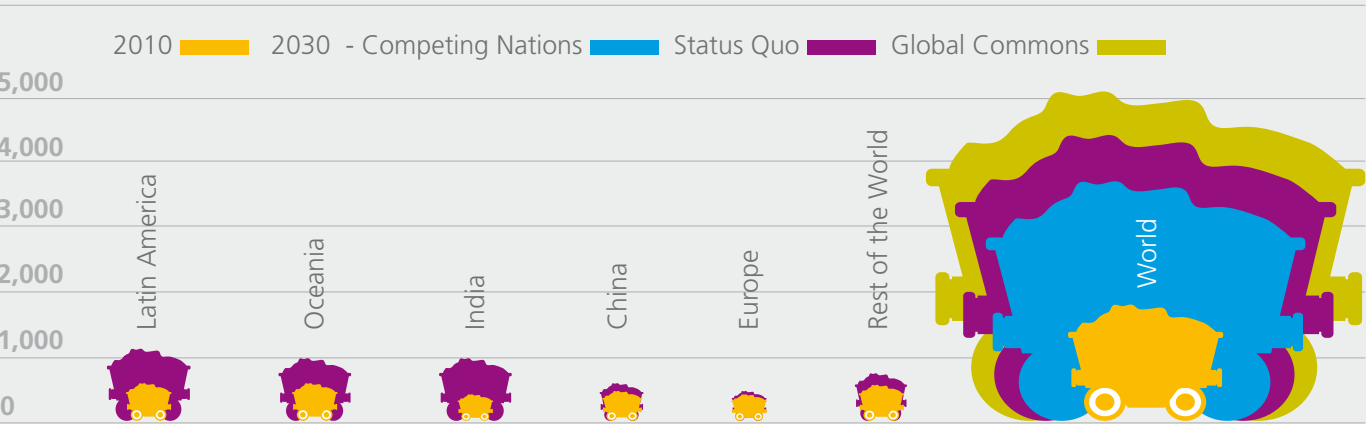


Fig. 35 Iron Ore production (million tonnes)

Source: MSI / LR



Crude Oil trade

Crude oil may be one of the most important seaborne cargos, accounting for about a quarter of goods shipped by sea.

Crude oil export Middle East/Arabian Gulf will still dominate the crude oil export in 2030.

Crude oil import China and South Asia will significantly increase their crude oil imports by 2030. They will join Western Europe as dominant importers. North American and Japanese imports will decline gradually over time.

Fig. 37 **Crude Oil import (million tonnes)**
Source: MSI / LR

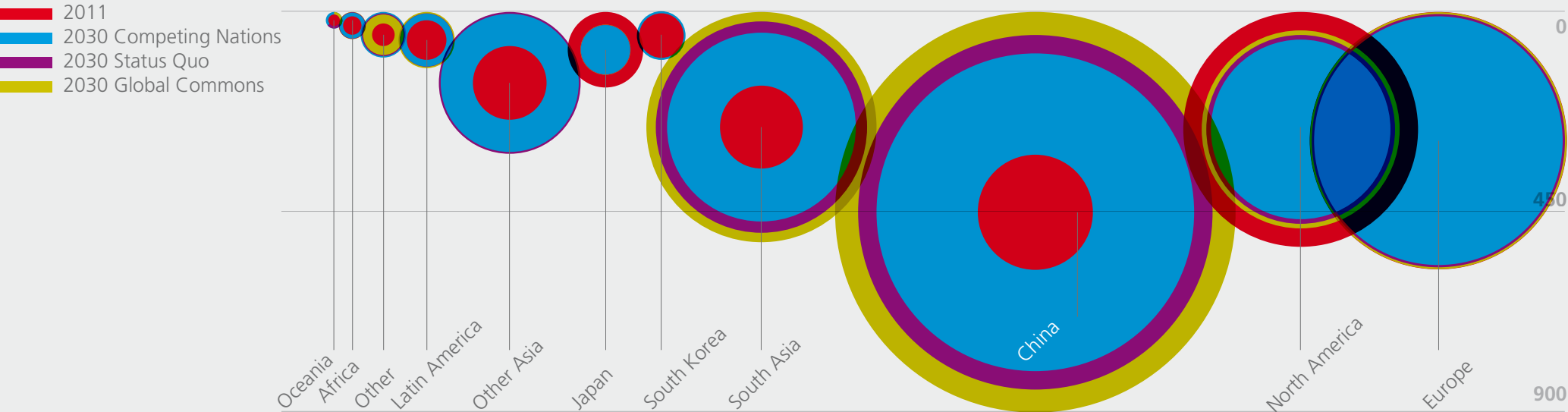
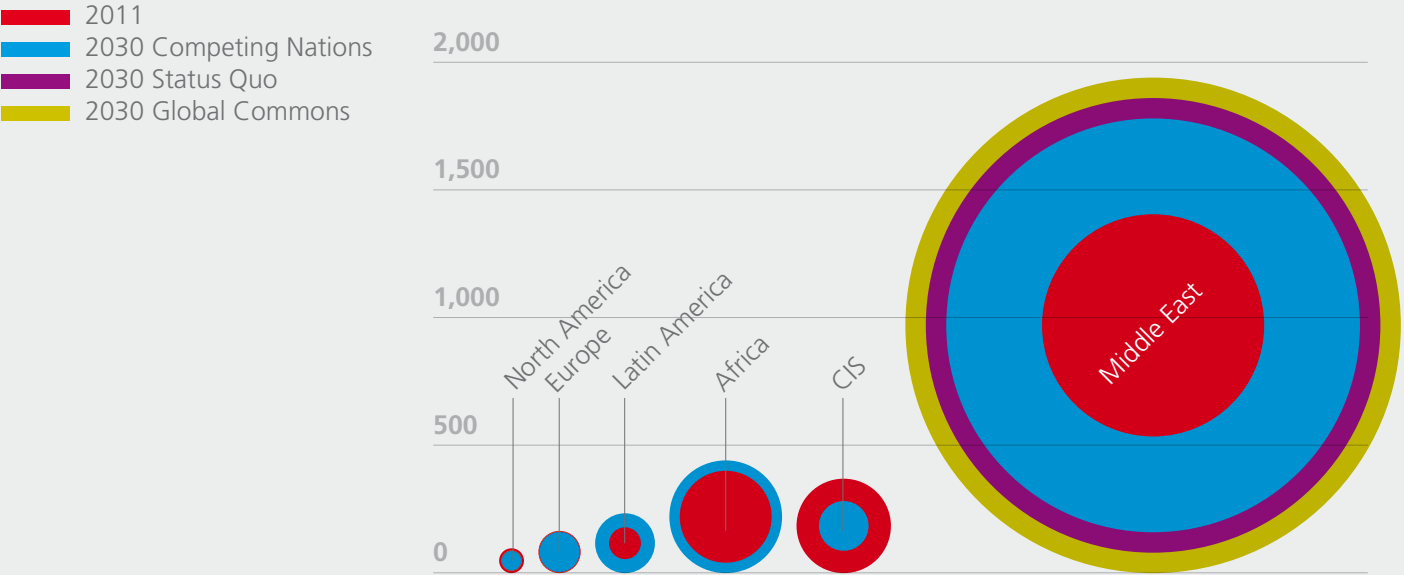


Fig. 36 **Crude Oil export (million tonnes)**
Source: MSI / LR



Crude Oil tanker trade routes

There is a large difference between the 3 scenarios for crude oil trade from the Arabian Gulf to China and South Asia. This is due to the economic growth uncertainties in China and South Asian countries. A pipeline project joining Pakistan to China could also change the landscape of crude oil logistics in the region.

The 2030 trade volume within Latin America for the Competing Nations scenario is larger than for the Global Commons scenario. The cause is a lack of demand elsewhere for crude oil, resulting in more cargo moving within the Latin America.

The largest increase in seaborne oil trade will come from the Arabian Gulf, Black Sea, and Latin America to China and other Asia. The rise will be caused by increased transport demand in these emerging regions.

North America and Japan will reduce seaborne oil imports over the next 20 years, benefiting from fuel efficiency gains, alternative energy supplies such as light tight oil and new transport technologies (e.g. electric cars). There will be a change in crude oil suppliers to North America, away from the Middle East and towards Latin America.

The majority of Russia's oil exports will still go to Europe in 2030, but there will be a trend to diversify its export to Asia, with a particularly significant increase to China.

Fig. 38 **Crude Oil seaborne trade (million tonnes)**
Source: MSI / LR

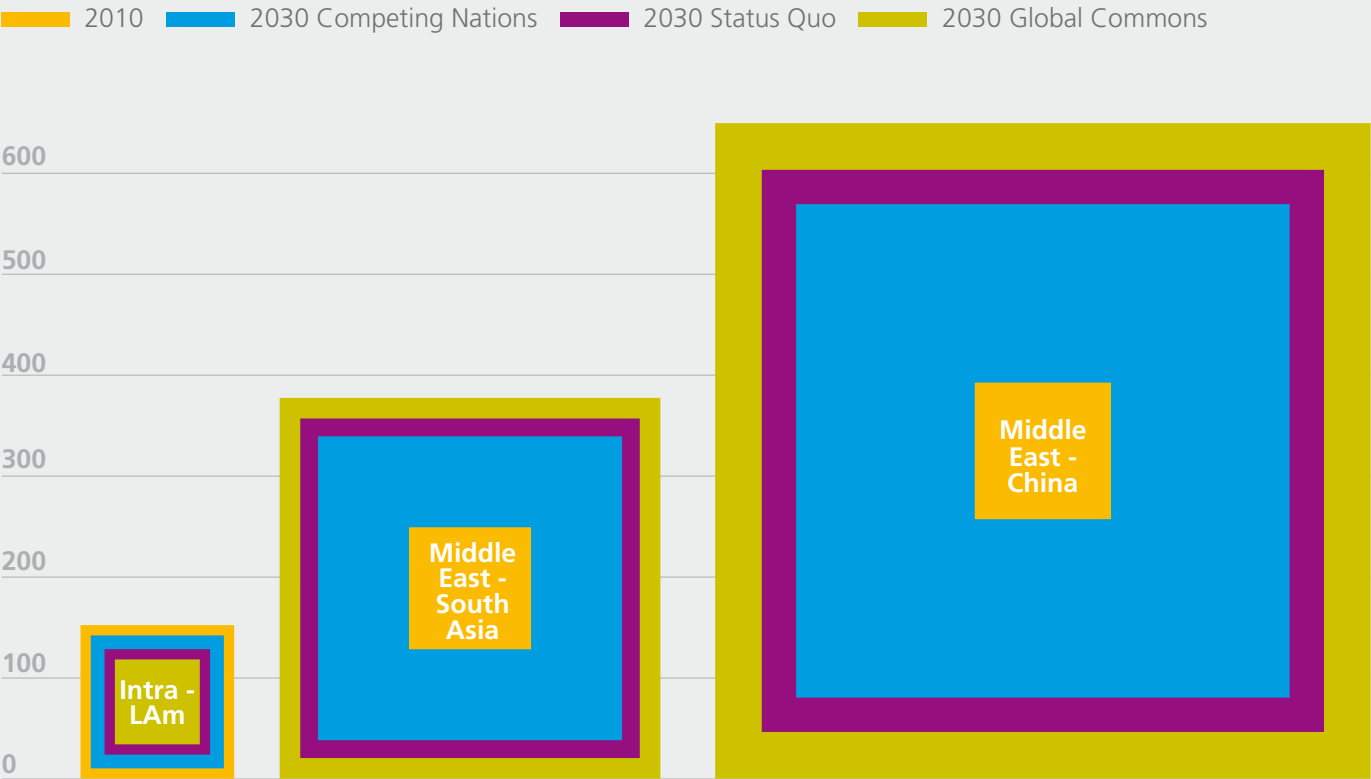


Fig. 39 Crude Oil seaborne trade 2010 (million tonnes)

Source: MSI / LR

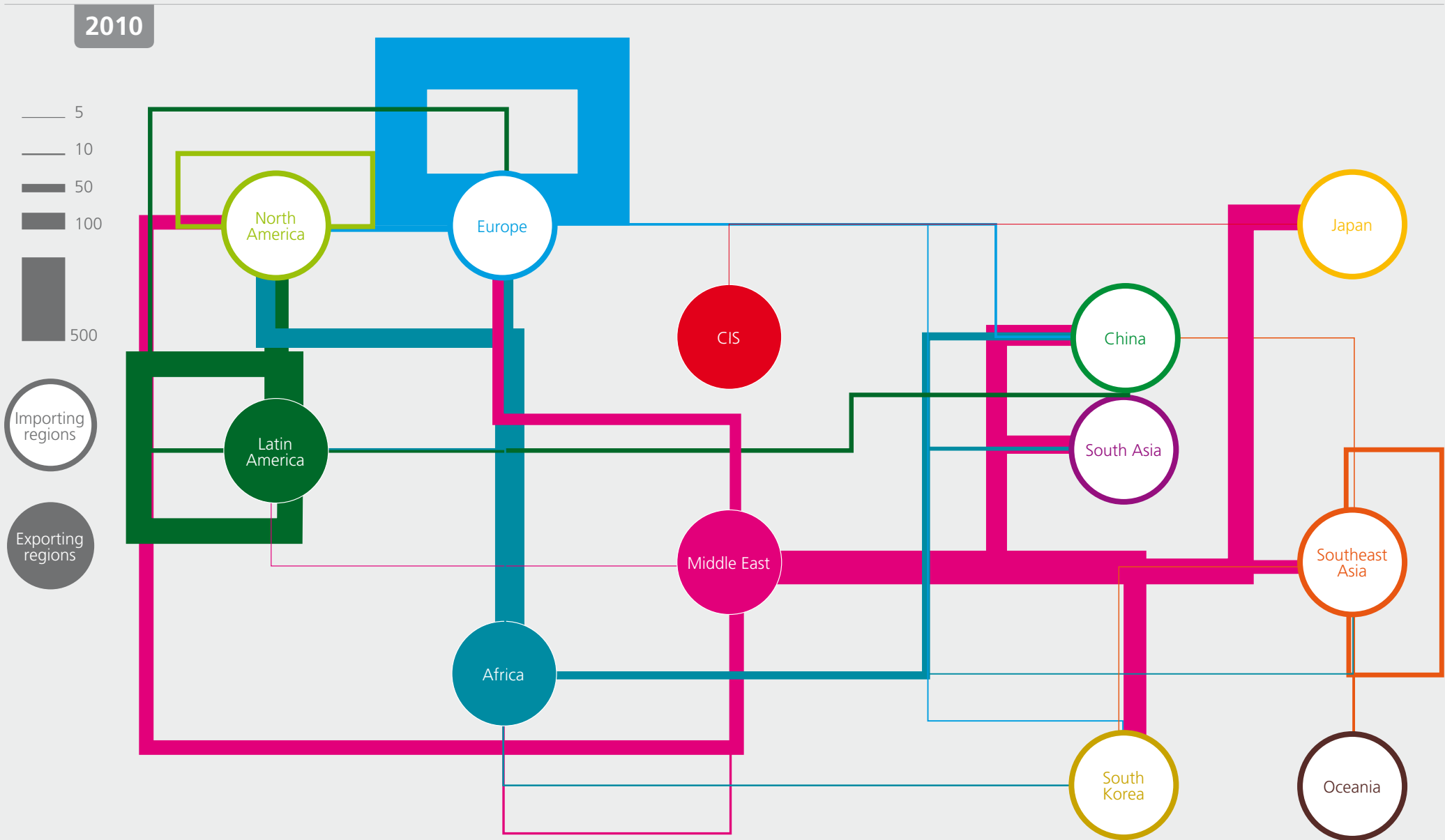
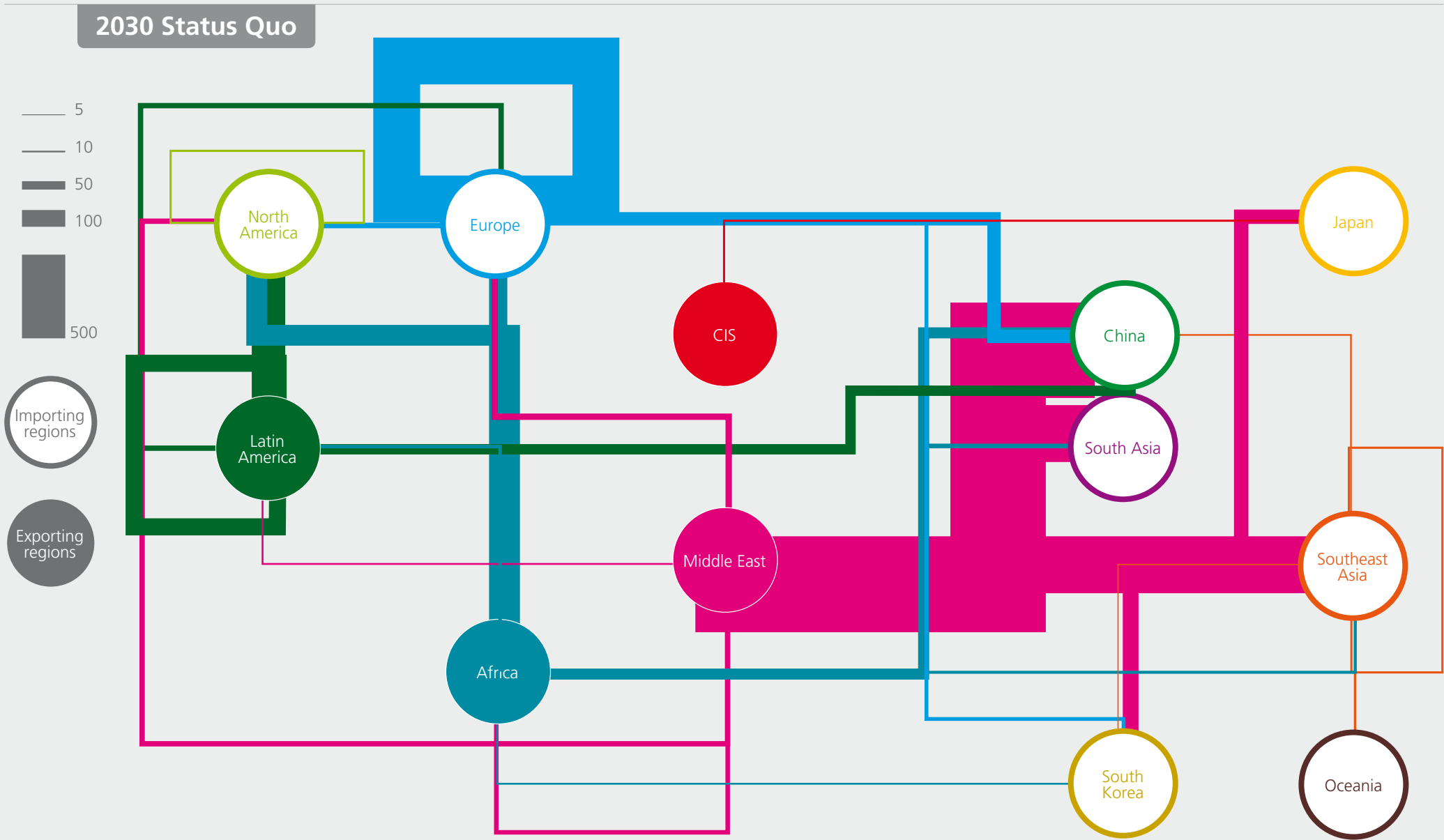


Fig. 40 Crude Oil seaborne trade 2030 (million tonnes)

Source: MSI / LR



Product Oil trade

Product Oil import

In the next 20 years, there will be a large increase in product oil import in Southeast Asia. As a whole, Southeast Asia and Europe will be the major importers in 2030.

Product Oil export

Similar to today, the product oil export will be dominated by Europe and CIS. There will also be a relatively large growth in CIS.

Fig. 41 Product oil import (million tonnes)

Source: MSI / LR

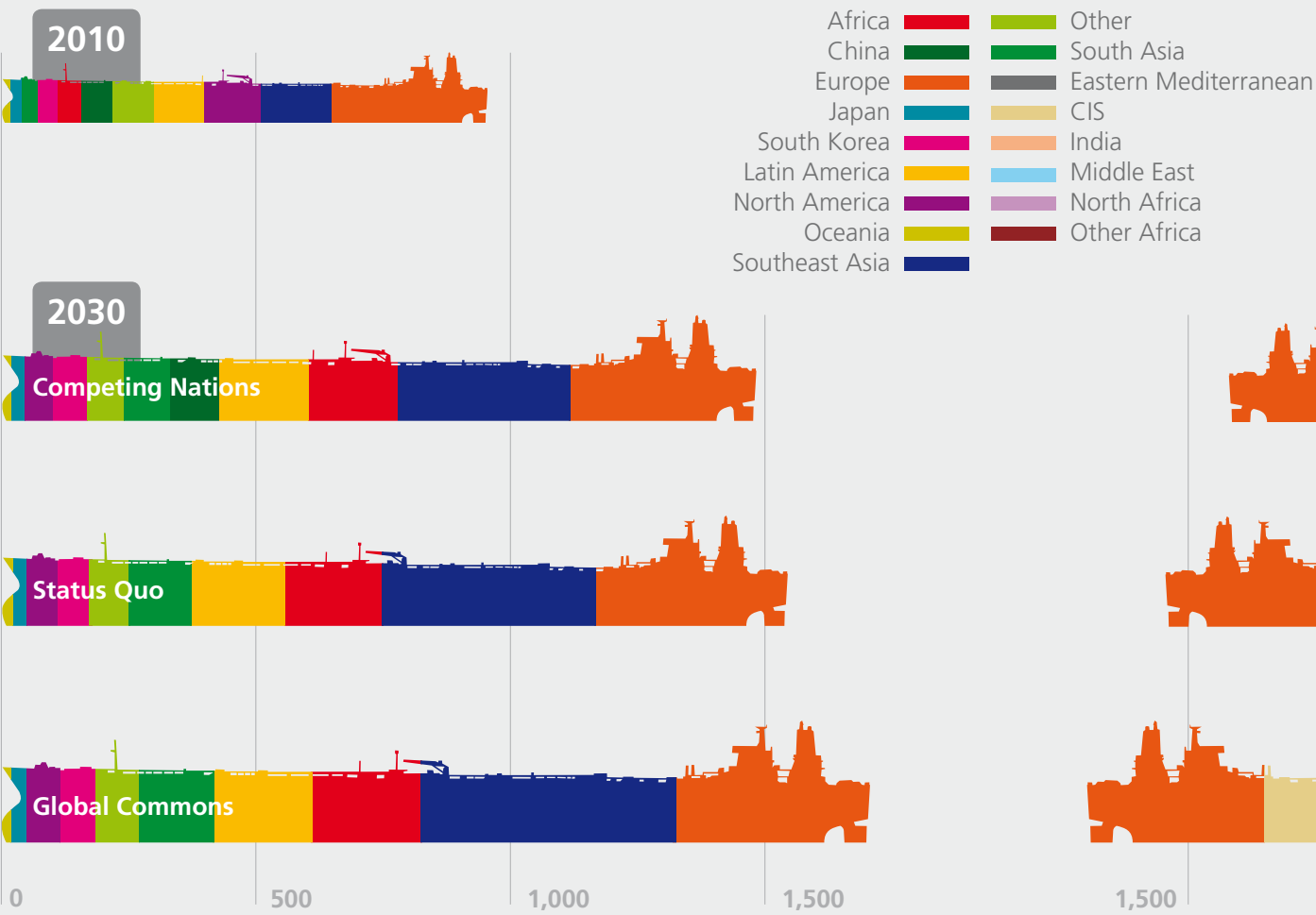
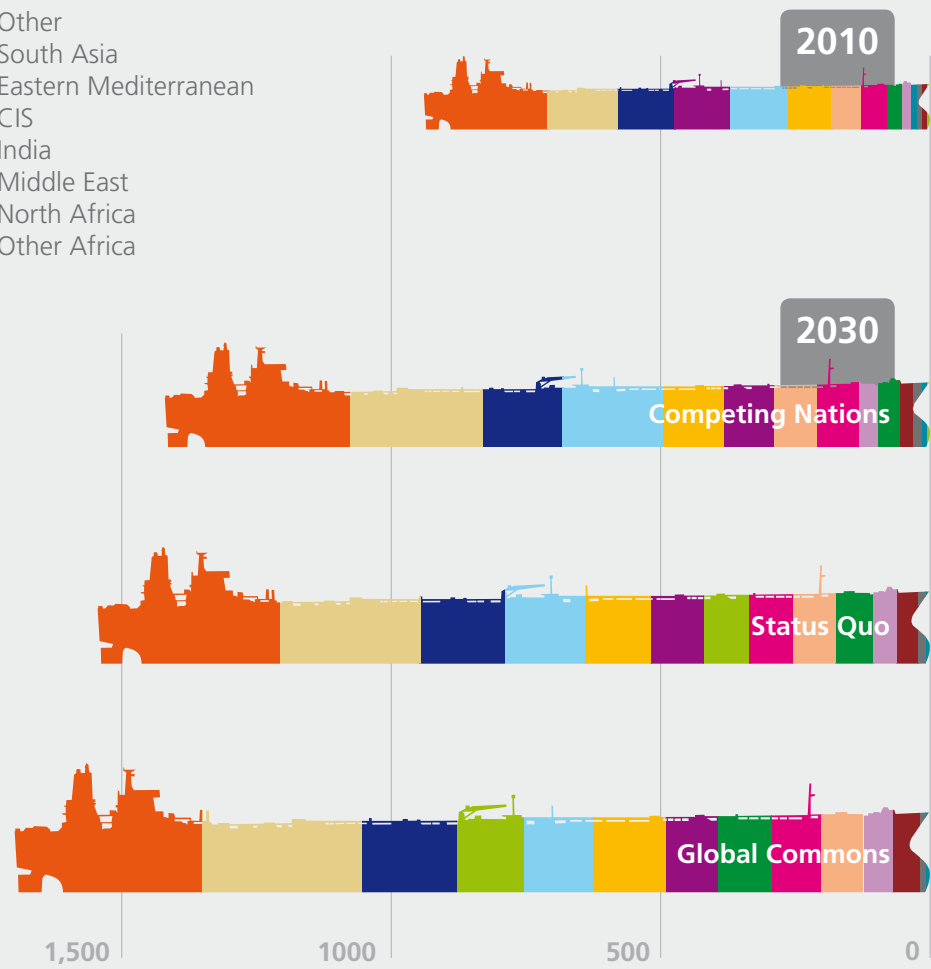


Fig. 42 Product oil export (million tonnes)

Source: MSI / LR



Product Oil trade

As today, the largest product oil trade will take place within the European and Mediterranean regions in 2030. The greatest difference between the 3 scenarios lies in the trade routes between Southeast Asia and East Asia (eg. Japan, South Korea, and China).

Fig. 43 Product Oil trade (million tonnes)

Source: MSI / LR

- 2010
- 2030 Competing Nations
- 2030 Status Quo
- 2030 Global Commons



Fig. 44 Seaborne Product Oil cargo trade 2010 (million tonnes)

Source: MSI / LR

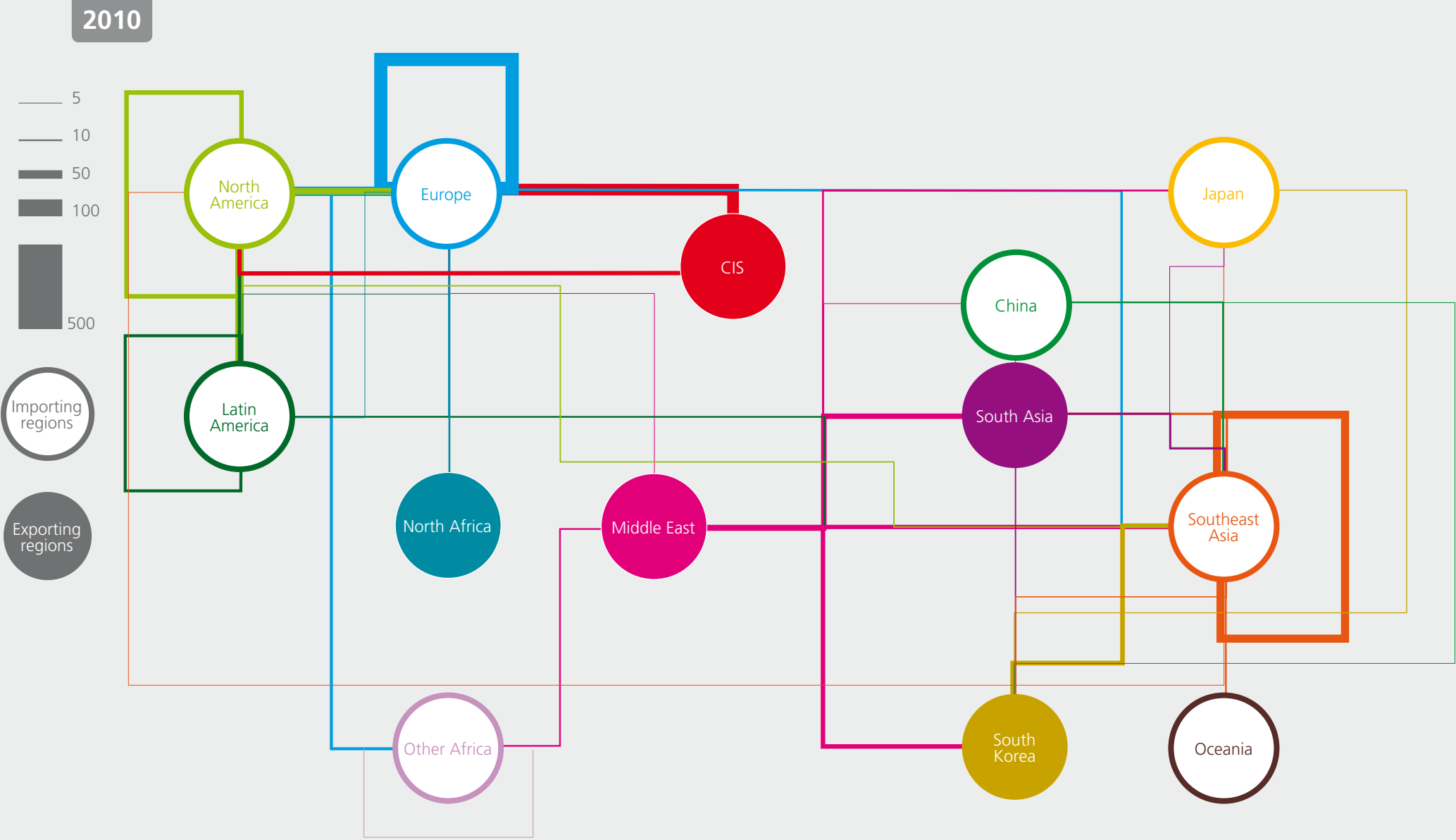
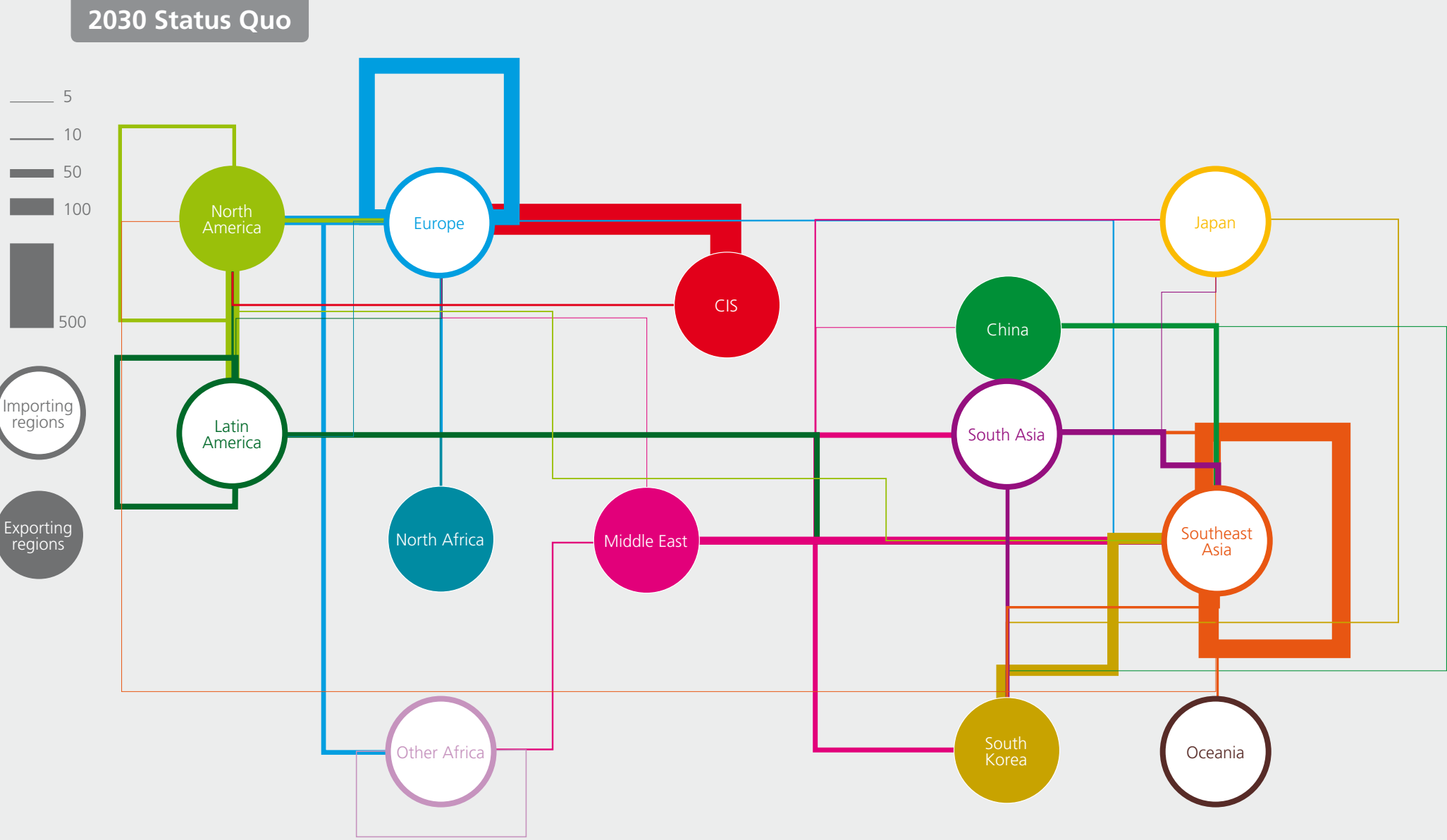


Fig. 45 Seaborne Product Oil cargo trade 2030 (million tonnes)

Source: MSI / LR



LNG trade

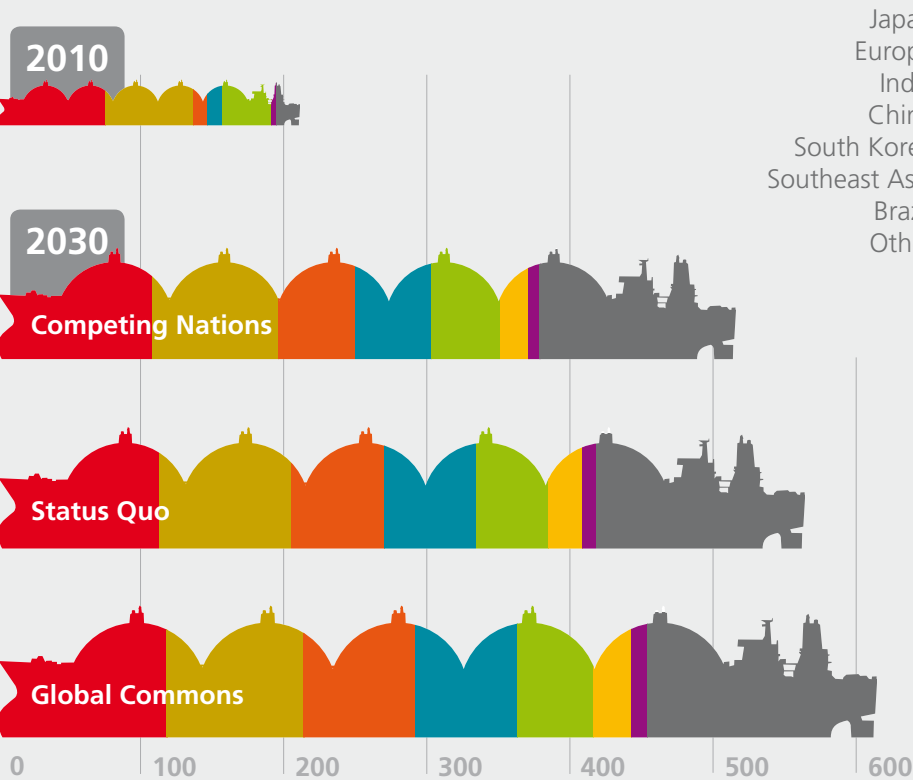
Liquefied Natural Gas (LNG) carriers could ship natural gas to distant market where pipeline transport becomes uneconomical.

LNG import

The largest increase in LNG import will come from the energy-hungry India and China between 2010 and 2030. The natural gas import will be dominated by Japan, Europe, India and China in 2030.

Fig. 46 LNG importer (million tonnes)

Source: MSI / LR



LNG export

LNG export will be dominated by Australia and Qatar in 2030. Qatar is the biggest LNG exporter today. But thanks to Australia's several LNG export projects under development, Australia is tipped to surpass Qatar by 2020. The largest export increases will take place in Australia and Nigeria. East Africa, in particular Mozambique, could be a new hotspot in LNG exports due to its recent large offshore discoveries.

Fig. 47 LNG exporter (million tonnes)

Source: MSI / LR

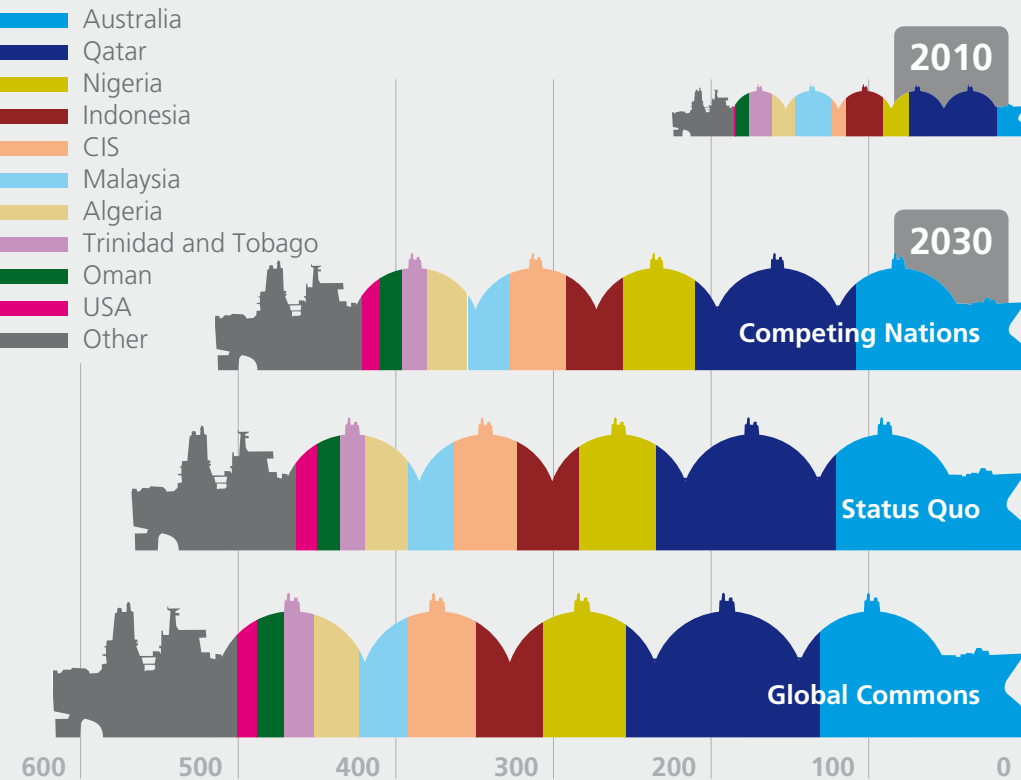
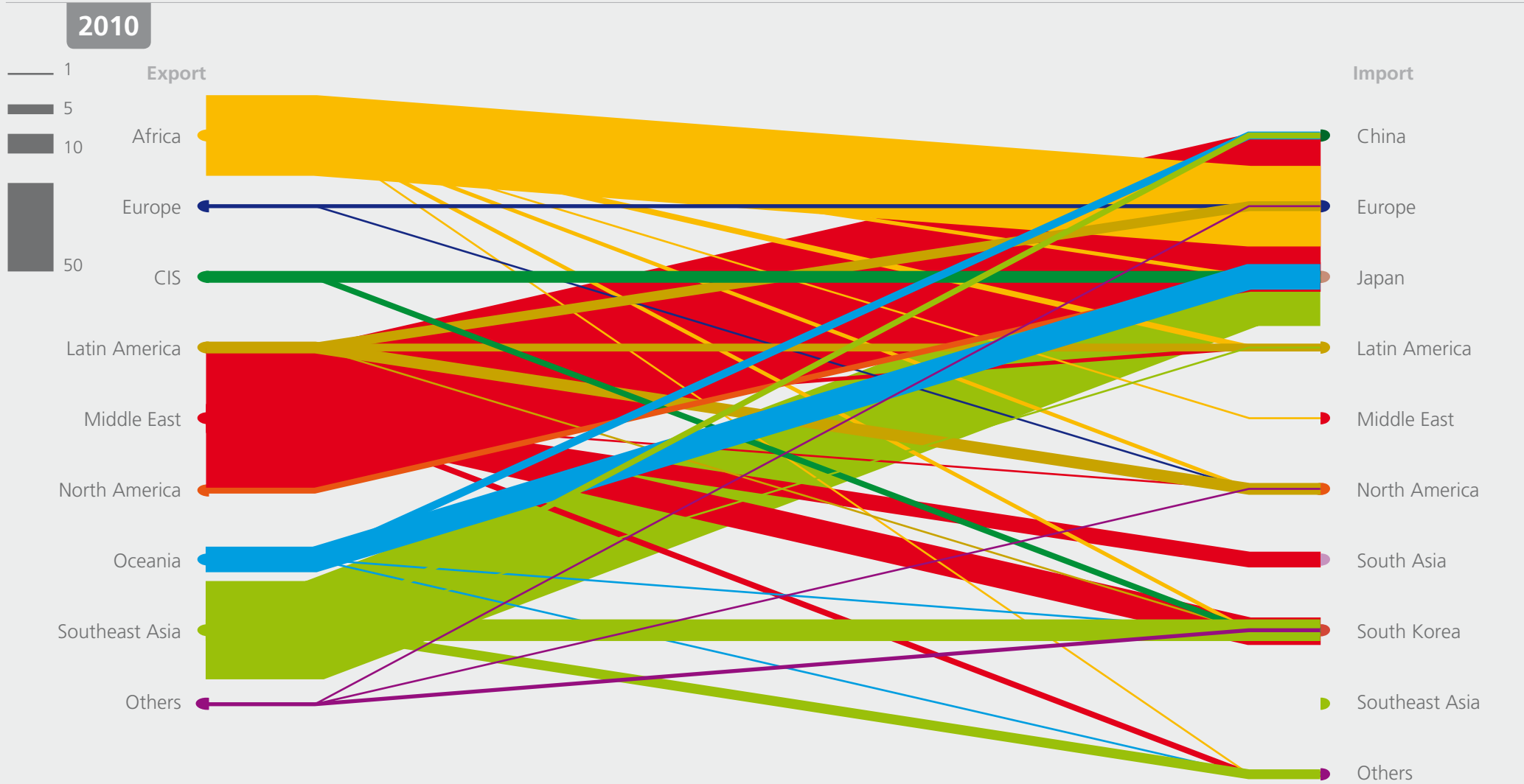


Fig. 48 Seaborne LNG trade in 2010 (million tonnes)

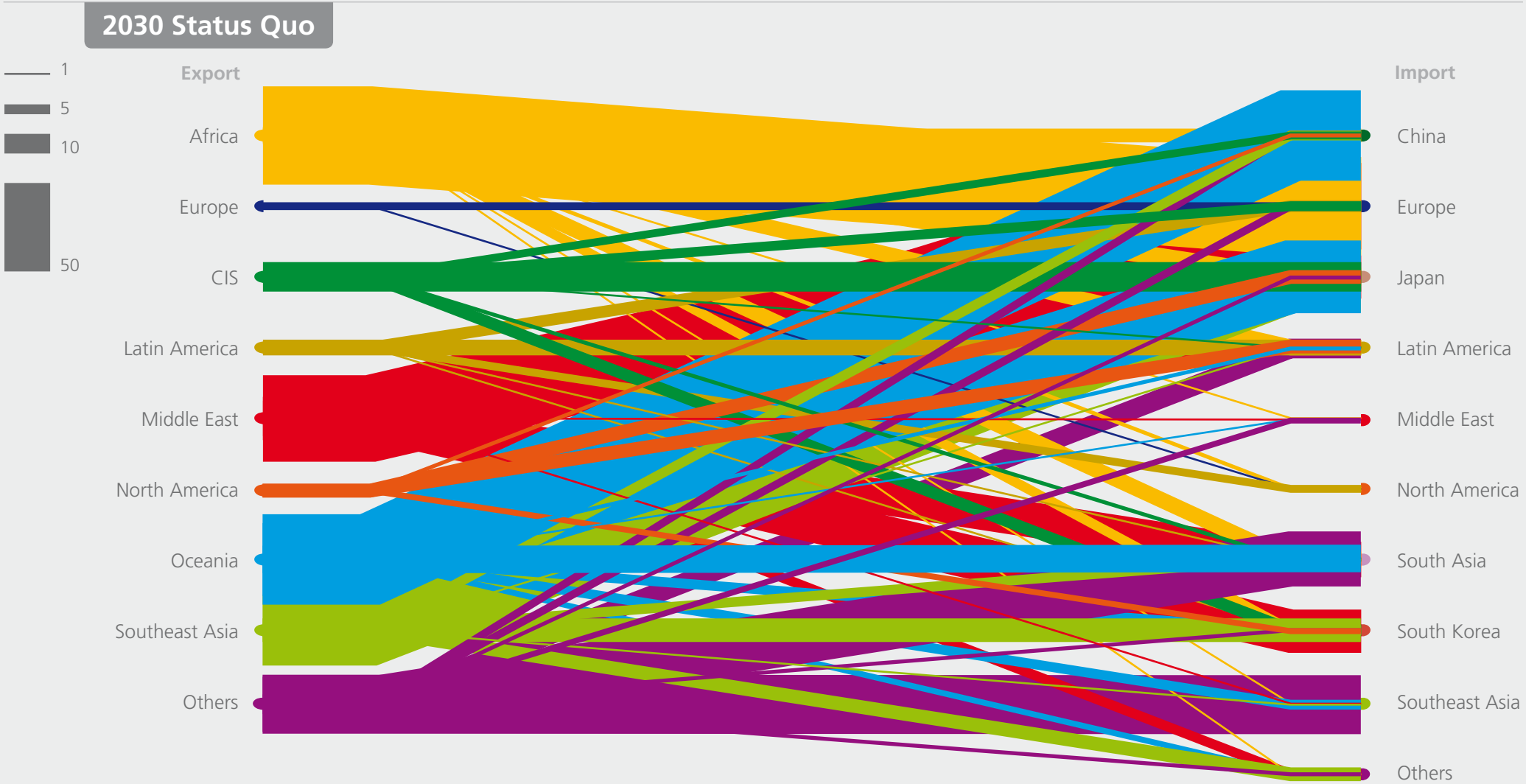
Source: MSI / LR



The major seaborne trade routes of Natural Gas trade in 2030 will be between: Australia to Japan; Australia to China. Routes with the largest increases are: Australia to China and Japan; Egypt to India and UK; CIS to Japan; Nigeria to China and UK; Qatar to India and UK.

Fig. 49 Seaborne LNG trade in 2030 (million tonnes)

Source: MSI / LR



Coal trade

Iron ore and coal are the two major dry-bulk cargoes. About two-thirds of coal transported is steam coal, used in power stations. A third of coal is coking coal, essential for steel production.

Coal import

Coal import will be dominated by India and China in 2030. India will overtake China and become the biggest coal importer before 2030. On the other hand there is high uncertainty about China’s coal trade in the long term. China is the world’s largest coal producer, and yet it only became a coal importer in 2009. This is due to the need for high quality coking coal as well as the transportation constraint of accessing China’s further inland coal supply (e.g. Inner Mongolia). The enhanced productivity of these inland coal production will also be pivotal to the global coal trade. There is also uncertainties resulting from China’s unconventional gas development which could change the country’s energy profile.

Japan and West European coal import growth will be small, and their influence on the coal market will wane.

Coal export

Australia will be at the helm of the coal export in 2030. Although Indonesia took over from Australia and became the biggest coal exporter in 2011, such dominance may not last long as the government will urge a curb in exports to conserve the limited coal reserves for the country’s expanding domestic use.

Fig. 50 Coal import (million tonnes of oil equivalent)

Source: MSI / LR

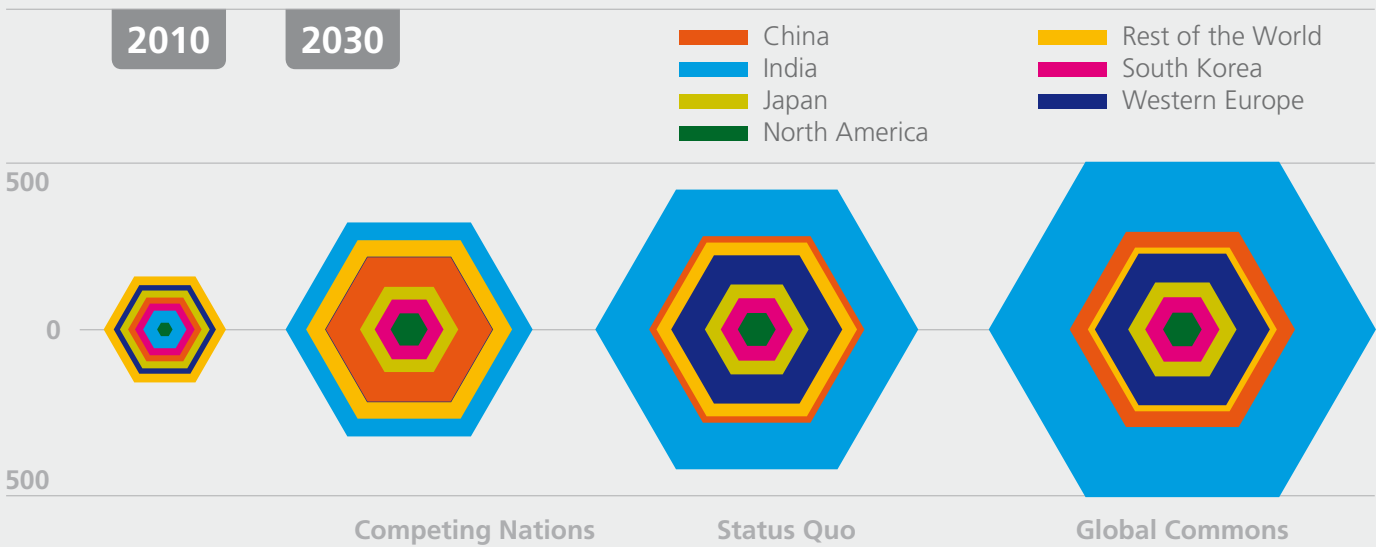
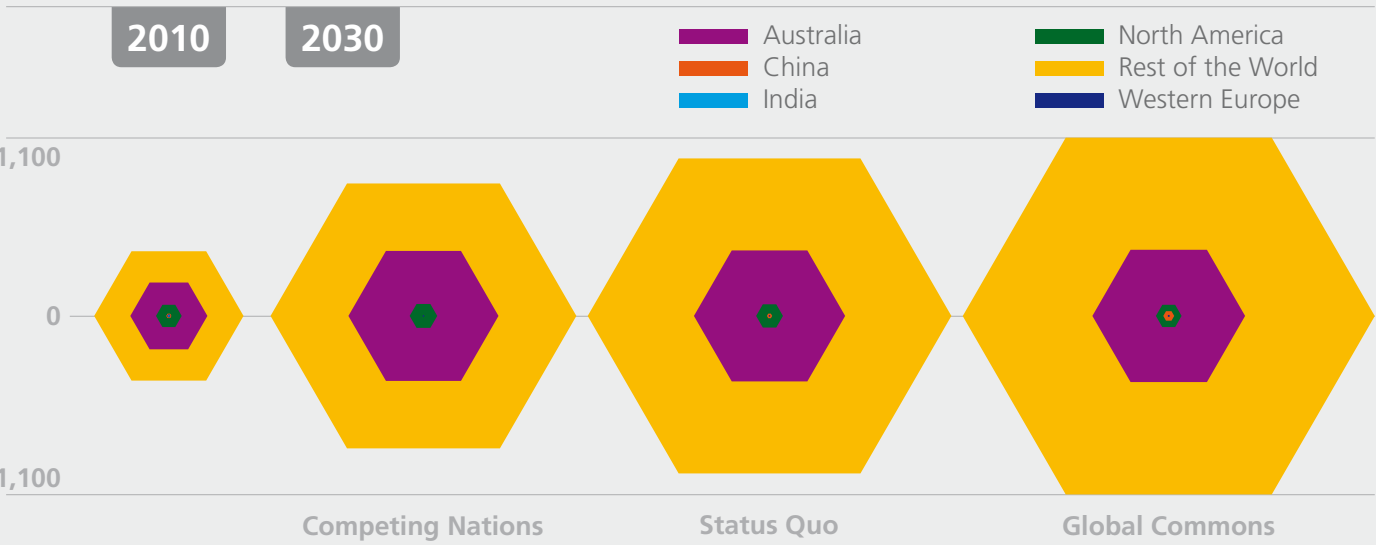


Fig. 51 Coal export (million tonnes of oil equivalent)

Source: MSI / LR



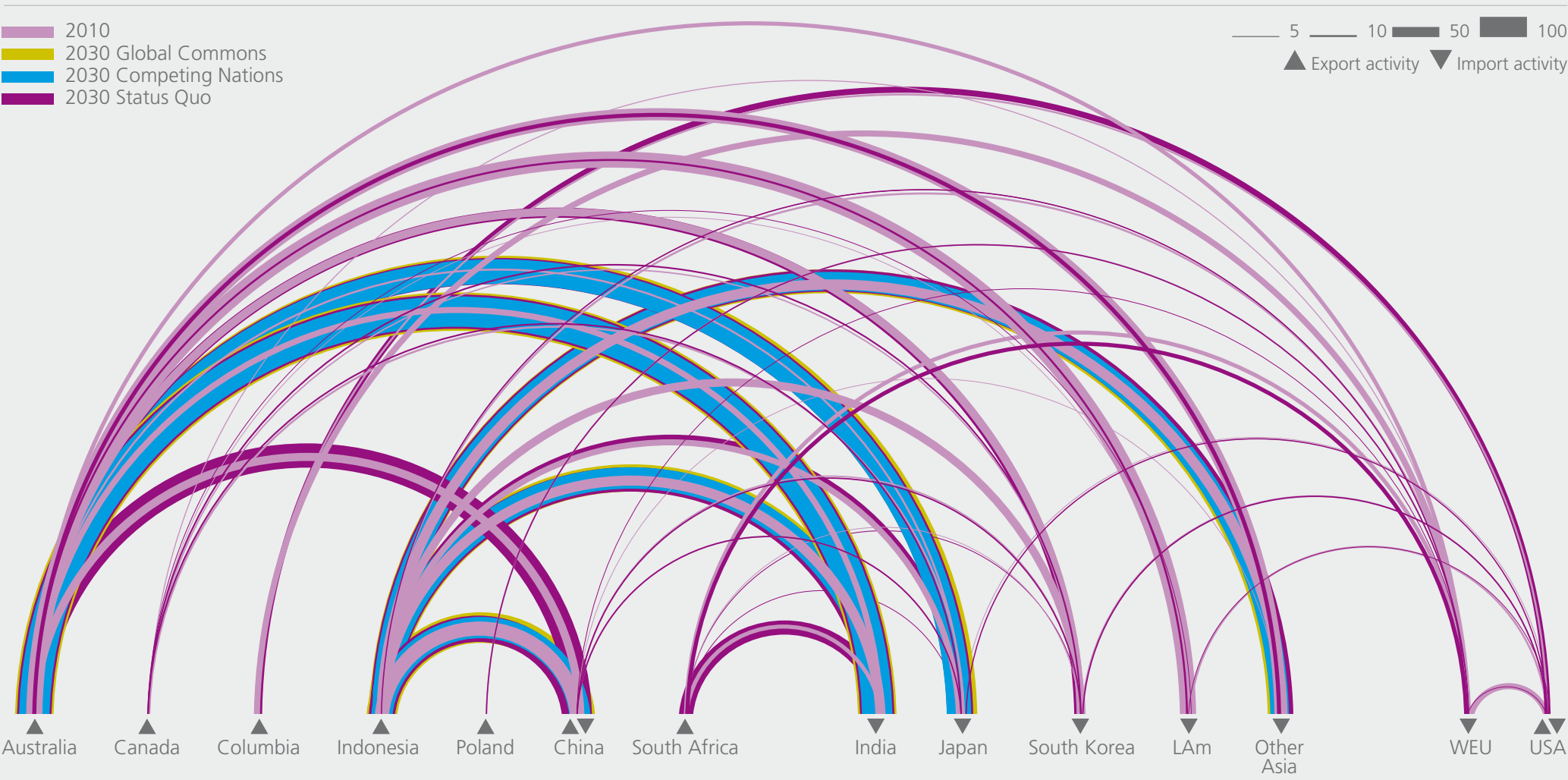
Coal trade routes

Apart from Indonesian exports, there are few differences between the three scenarios for most coal trade routes.

Indonesia’s limited reserves and its government’s policy of protecting energy resources will create uncertainties.

Fig. 52 Seaborne Coal trade (million tonnes)

Source: MSI / LR



Iron Ore trade

Iron Ore import

Iron ore import will be driven by demand which is linked to urbanisation and industrialisation, particularly in Asia. Although China’s steel intensity will decline as the country develops, China’s robust economic development and urbanisation will see its absolute dominance in iron ore import remain intact.

China is a major iron ore producer, but its domestic mines only met 34% of the demand in 2010. This is because China needs to import higher grade iron ore from overseas. Chinese iron ore has a low iron content only reaching 28% by weight, compared to other major producers averaging over 60%.

India is a major iron ore exporter hence it is excluded from “other Asia” in the importer list.

Iron Ore export

The traditional iron ore sources, Oceania and Brazil, will continue to dominate the export market with significant growth. India will remain number three in terms of exporting iron ore, although growing less rapidly.

Fig. 53 Iron Ore import (million tonnes)

Source: MSI / LR

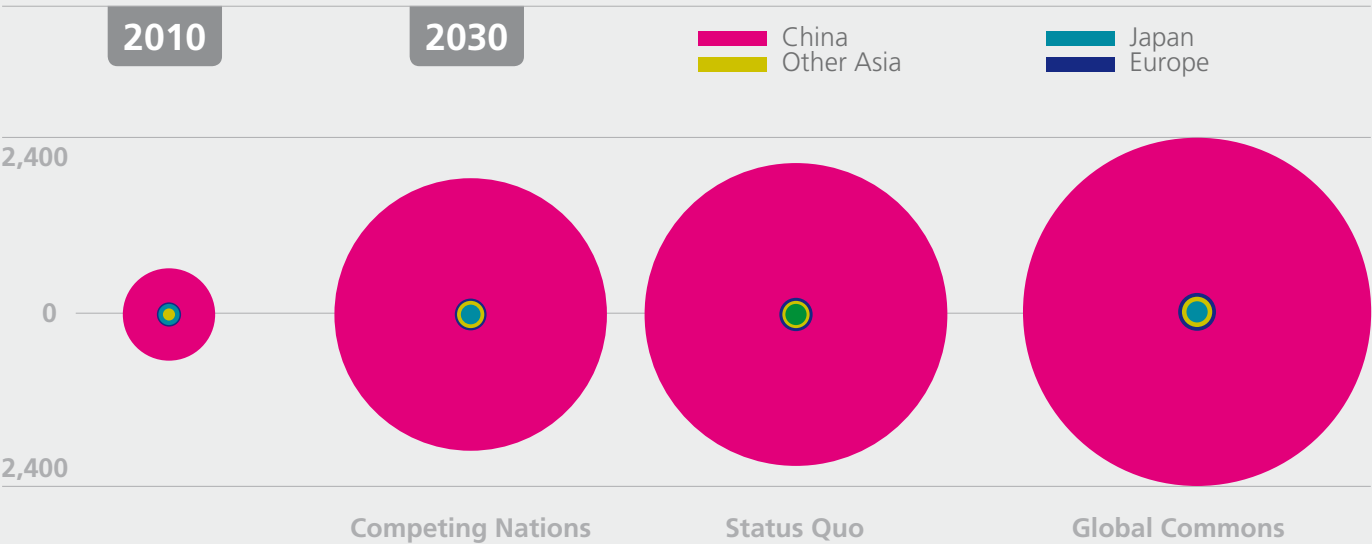
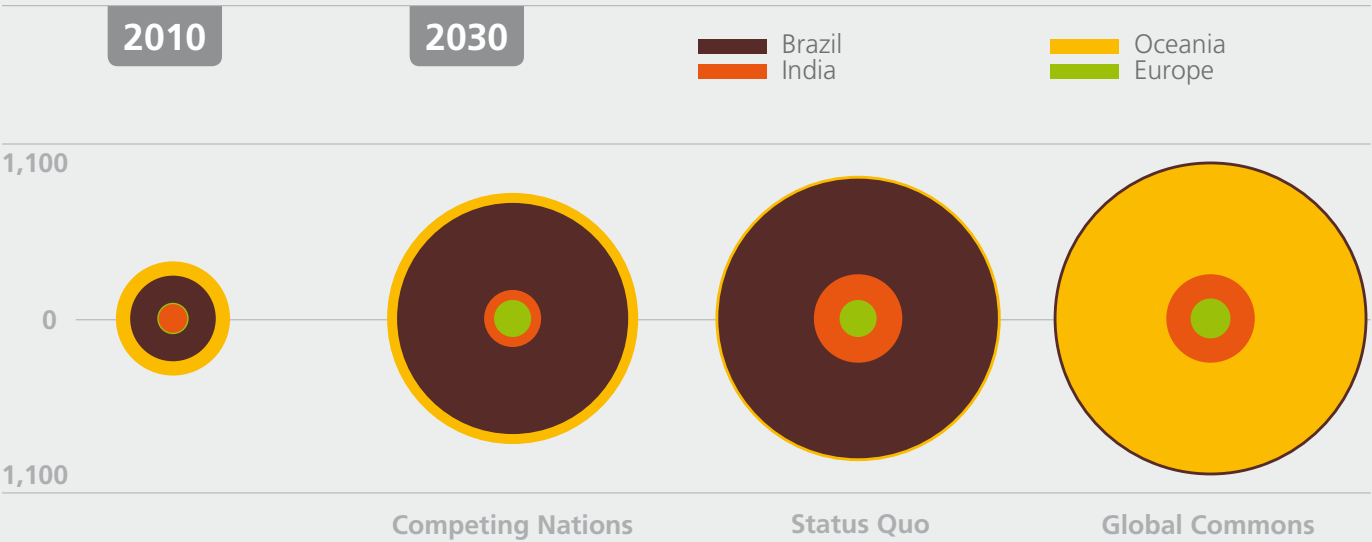


Fig. 54 Iron Ore export (million tonnes)

Source: MSI / LR



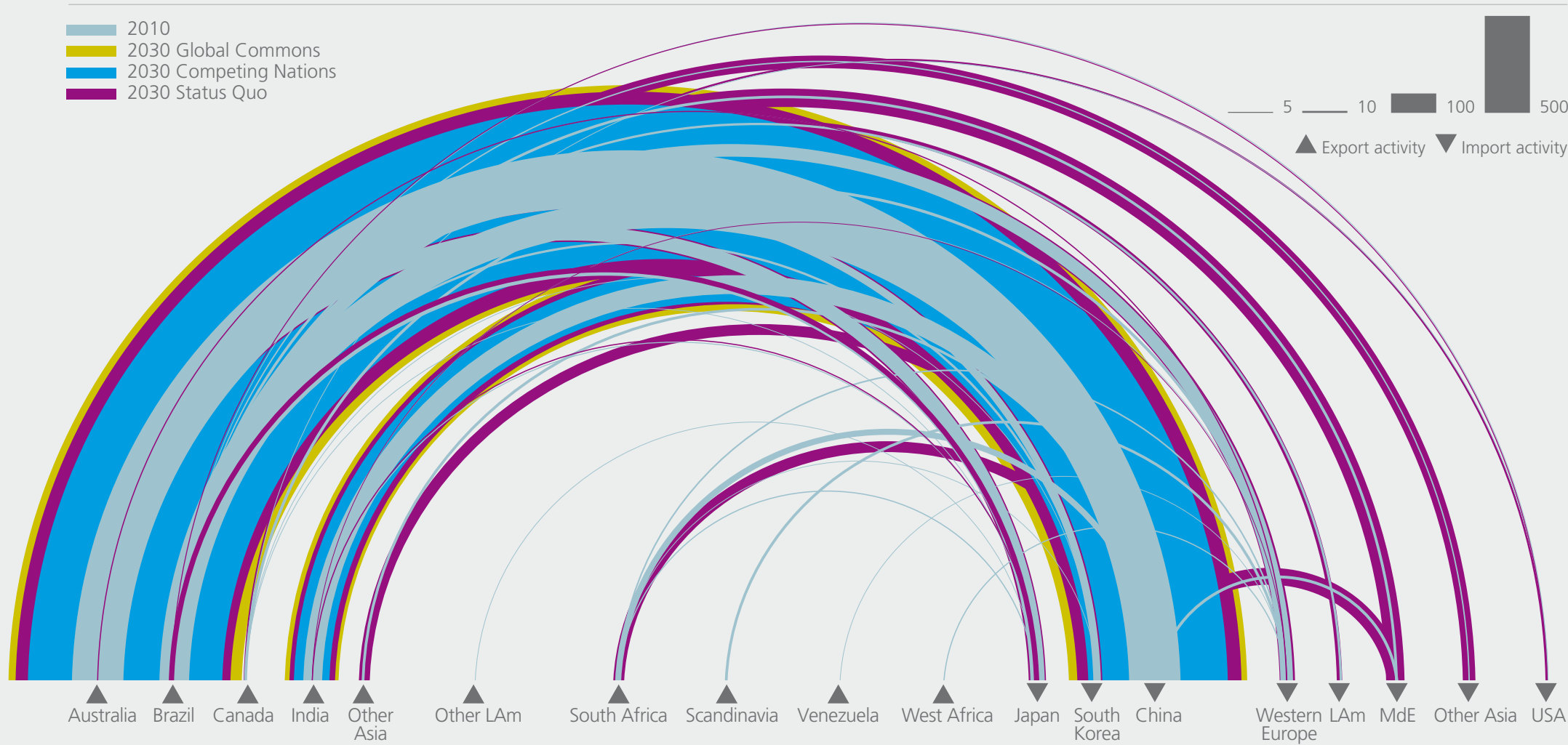
Iron Ore trade routes

China’s continuous iron ore demand will dominate the iron ore seaborne trade for the next 20 years. Trade routes between Australia, Brazil, India, and China will not only

lead the table but also contribute the largest increase. Meanwhile, there is major uncertainty/difference between the three scenarios in the above trade routes.

Fig. 55 Seaborne Iron Ore trade (million tonnes)

Source: MSI / LR



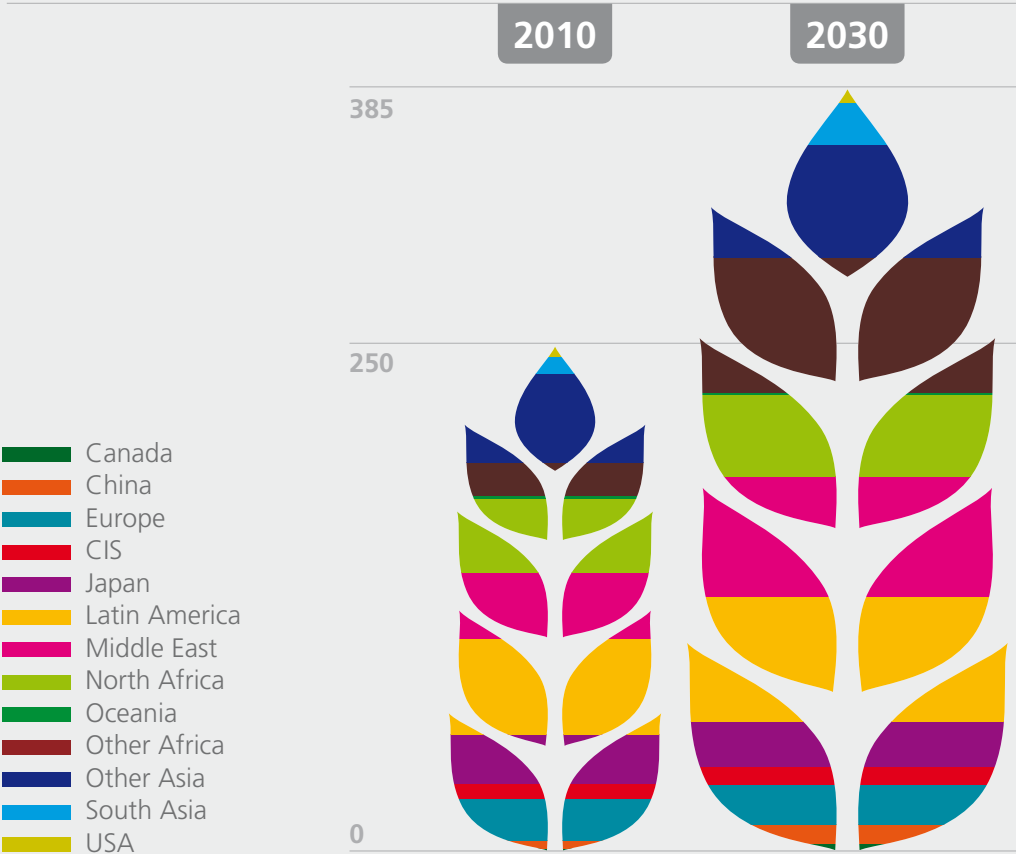
Grain trade

Grain import

There will be large increase in the import levels in Africa and the Middle East. In 2030, grain import will be dominated by Africa, Latin America, Middle East, and Southeast Asia.

Fig. 56 Grain import (million tonnes)

Source: MSI / LR

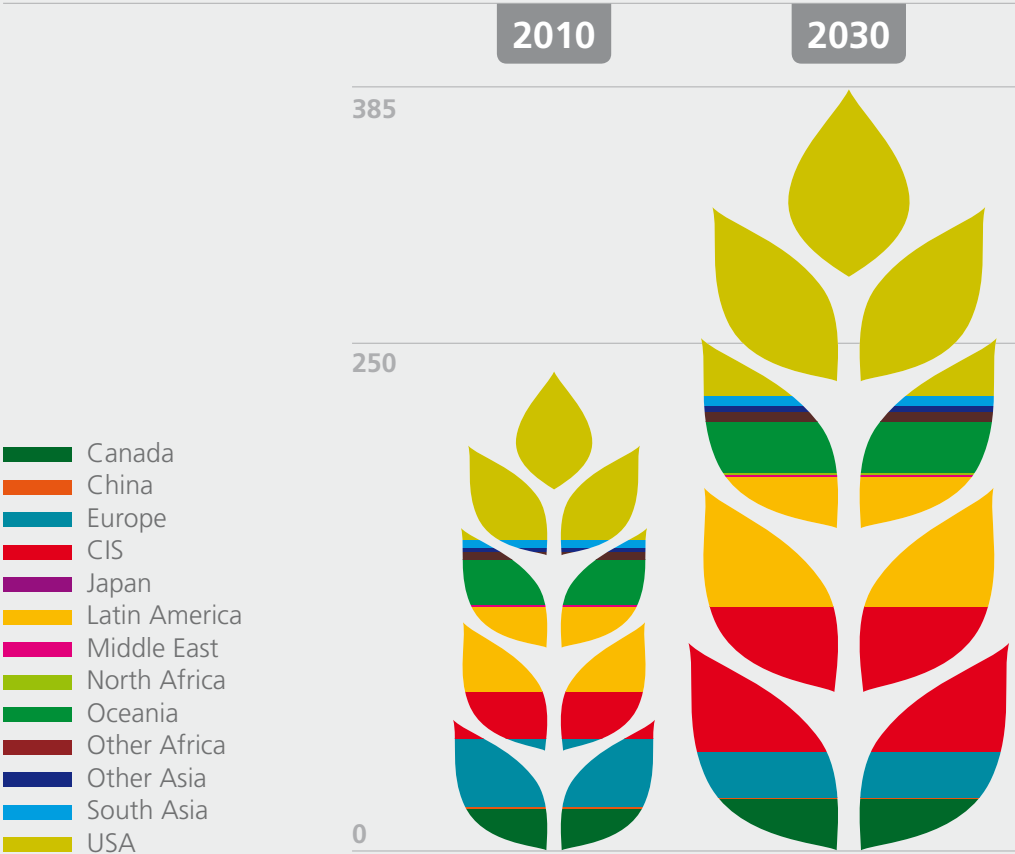


Grain export

There will be a relatively large increase in the USA and CIS. Grain export will still be dominated by the USA in 2030, accounting for 40% of the world's exports.

Fig. 57 Grain export (million tonnes)

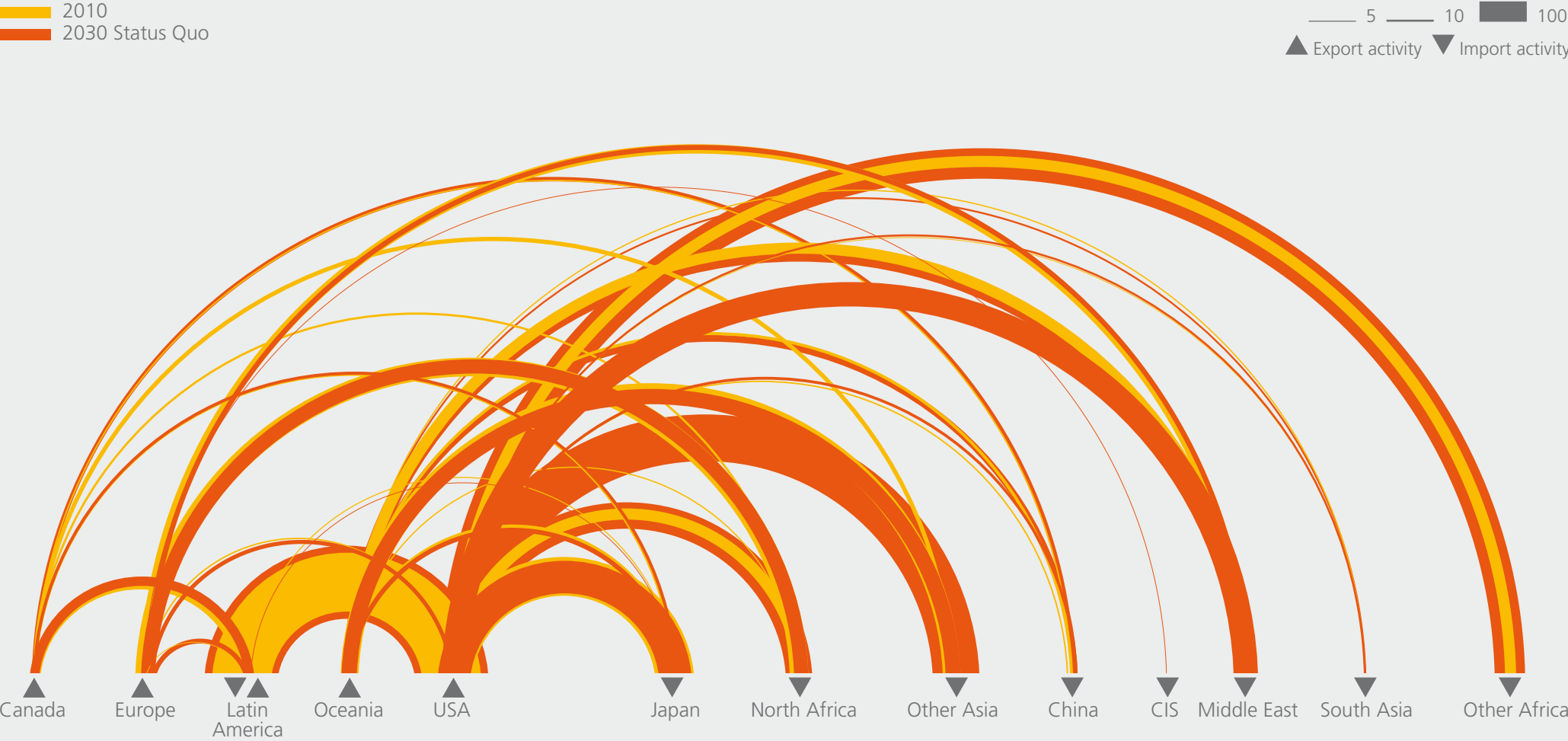
Source: MSI / LR



Grain trade routes

Fig. 58 Seaborne Grain trade (million tonnes)

Source: MSI / LR



Container trade

In 2030, China will still enjoy her leading role in primary container trades. Latin America will bear the highest uncertainties across 3 scenarios, overtaking Europe and become second in 2030 in the Global Commons scenario. However Latin America will remain the fourth, after Southeast Asia, in the Competing Nations scenario. This relies on the potential and challenges of the industry reforms and transforming Latin America's society into an economy with competitive manufacturing and growing consuming power.

The largest container tranship loaded lifts will still take place in Southeast Asia in 2030. Europe, the current second largest transshipment destination around the world, will face a much slower growth. Her position will be subsequently rivalled by China and the Middle East's remarkable progress by 2030 across all scenarios.

Fig. 59 **Container primary loaded lift (thousand TEU)** ■ Africa ■ Europe ■ China ■ Latin America ■ Middle East ■ North America ■ Oceania ■ South Asia ■ Southeast Asia

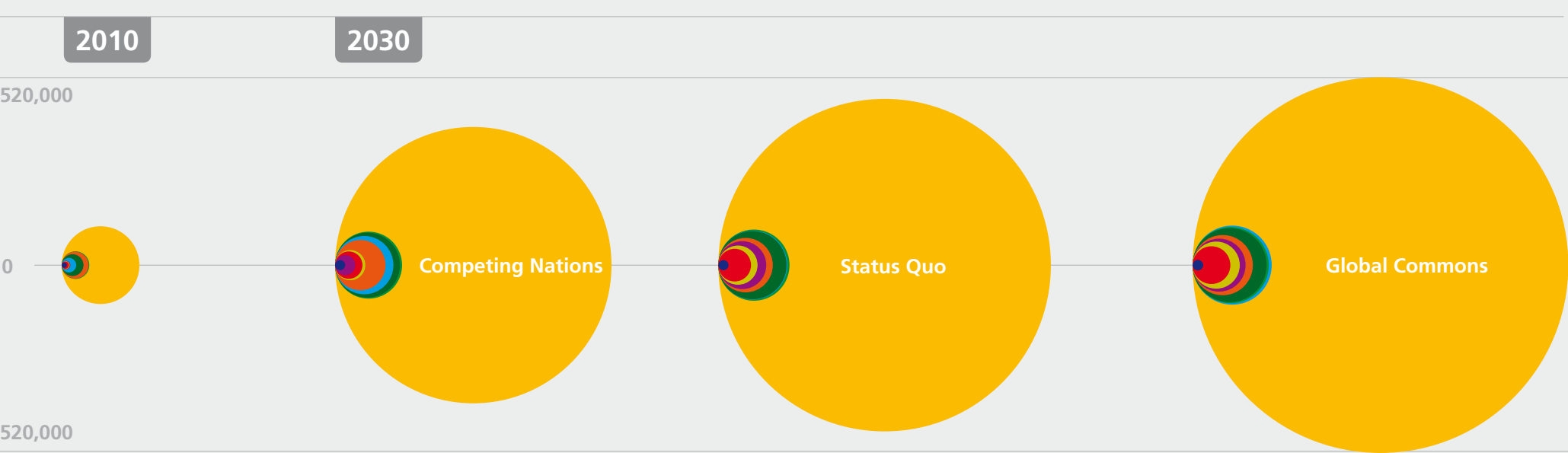
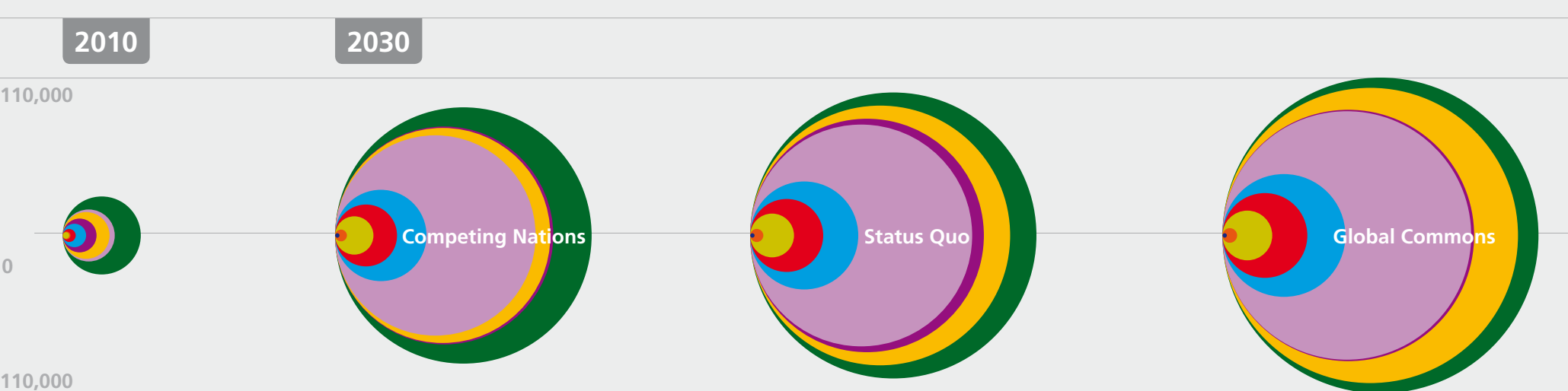


Fig. 60 **Container tranship loaded lifts (thousand TEU)** ■ Africa ■ Europe ■ China ■ Latin America ■ Middle East ■ North America ■ Oceania ■ South Asia ■ Southeast Asia



Major Container trade routes

The greatest growth in container trade will take place between the Far East and the Middle East for the next two decades. The Indian Ocean and Asia Pacific will be at the

centre stage of the global container market. There will also be a significant growth in trades between the Far East and Latin America.

Fig. 61 Seaborne Container trade 2010 (thousand TEU)

Source: MSI / LR

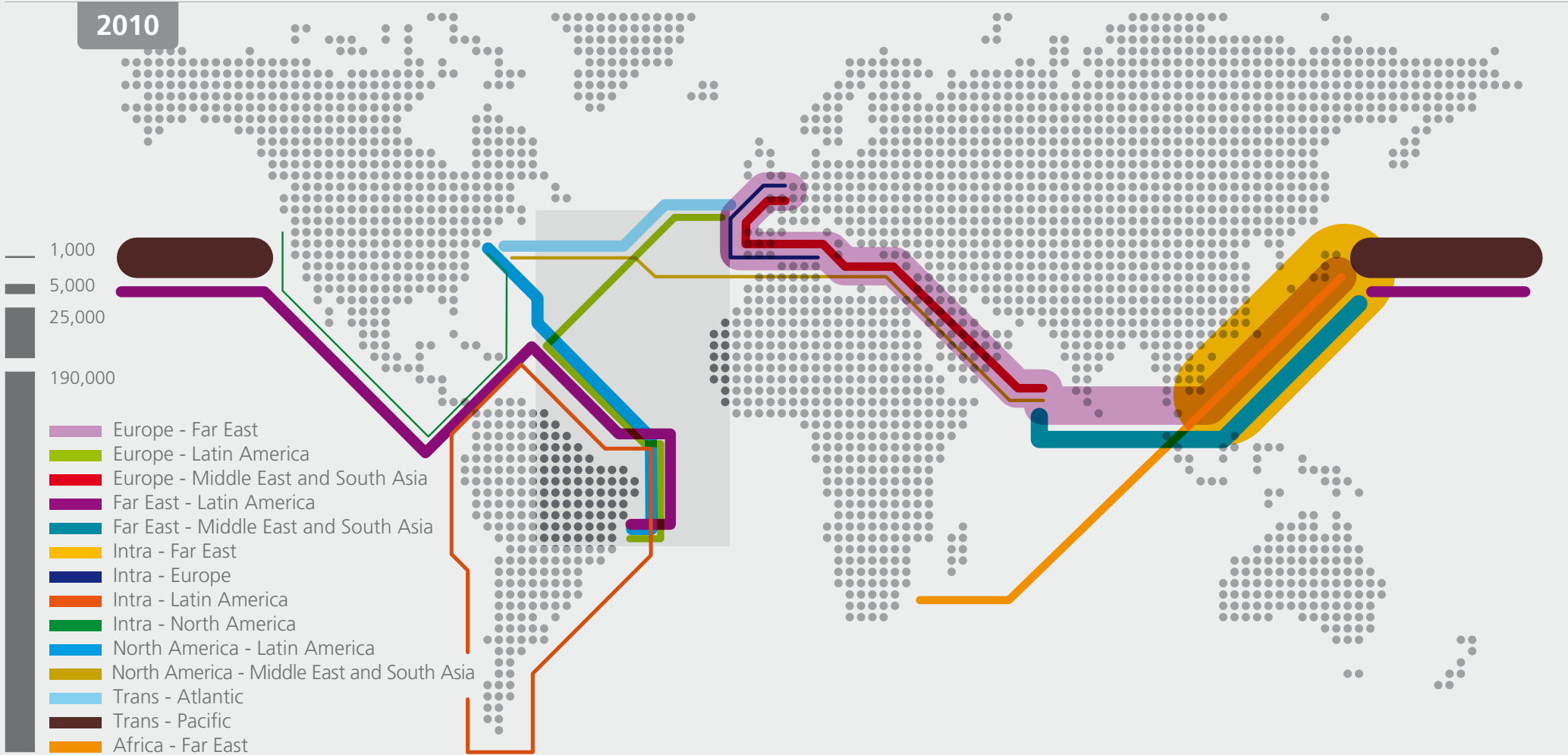
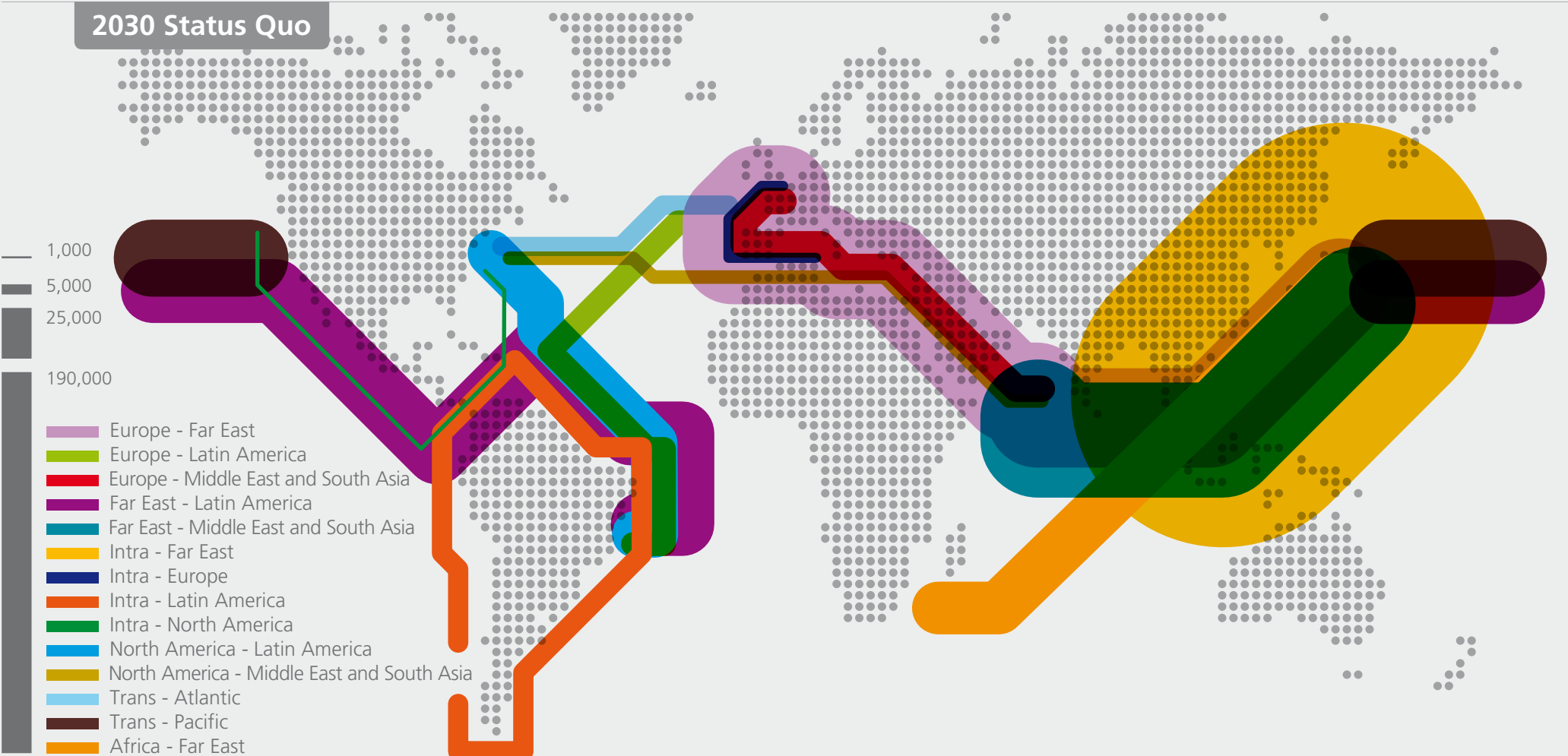


Fig. 62 Seaborne Container trade 2030 (thousand TEU)

Source: MSI / LR



Total fleet size

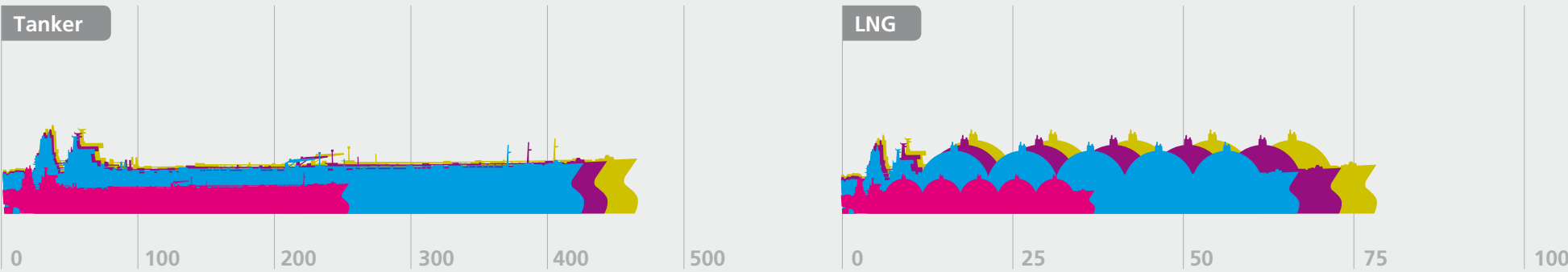
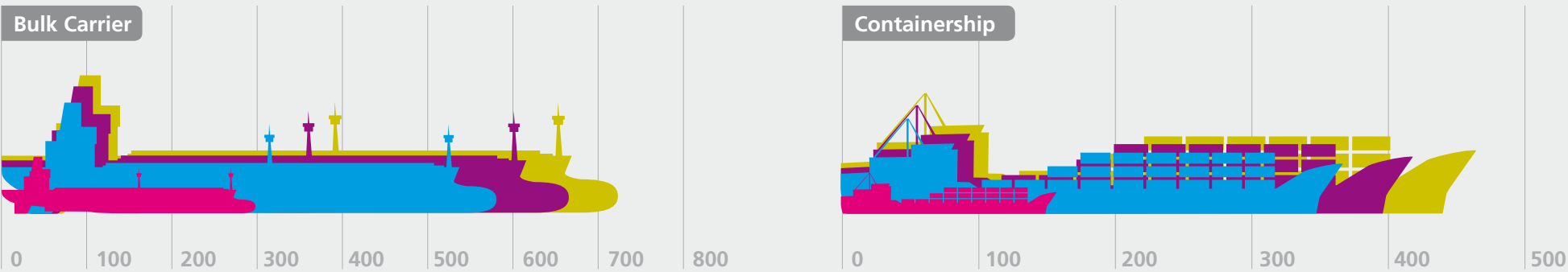
Total tonnage and vessel numbers will increase for all major ship types. The increases for tankers will be at a slower rate. The total tonnage of tankers is expected

to grow only 1.7-1.8 times, compared to bulk carriers, containerships and LNG, which are expected to grow between 1.8 and 3 times over the next two decades.

Fig. 63 Bulk Carrier/Tanker/Containership/LNG carrier fleet (million GT)

Source: MSI / LR

2010 2030 - Competing Nations Status Quo Global Commons



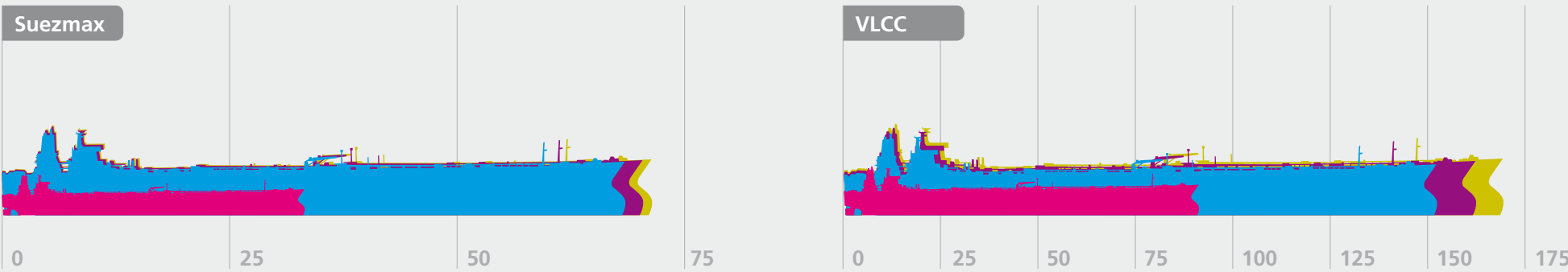
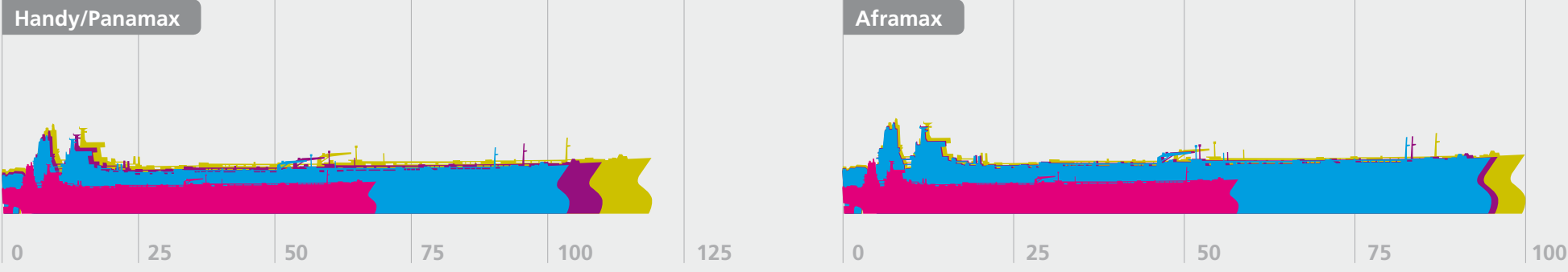
Tanker fleet

The total tonnage of Suezmax will grow slightly faster than other tanker sizes. (Suezmax to grow about 2 times compared to other ship sizes to grow 1.6-1.8 times for the next 20 years)

Fig. 64 Tanker fleet size (million GT)

Source: MSI / LR

2010 2030 - Competing Nations Status Quo Global Commons



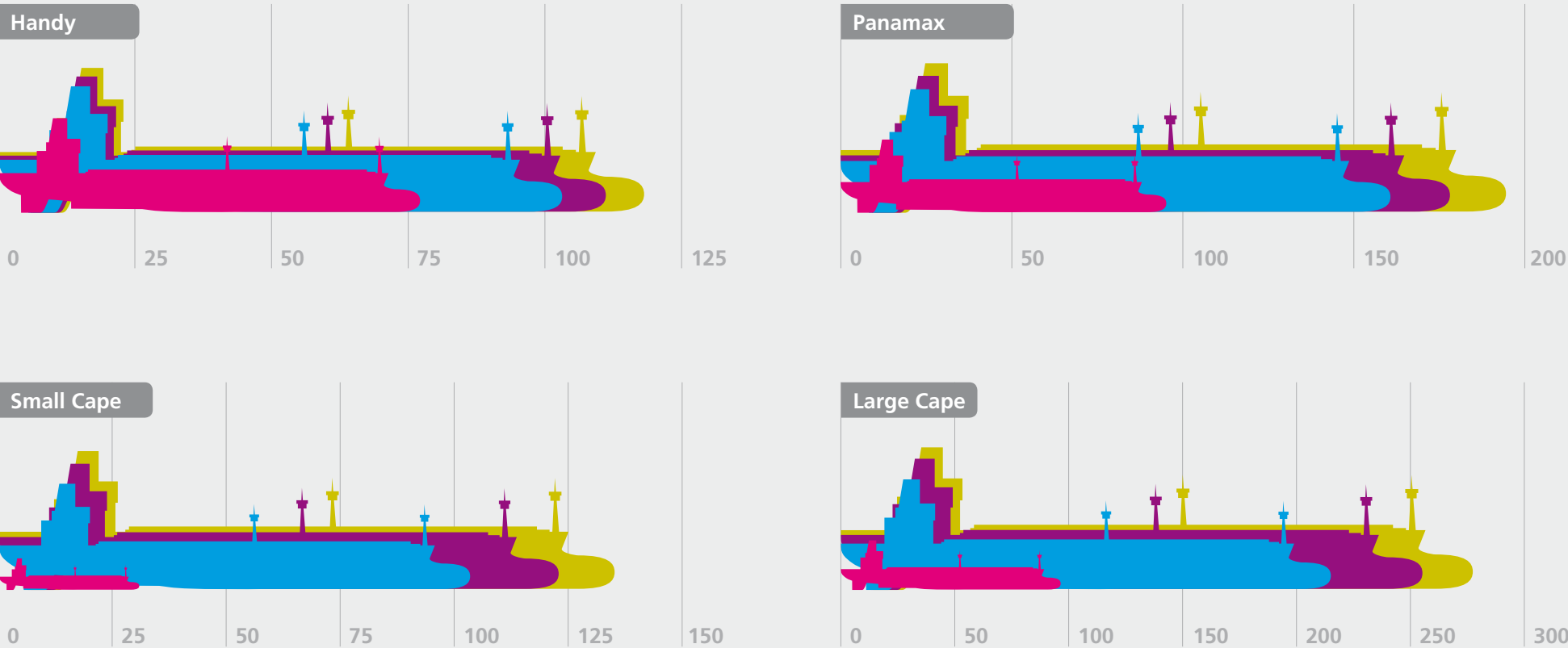
Bulk Carrier fleet

The total tonnage of small and large Cape size bulk carriers will increase faster than smaller bulk carriers. (Cape to grow 2.5-3 times compared to Handy and Panamax to grow 1.5-1.8 times for the next 20 years). Bulk carriers’ operational efficiency could be

improved by China’s increasing importance and their versatile role in dry bulk trade. China will not only be the lead importer of industrial raw materials but also an exporter of coal and steel products. Ballast journey could be reduced.

Fig. 65 Bulk Carrier fleet size (million GT)
Source: MSI / LR

2010 2030 - Competing Nations Status Quo Global Commons

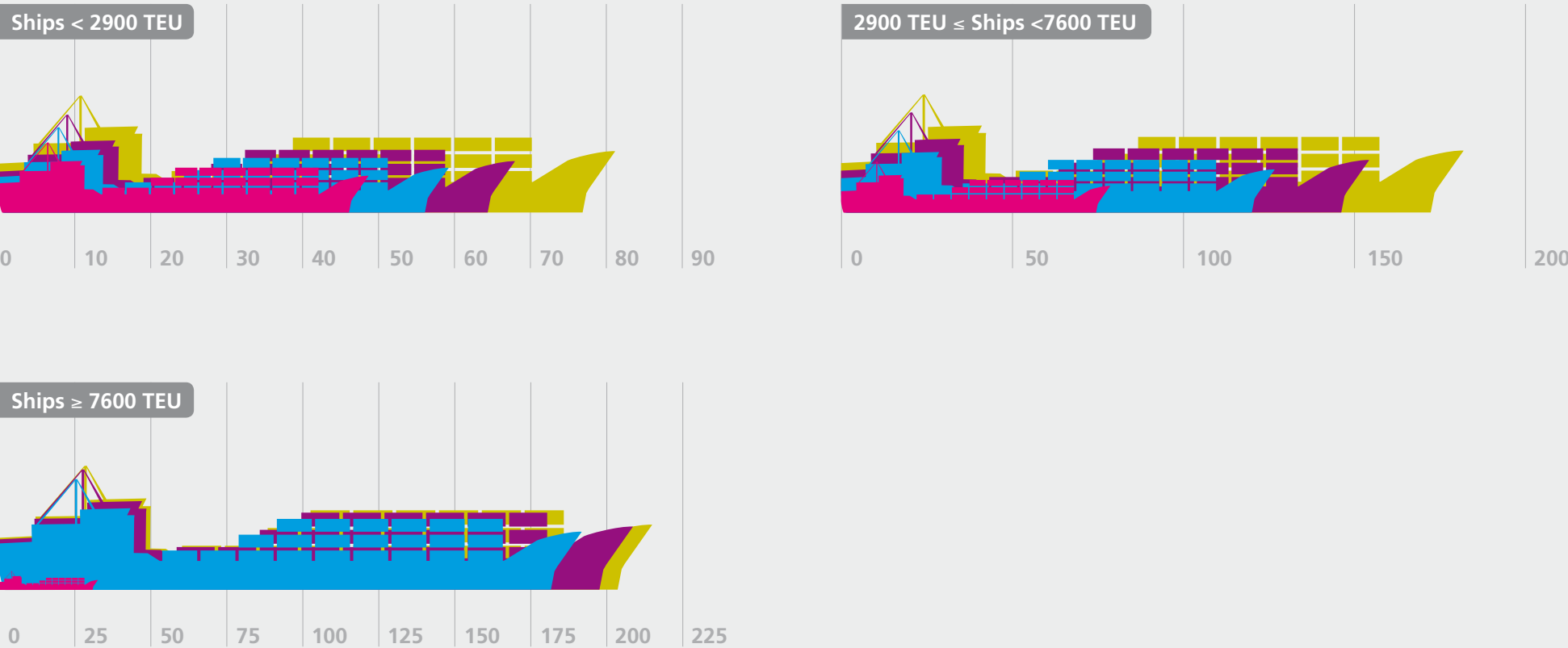


Containership fleet

The total tonnage of larger containerships will increase faster than smaller ones. (Ships larger than 7,600 TEU to grow 6-6.5 times compared to ships smaller than 7,600 which are to grow 1.4-2 times for the next 20 years)

Fig. 66 Containership fleet size (million GT)
Source: MSI / LR

2010 2030 - Competing Nations Status Quo Global Commons



Fleet ownership

24% China's fleet ownership in 2030

Major fleet ownership

China will see the largest growth in fleet ownership above all regions, growing from 15% in 2010 to 19-24% in 2030, rivalling Greece and the rest of the European countries. Japan, with a large fleet ownership share today, will shrink from 12% in 2010 to 5.6%-6.7% in 2030.

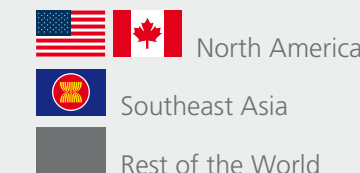
With increasing dependence on international shipping trade in the future, China, Southeast Asia and South Asia will seek to expand their interest in fleet ownership in the Competing Nations Scenario. The traditional large countries such as Greece and other European countries will see their share of the commercial fleet reduced.

Under the Global Commons scenario, Europe will remain a larger influence in the global commercial fleet. This is a world of less protectionism, other smaller countries with ambitions in fleet ownership will find the market easier to penetrate.

Fig. 67 **Major fleet ownership**

Source: MSI / LR

2010



2030

Competing Nations

Status Quo

Global Commons

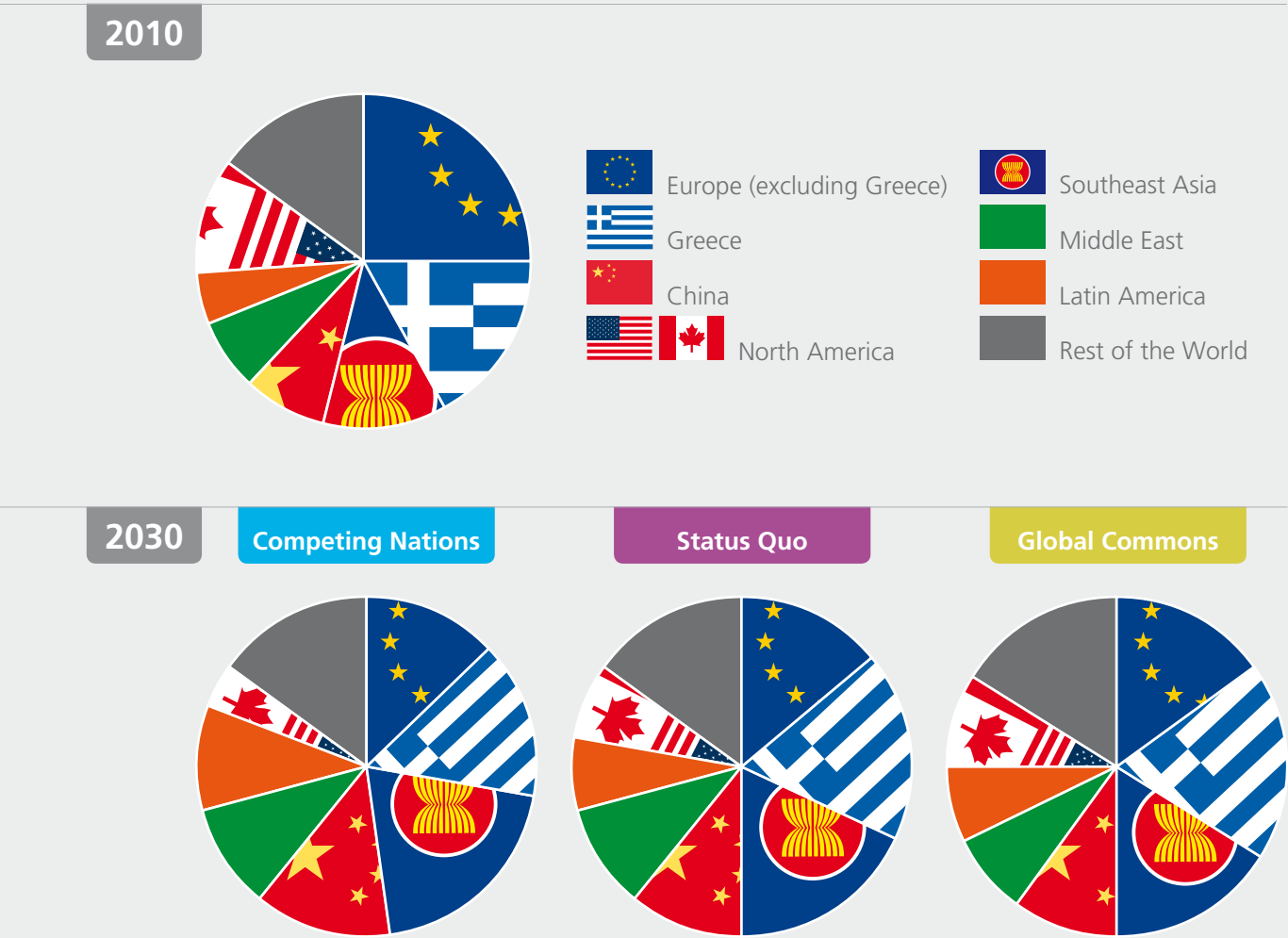


Tanker ownership

Europe’s tanker share will decrease from 41% in 2010 to 27%-34% in 2030. Southeast Asia’s share will grow from 11% in 2010 to 16%-19% in 2030. China’s share will grow from 7.6% in 2010 to 10%-13% in 2030.

Similar to the trend in the world’s fleet, traditional European countries will retain a larger share of the tanker fleet ownership in the Global Commons scenario, and own a smaller share in the Competing Nations scenario.

Fig. 68 Tanker ownership
Source: MSI / LR

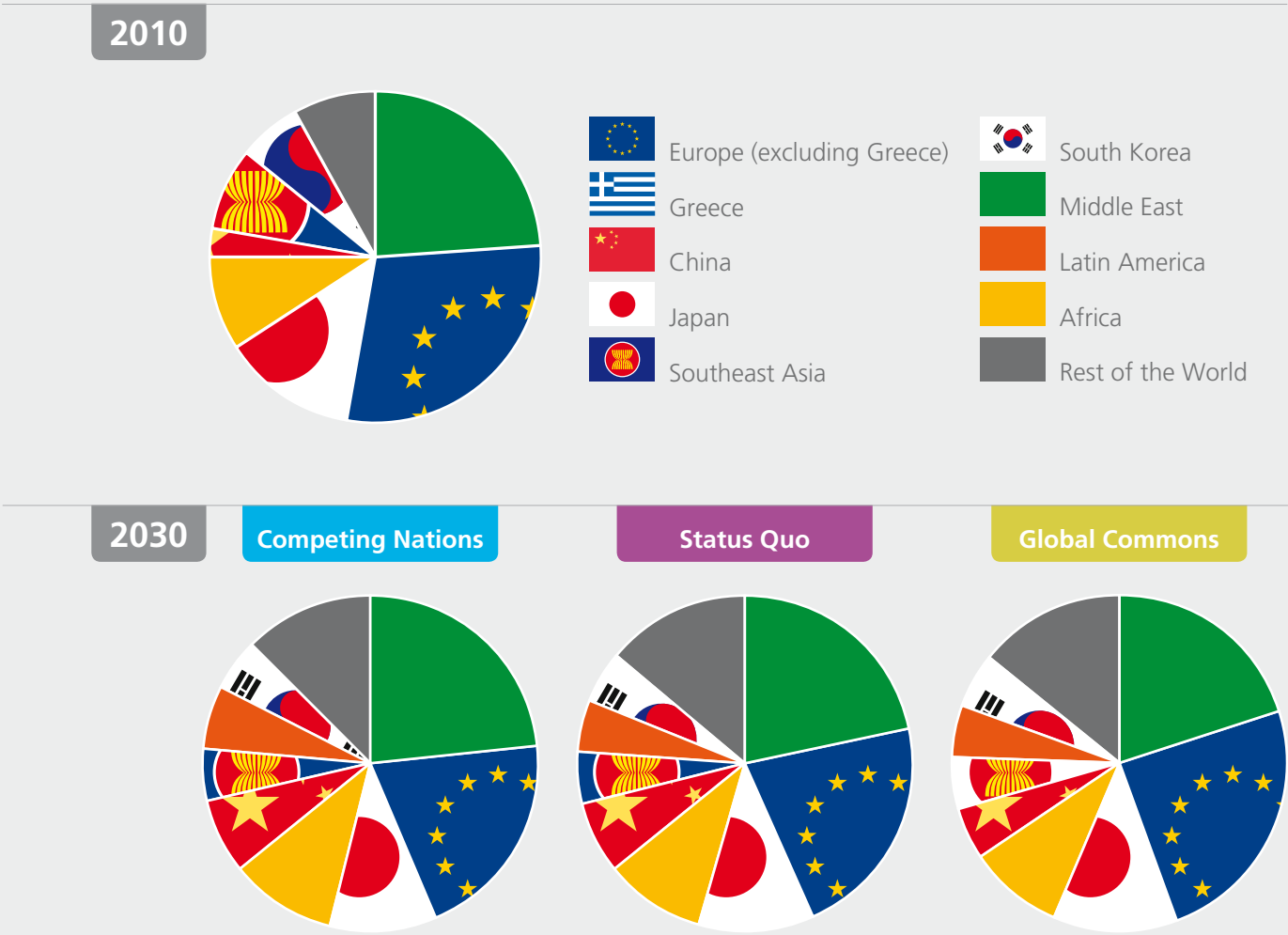


LNG Carrier ownership

LNG carrier ownership will still be mainly controlled by the Middle East, Europe, and Japan in 2030. However, their dominance will be challenged by the rise of Africa and China. Western Europe’s LNG carrier share will decrease from 29% to 21%-23% in 2030.

The difference between three 2030 scenarios is small across all regions except for China. With the help from the government plan, China may enjoy a larger share of LNG carrier fleet ownership in the Competing Nations scenario and a smaller interest in the market in the Global Commons scenario.

Fig. 69 LNG Carrier ownership
Source: MSI / LR



Bulk Carrier ownership

The largest increase in bulk carrier ownership will come from China. China's share will grow from 22% in 2010 to 26%-31% in 2030.

Europe's bulk carrier share will drop from 16% in 2010 to 12%-15% in 2030. Japan, currently another large player in the bulk carrier market, will reduce its ownership from 12% in 2010 to 5.6-6.7% in 2030.

China, Southeast Asia, and South Asia will own a larger share of the total fleet in the Competing Nations scenario. In the Global Commons scenario, Greece and other European countries will retain a larger portion of the market.

Fig. 70 Bulk Carrier ownership
Source: MSI / LR

2010



2030

Competing Nations

Status Quo

Global Commons



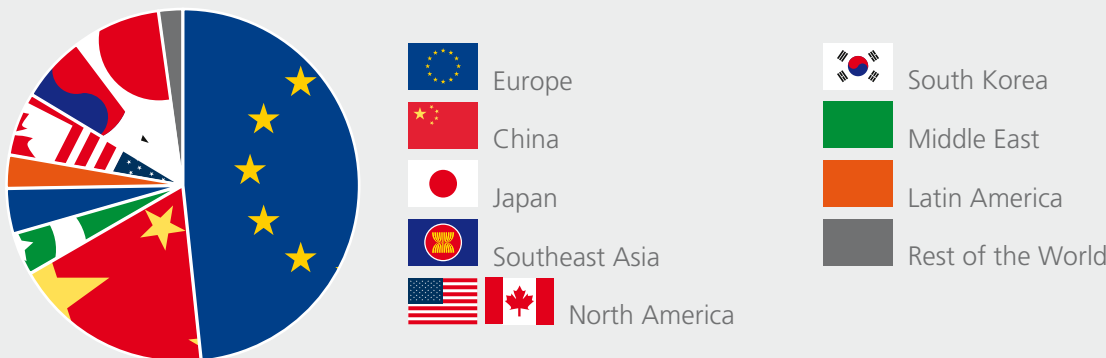
Containership ownership

Europe's containership share will drop from 48% in 2010 to 29.5%-35.6% in 2030. North America's containership share will drop from 5.6% in 2010 to 3.7%-4.7% in 2030.

China's containership share will rise from 18.3% in 2010 to 20.5%-27.2% in 2030. The Middle East's share will also rise from 4.3% in 2010 to 8.9%-10.9% in 2030. Similar trends will take place in Southeast Asia and Latin America.

Fig. 71 Containership ownership
Source: MSI / LR

2010



2030

Competing Nations

Status Quo

Global Commons



Shipbuilding

Shipbuilding market

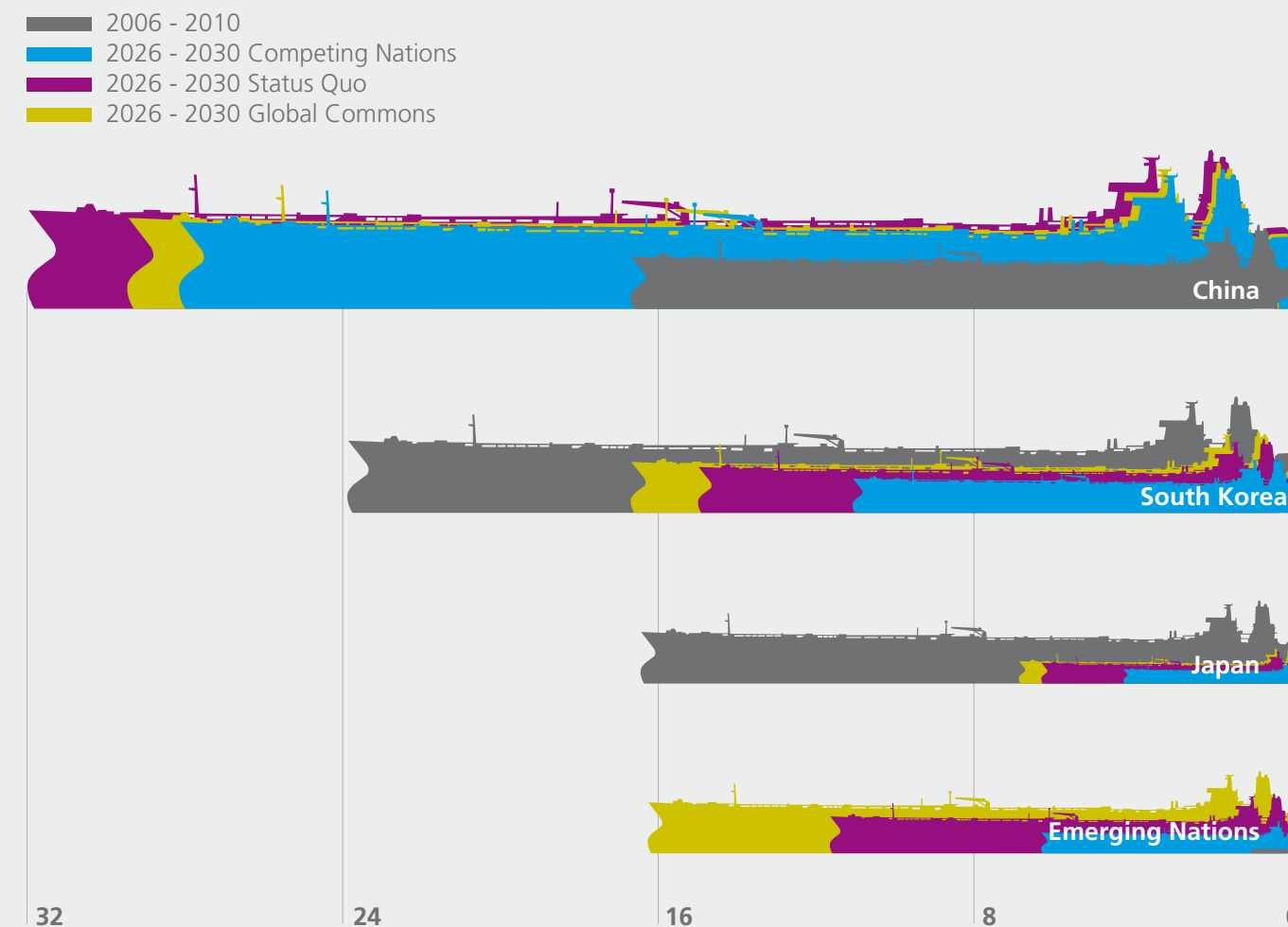
Bulk Carrier, Tanker, LNG, containership

The total deliveries will remain at the current level in 2030. China and emerging countries will determine the ship newbuilding market landscape after 20 years.

Japan and South Korea, however, will lose their market share. South Korea's market share will fall from 34% (in 2010) to around 22% (in 2030). Japan's share will fall from 21% to 9-10%.

Fig. 72 Bulk Carrier, Tanker, LNG, Containership (million GT)

Source: MSI / LR



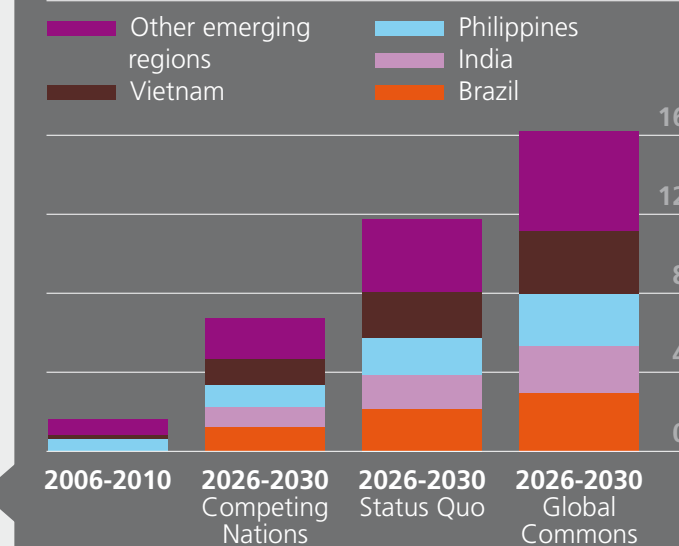
Emerging countries

The total deliveries from the emerging countries will increase. Vietnam, Brazil, India, and Philippines will be the potential leaders.

Brazil and India will see the largest percentage increase, while Vietnam will gain the largest volume. However, their individual deliveries will remain significantly smaller than those from China or South Korea in 2030.

Fig. 73 Emerging countries newbuilding delivery (million GT)

Source: MSI / LR



Shipbuilding market Tanker

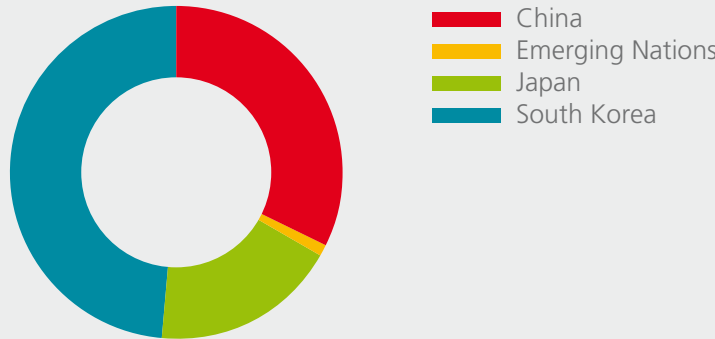
Tanker is the only ship type that we anticipate a decreasing delivery for the next 20 years. Newbuildings will be dominated by China (44-55%), South Korea (25-27%), and emerging countries (8-20%) in 2030.

There will be a large increase in China and emerging nations' tanker deliveries. Due to the open cooperation mentality, emerging nations will gain the largest market share in the Global Commons scenario.

Fig. 74 Tanker market share of total shipbuilding deliveries (%)

Source: MSI / LR

2010



2030

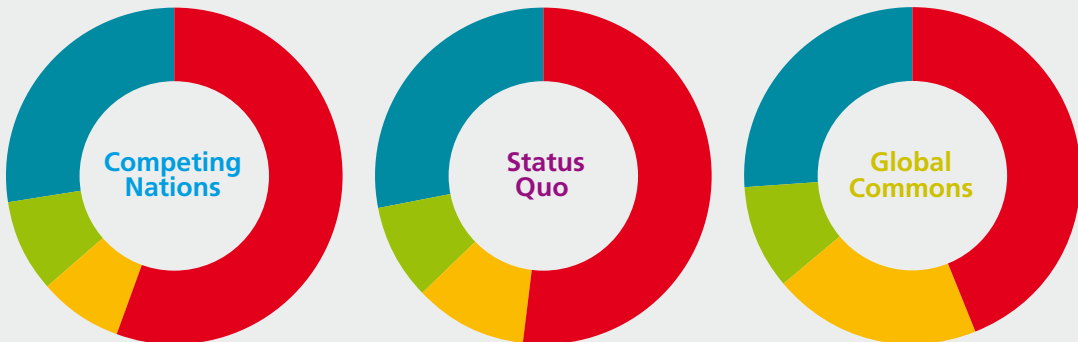


Fig. 75 Tanker newbuilding deliveries (million GT)

Source: MSI / LR



Shipbuilding market LNG Carrier

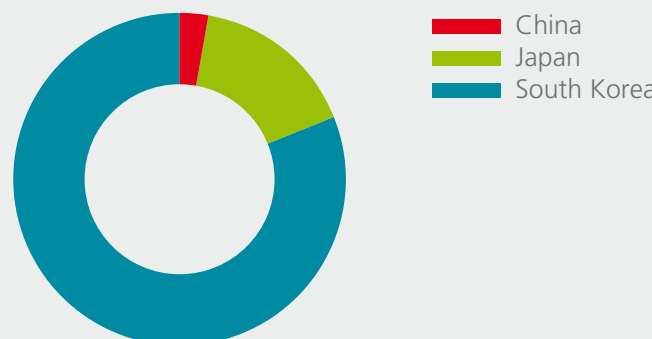
Total LNG Carrier deliveries will rise by 2030. South Korea will gradually lose her total dominance in LNG carrier newbuildings by 2030. China's market share (41-51%) in LNG newbuildings will be on par with South Korea's (43-53%) by 2030.

The Chinese government's stronger interest to support the LNG carrier newbuildings will lead to a larger market share in the newbuilds in the Competing Nations scenario.

Fig. 76 LNG Carrier market share of total shipbuilding deliveries (%)

Source: MSI / LR

2010



2030

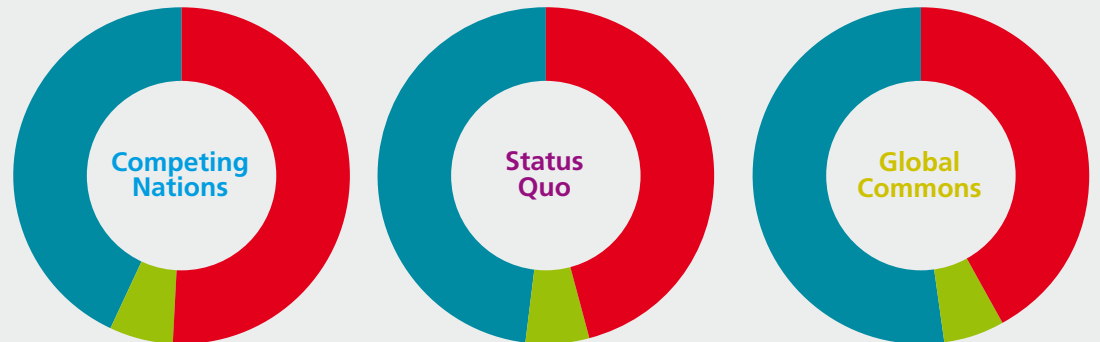


Fig. 77 LNG Carrier newbuilding deliveries (million GT)

Source: MSI / LR



Shipbuilding market Containership

The total deliveries of containership will be increased in 2030. The containership shipbuilding market will be dominated by China (39-48%) and South Korea (40-44%).

China's share will continue to rise, while South Korea and Japan's share will wane.

Fig. 78 Containership market share of total shipbuilding deliveries (%)

Source: MSI / LR

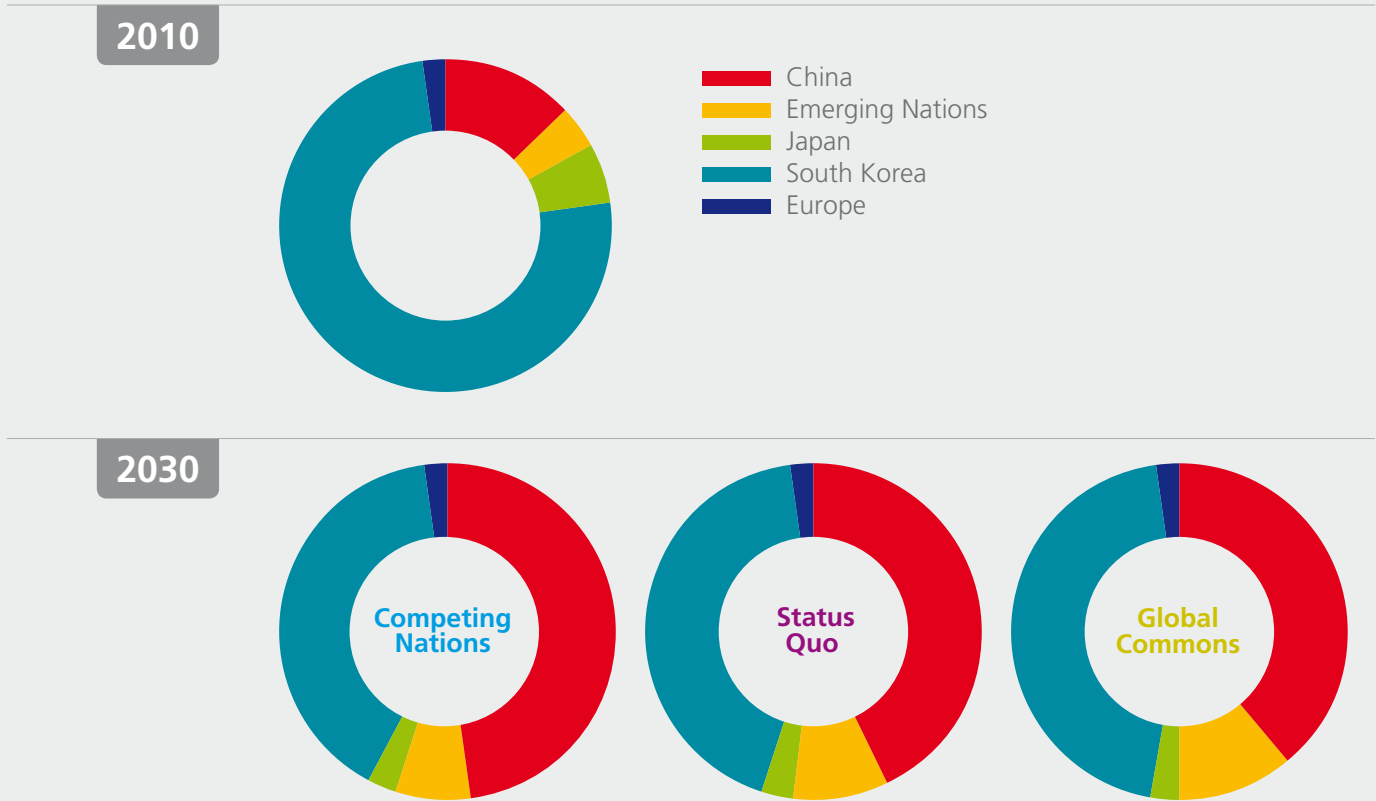


Fig. 79 Containership newbuilding deliveries (million GT)

Source: MSI / LR



Shipbuilding market Bulk Carrier

The total bulk carrier deliveries will have increased for the next two decades. Newbuildings in bulk carrier will be dominated by China (40-59%) and emerging countries (26-43%) in 2030.

Similar to other ship types, China will have a larger market share in bulk carrier shipbuilding in the Competing Nations scenario, while emerging nations will gain a significant share in the Global Commons scenario.

Fig. 80 Bulk Carrier market share of total shipbuilding deliveries (%)

Source: MSI / LR

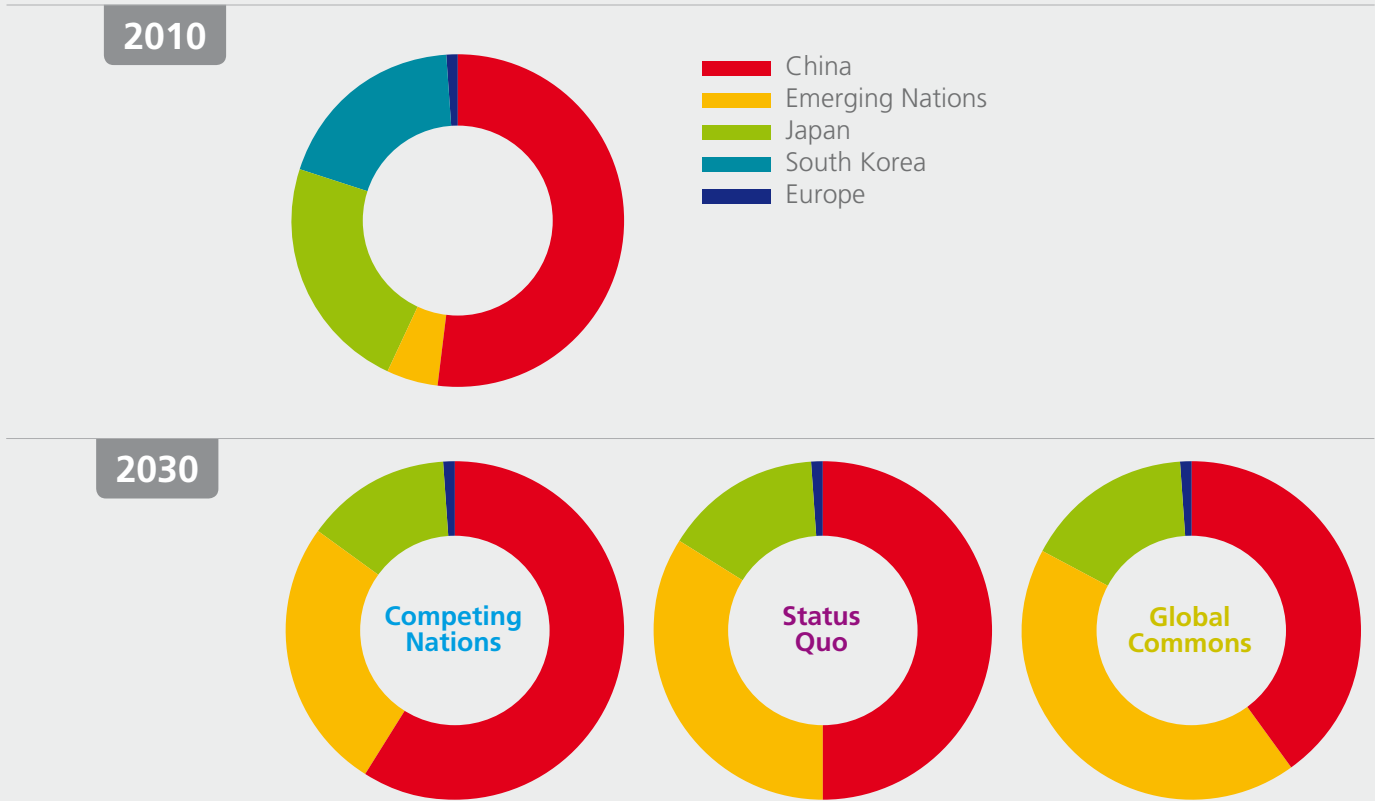
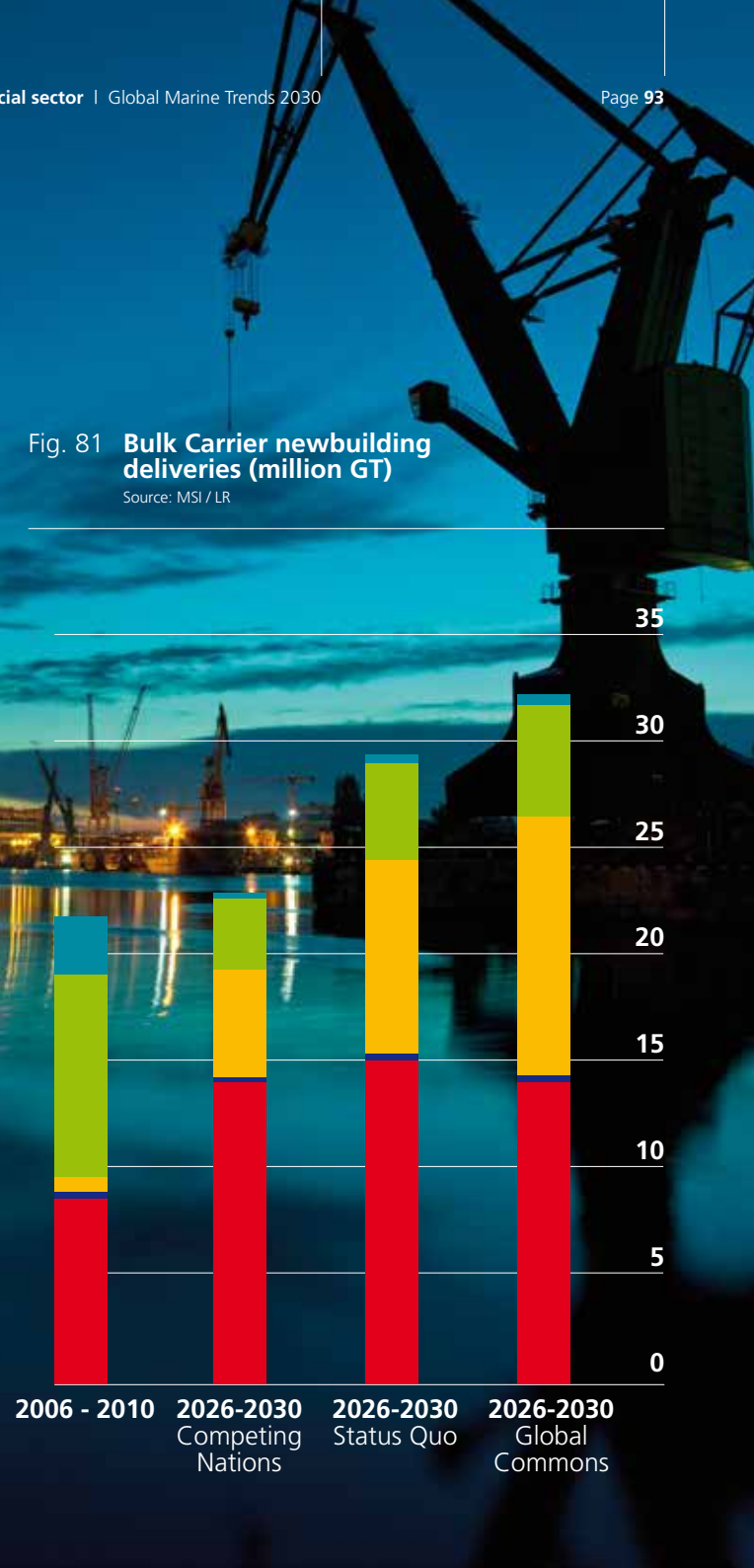


Fig. 81 Bulk Carrier newbuilding deliveries (million GT)

Source: MSI / LR



Naval sector

Foreword



Unpredictable, unimaginable: Naval probably seems like the least certain of the maritime sectors, dominated by surprise, secrecy, and political change – all of which can have dramatic effects. However, the underlying trend of increasing economic growth is closely tied to growing naval capability, and the surprises appear in how that capability is exercised as power.

Much of our time at QinetiQ is occupied with considering possible naval futures, and we constantly seek better ways to help our clients prepare for them. Our work to support Naval clients at a more strategic level is less known than our technical support, so we were delighted when Lloyds Register asked us to contribute.

Strategic thinking is an essential component of Naval capability. Planning, for the naval wars no-one wishes to fight, requires as much forethought as real warfare. Understanding possible futures, and how to shape them, helps to win the battles that may have to be fought around the world. However, this knowledge also helps to win battles at home about defence budgets. Naval platforms have an operational lifespan of 25 years or more, so as we design now, we must be thinking about Operational Concepts for 2020, 2030 and beyond. Accurate thinking about expected operations will have a substantial impact on the through-life cost of the platform.

Our findings support others with respect to the potential for conflict in the future. In the three scenarios we considered, the potential is clearly higher if humanity fails to develop co-operatively. We expect that growing levels of education and knowledge sharing will tend to increase peace and diminish conflict. However, navies are deployed where (and when) this fails, and we see continuing potential for such failures to occur, in locations with maritime interests.

Naval power is broad ranging, and notoriously complex to define. We have used a simple definition for our Naval Power Index (NPI). For each nation, the index is the product of the number of platforms in a given type, a representative complement, and the primary weapon's range, warhead mass and numbers. Although a large portion of the cost of modern platforms is in the massively complex command and control systems, these are difficult to represent numerically with any consistency. They are also not required to achieve correlation with the economic dimension. The Naval Power Index is more than 97% correlated with GDP.

Our new understanding of the close relationship between naval power and GDP has enabled us to objectively link the economic driver with subjective issues like politics and demographics to suggest the scale of naval powers in 2030. We aimed to make this document stimulating and creative, so we look forward to your reaction to it.

Sarah Kenny
Managing Director
QinetiQ Maritime

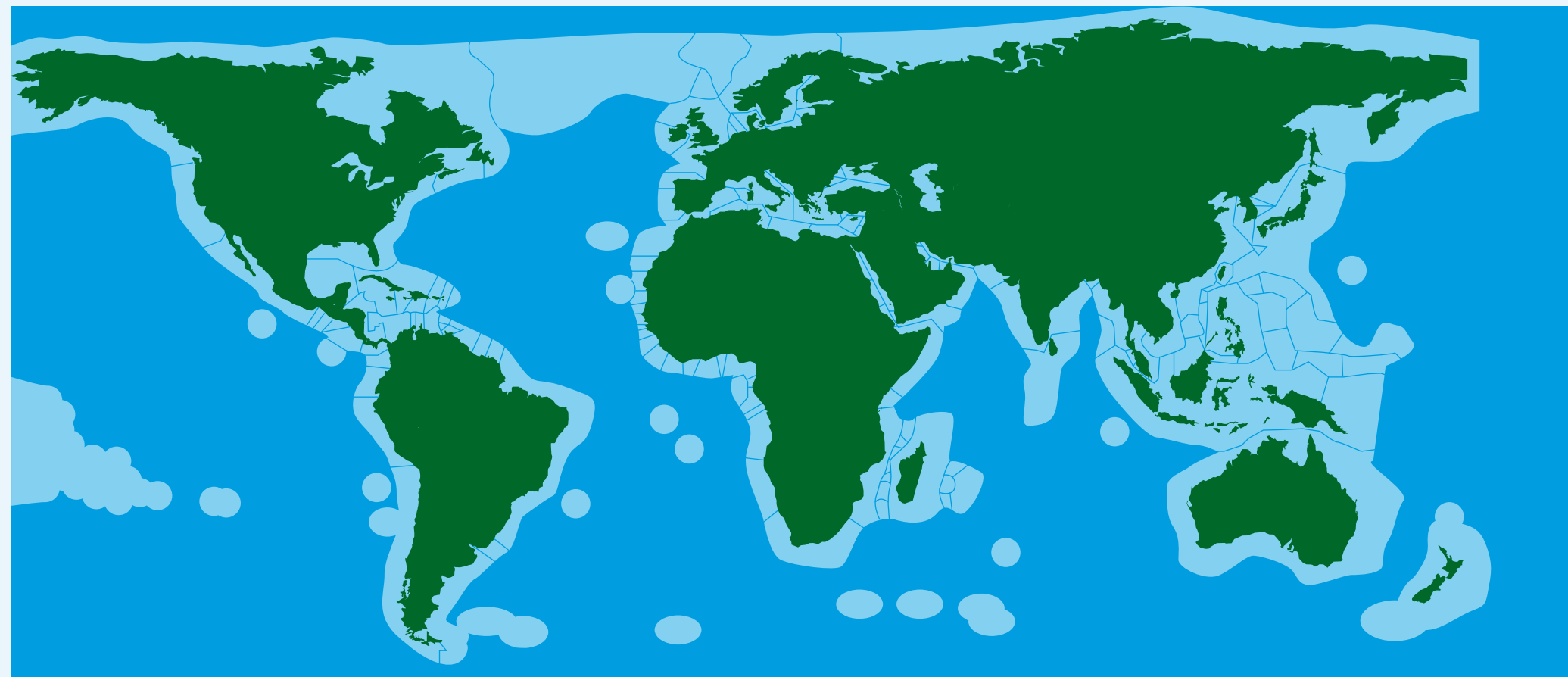
Planning for naval wars requires as much forethought as real warfare



Scenario and global driver impacts on the Naval sector

Fig. 82 Major International boundaries and Exclusive Economic Zones at sea

Source: www.vliz.be/vmdcdata/marbound



“The potential for conflict is growing”
(British Maritime Doctrine 2011)

Politics –the process by which groups of people make collective decisions - plays the most significant part in driving the naval sector. Politics can create conditions for significantly greater or lesser development in military forces. The political dimension is accommodated by our three scenarios (Global Commons, Status Quo and Competing Nations).

This political power is illustrated by the UN convention on the Law of the Sea (UNCLOS), which offers all nations the freedom of the seas. UNCLOS has been ratified by most

maritime nations, the USA being the most notable exception. The boundaries are shown in the figure below.

Demographics and environment play a smaller role in naval sector change - affecting recruitment, and the design or operation of naval platforms.

The economy has the largest measurable impact on the naval sector and we’ve used this to characterise our understanding of the naval sector in 2030.

Politics at world, regional and national levels will play the most significant role

Recent evolution of ships and systems

Recent development of national naval systems has been most significant in information technology, rather than personnel or platforms & mechanical systems. The twentieth century naval adoption of technology from mechanical to electro-mechanical to electronic systems continues. Navies are increasingly complex, and integrated, military information networks, with the potential for self repair and autonomy. The need to put personnel in harms way, especially for naval warfare which is so technology-centric, is decreasing.

Shrinking fleets

The number of platforms have been falling among Western naval fleets, but increasing in the East.

Does the fall in platform numbers mean Western navies are less powerful?

Fig. 83 Shrinking fleets in the West (USA, Russia, UK, European, Brazil, Canada)

Source: QinetiQ Note: Complex platforms - Aircraft carriers, Major warships, submarines.

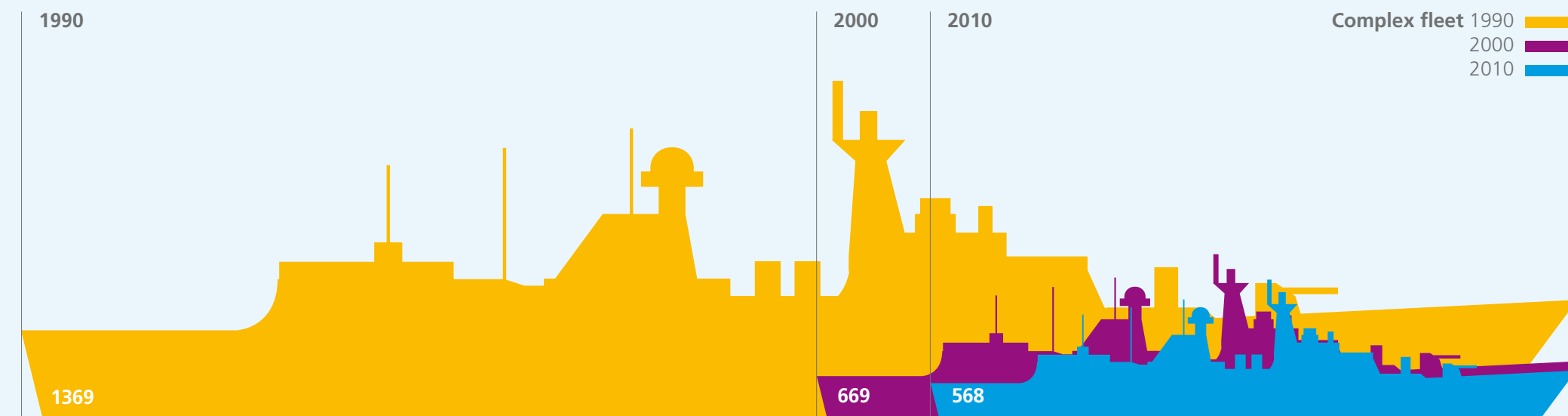
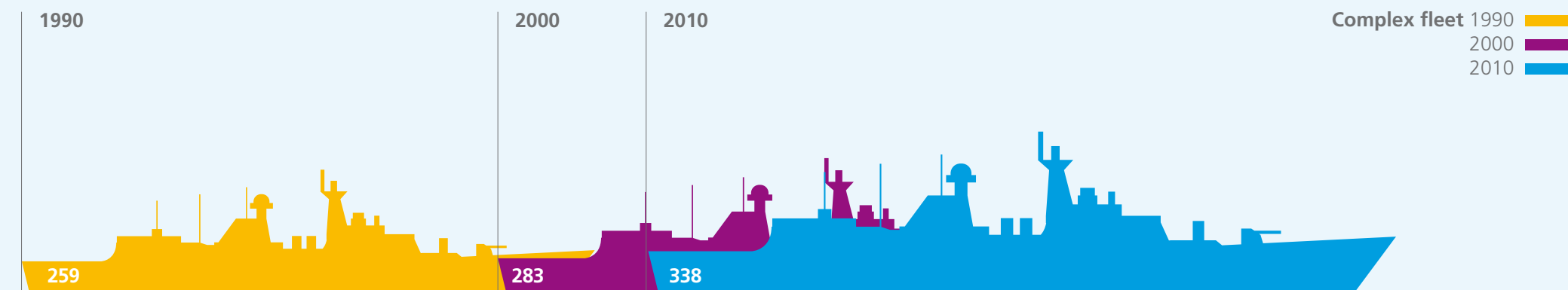


Fig. 84 Growing fleets in the East (China, Republic of Korea, Japan, Singapore, Malaysia, Thailand, Vietnam)

Source: QinetiQ Note: Complex platforms - Aircraft carriers, Major warships, submarines.



Evolution of Naval power

To understand the relationship between naval power and the drivers for change, we need to consider the complete costs for navies.

Navies' Systems, Platforms and Manpower are mainly affected by a country's ability to pay (economic driver) and its willingness (political driver).

Our Naval Power Index (NPI) captures the number of platforms, representative crew size, and representative system capability. It is a simplified measure of naval capability, but closely correlated to national GDP.

Fig. 85 Ratio of Naval Power Index growth to GDP
Growth is constant around 6% over 40 years for key navies
Source: QinetiQ Note: key navies - US, Russia, Japan, China, UK, India

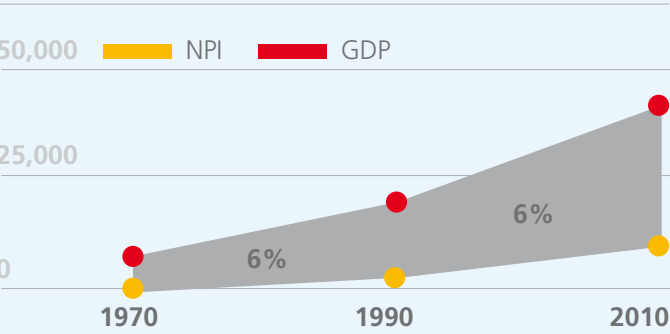
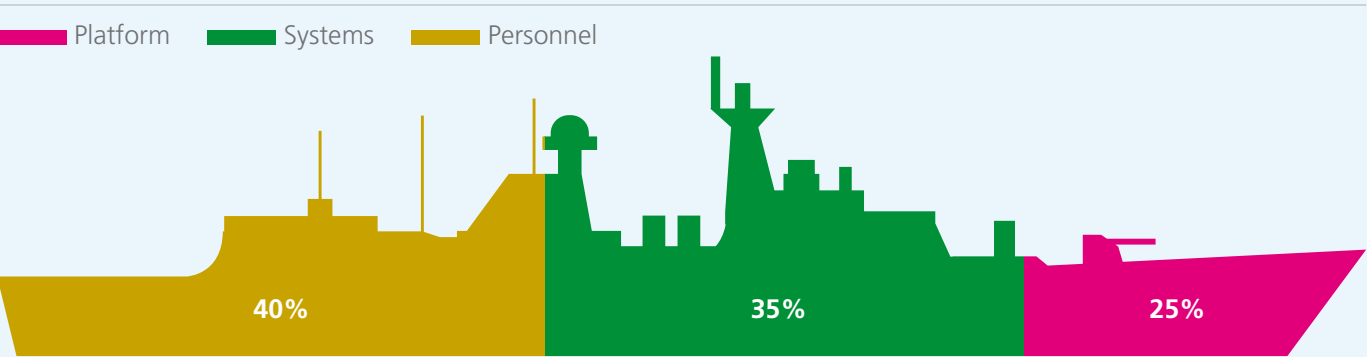


Fig. 86 Relative life-cycle costs of navies
Source: QinetiQ



Marine security status

National and international efforts to control lawbreakers exploiting the freedom of the seas require the cooperation of navies. It includes control of smuggling and illegal immigration, response to natural disasters (especially for island nations), and preventing theft and kidnapping.

Maritime security issues stem from a combination of coastal access to the seas, and relative local weaknesses in policing and economics. Conflict and low levels of economic development are linked.

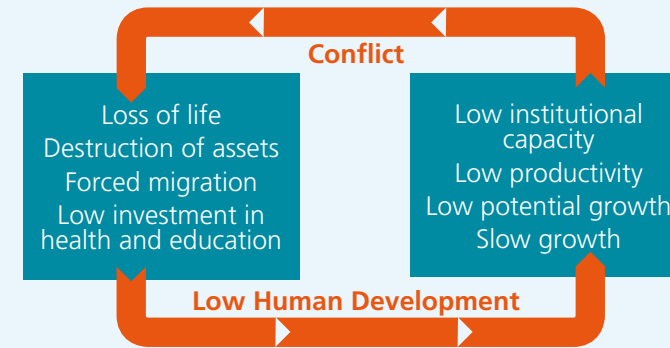
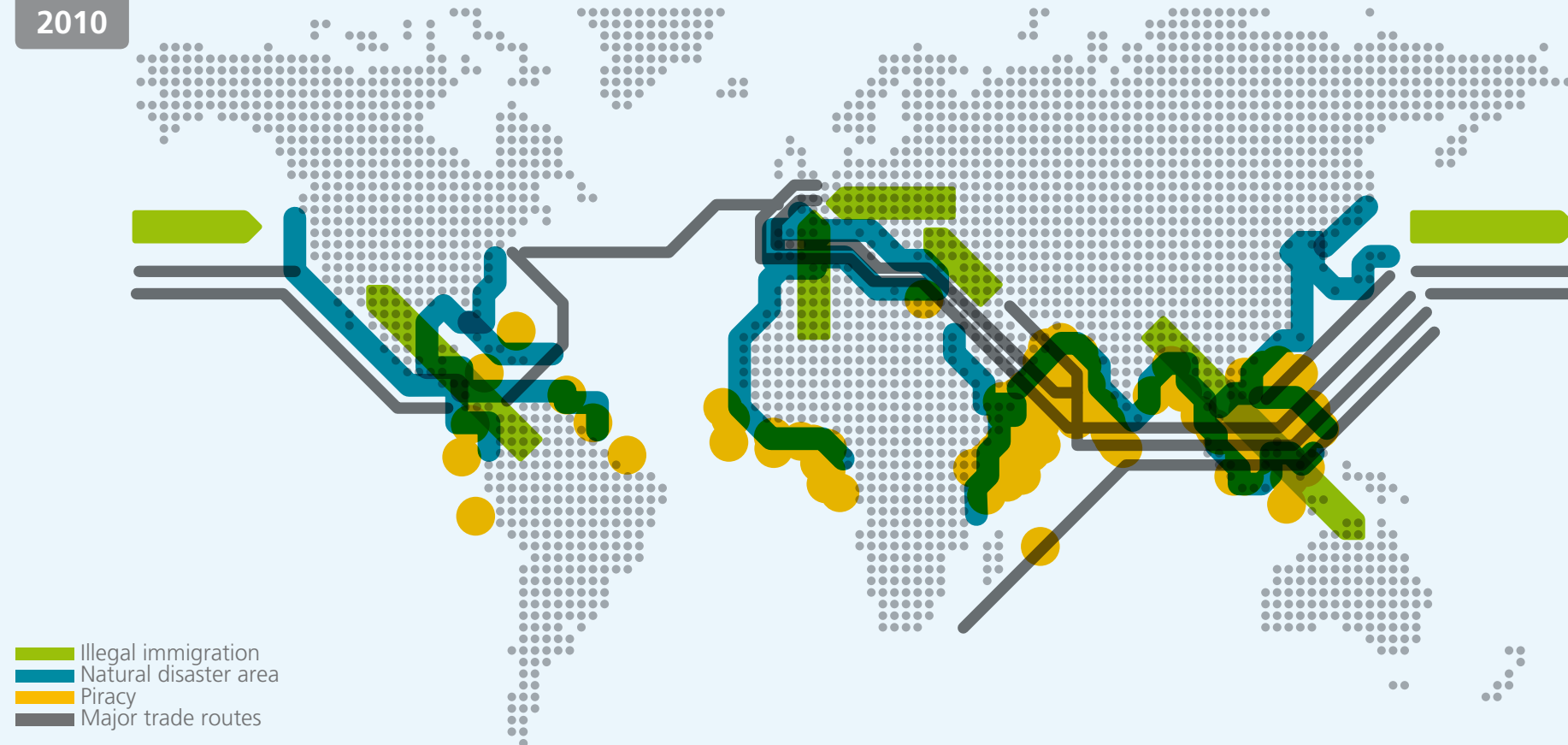


Fig. 87 Maritime security

Source: IMB / QinetiQ

2010



■ Illegal immigration
 ■ Natural disaster area
 ■ Piracy
 ■ Major trade routes

In all scenarios, environmental security will be a greater concern. Two scenarios may tend to reduce piracy: many economic actors in the “pinch point” regions of international maritime trade routes (eg Gulf of Aden, Malacca Straits) will have a better standard of living. As a percentage of the population, the young will have reduced in the Middle East, although not in Sub-Saharan Africa.

Global Commons

Cooperation is likely to significantly increase security. Higher GDP growth will have an even more positive effect on poorer societies.

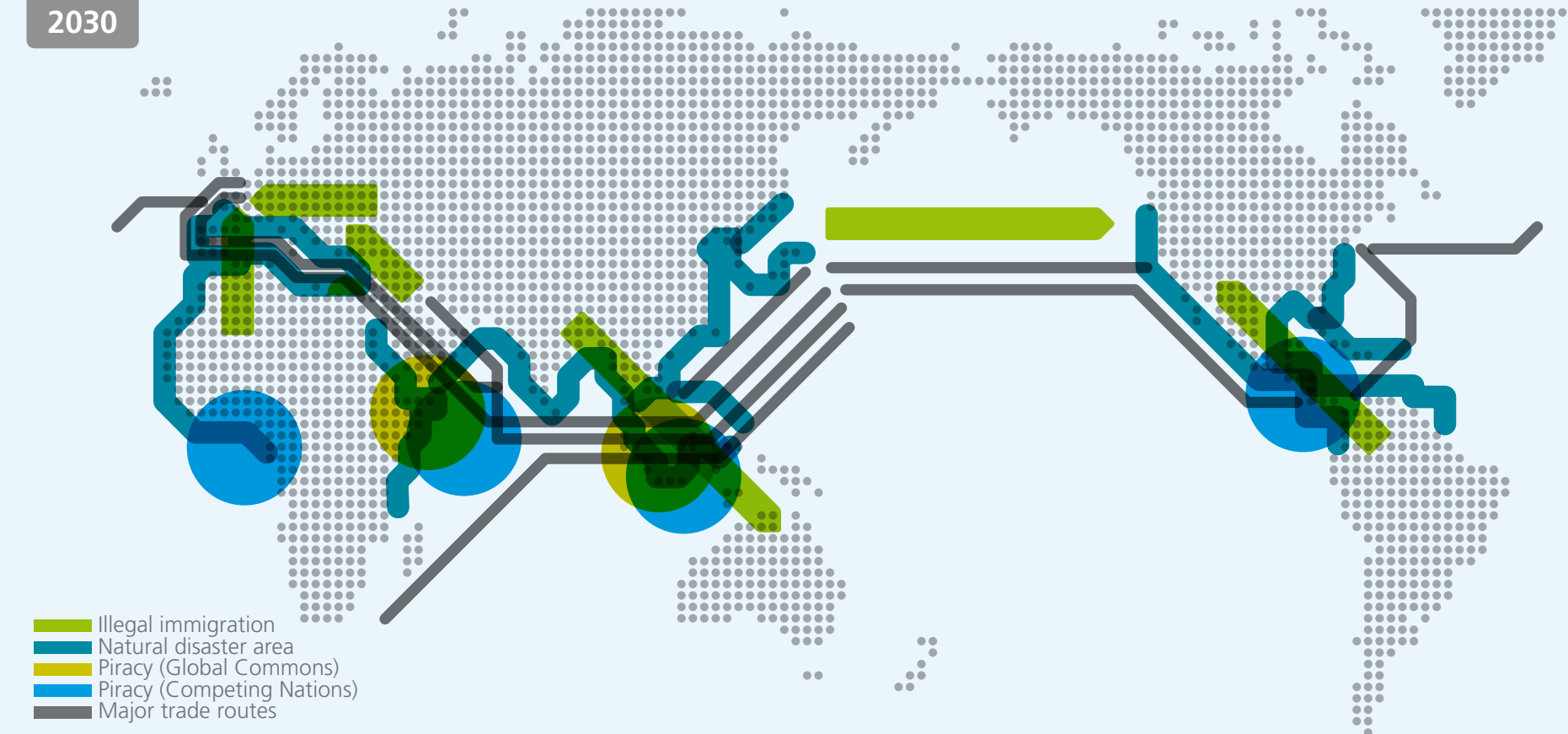
Competing Nations

Ineffective Governments will persist, so a second generation, which has grown up with piracy as the main source of income, may persist with piracy. Constabulary and coastal patrol duties will continue in these regions. Significant littoral and riverine naval efforts will be directed at coastal region unrest and at environmental catastrophe mitigation.

Fig. 88 Maritime security

Source: IMB / QinetiQ

2030



■ Illegal immigration
 ■ Natural disaster area
 ■ Piracy (Global Commons)
 ■ Piracy (Competing Nations)
 ■ Major trade routes

2010 US Navy power dominates the global seas

Physical protection of territorial integrity is the irreducible minimum requirement for a navy.

The difference between the US Navy's power and the next most powerful navy is colossal. Although challengers are appearing on the horizon, the lead in scale and technology is substantial.

Modern navies provide force projection, for deterrence, airspace control, land attack and humanitarian action. They are not frequently used for direct engagement at sea.

Fig. 89 Naval Power Index, 2010

Source: QinetiQ

USA	3,870
China	20
Russia	17
Japan	3
UK	1

2030 Naval Power

Competing Nations

This scenario suggests a world in which international political climates heat up, and tempers may flare. With GDP growth at a slower pace, we would expect higher rates of conflict in some areas, and probably higher rates of defence expenditure as a percentage of GDP. GDP growth will be slower.

Status Quo

This scenario suggests a significant increase in GDP for most countries - aligned to economic growth - and we expect larger navies to result. In particular, it would suggest that the USA will retain global maritime dominance. Any country considering a challenge would require a massive change in its ability to generate GDP, or in its willingness to commit a higher percentage of GDP to naval expenditure, relative to the USA.

Global Commons

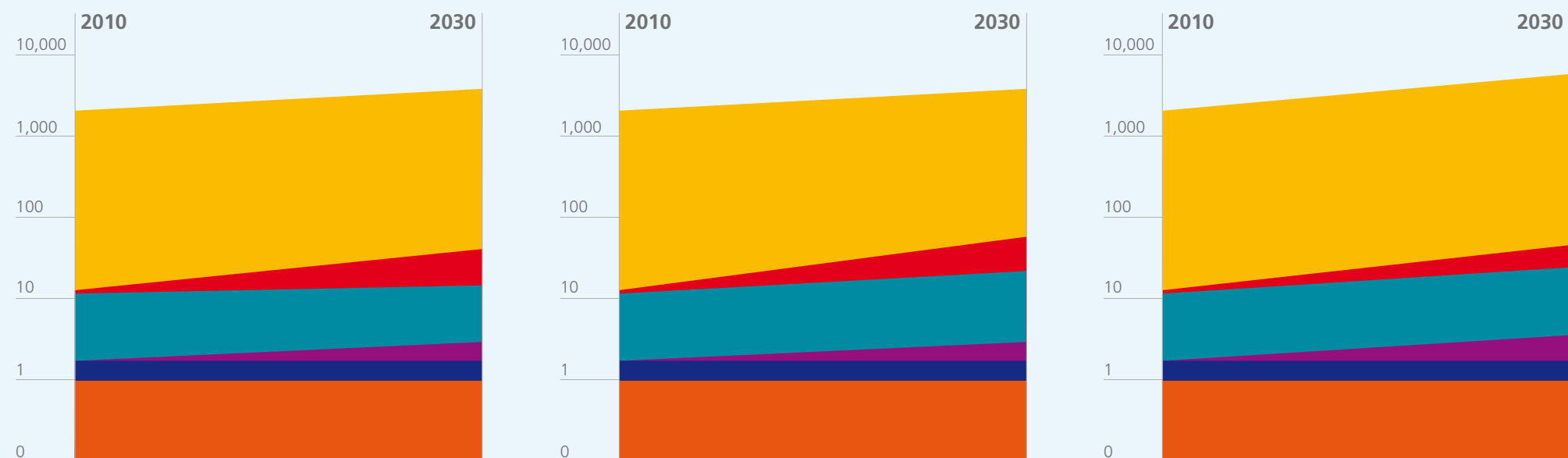
If the world develops more in line with the Global Commons scenario, we can expect even greater GDP growth, but relatively less tension and lower relative spend on defence. These effects act against each other, resulting in an actual increase in naval firepower over the relatively short timeframe of 2030.

US The US Navy is still the dominant force

Fig. 90 Naval Power Index 2030 (in log scale)

Source: QinetiQ

USA China Russia Japan India UK



Naval power doubles for the top navies

x2

The big picture suggests growing naval capability and power in leading nations, with modest variability relating to scenario variations.

Within this big picture is hidden the key naval power factors: platforms, weapons and manpower. We can separate them out to show which are likely to change. This suggests that in 2030, navies will be maintaining and refreshing numbers of platforms and personnel, rather than expanding them.

They will also develop significantly more powerful weapons for Naval platforms. We do not make any prediction of speed or size of platforms, which are likely to depend on technological advances and availability of resources. This escalation in naval capability suggests that there are growth opportunities for the naval sector. Closer examination of the development suggests that it will be armament capability rather than platforms or people, which will grow. Navies will build on current strengths.

Fig. 91 Significantly more powerful systems (%)

Source: QinetiQ Note: key navies - US, Russia, Japan, China, UK, India

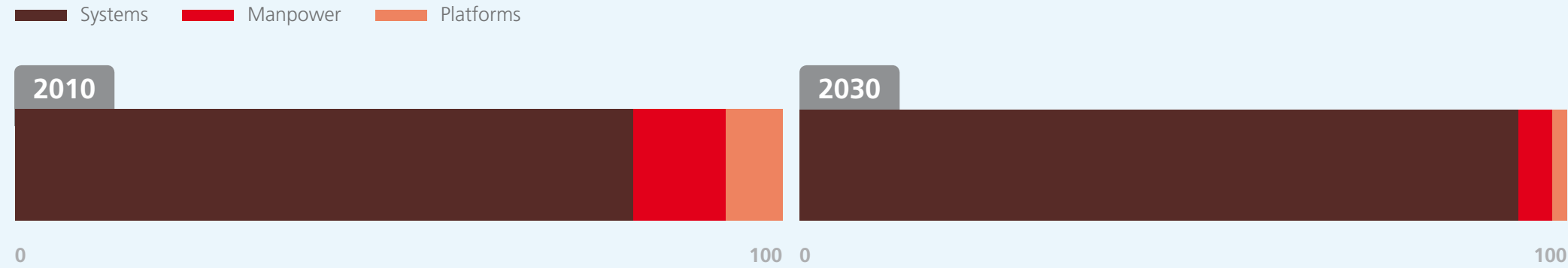


Fig. 92 Fleet size falling for key navies

Source: QinetiQ Note: key navies - US, Russia, Japan, China, UK, India



2010 Naval ship and system exporters

Most coastal nations see strategic significance in the ability to build and operate warships. Some nations can afford to operate a navy that they can't afford to develop, design and build. So there is a lively international market in the export of naval platforms, systems and even support services.

Fig. 93 Naval ship and system exporters

Source: SIPRI (selected deliveries or orders for ships 2009 - 2011) / QinetiQ



We anticipate growing GDP in most countries, and that suggests a continuing increase in naval forces in all scenarios.

The question will then be about which nations have a need to project maritime power. The most significant areas of naval

interest in 2030 will remain the defence of states (including maritime economic zones and stand-off deterrence) and protection of trade routes. States with strong or growing power bases, or major international sea trades, are likely to be important players

Fig. 94 **Zones of tension**
Source: QinetiQ



Fig. 95 **Zones of tension**
Source: QinetiQ



2030 Future naval systems

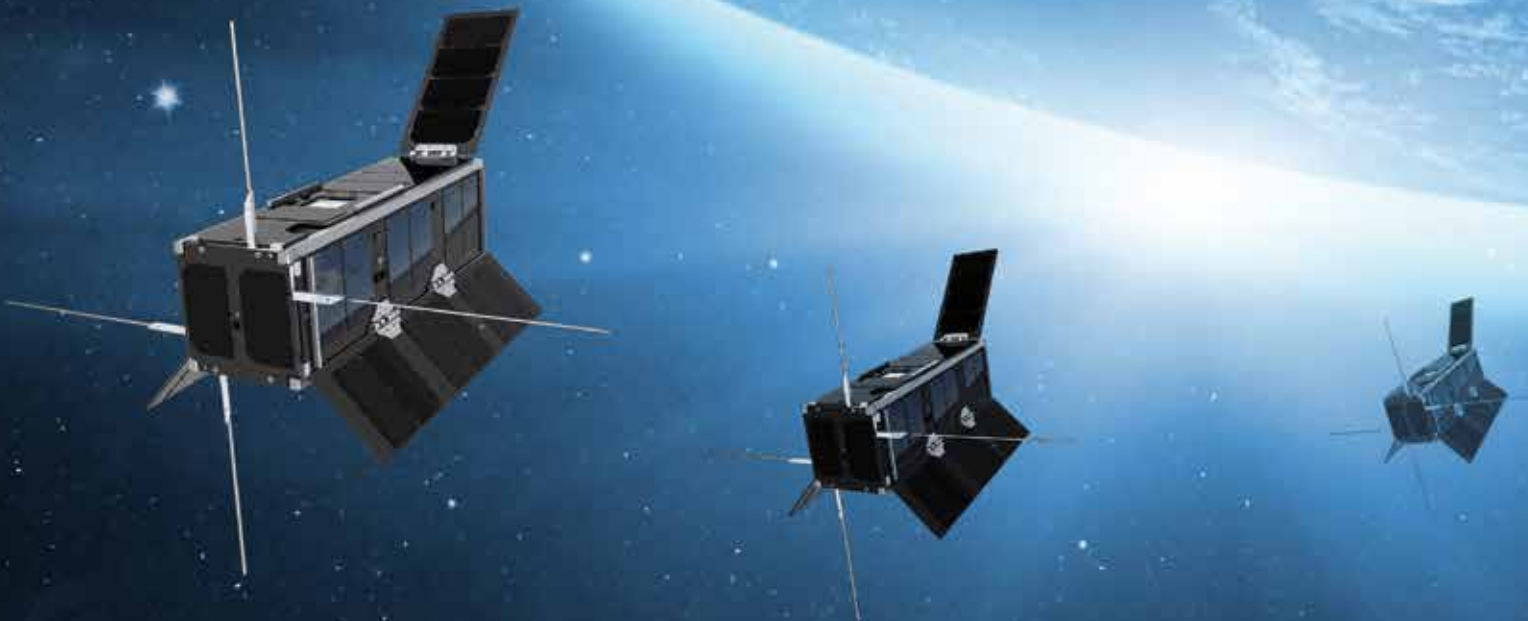
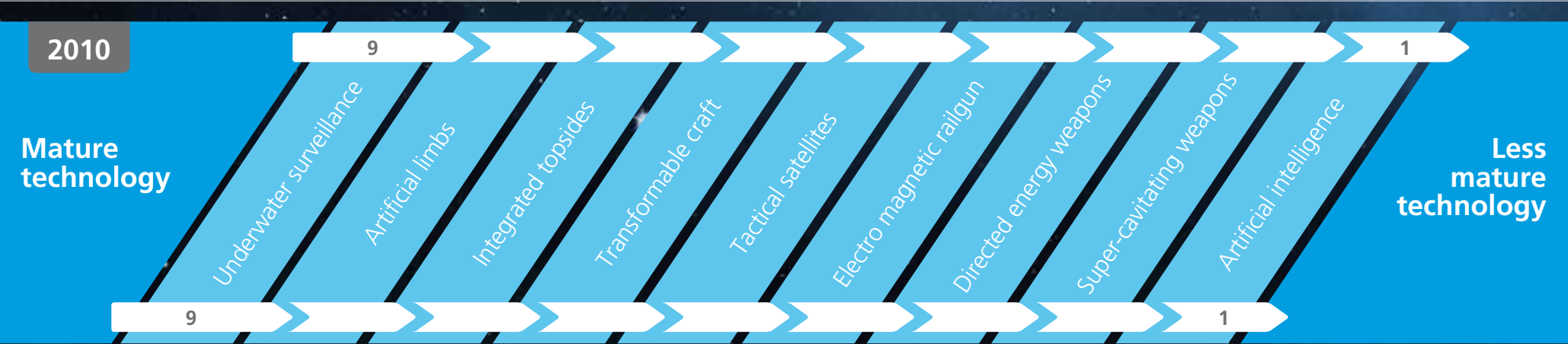


Fig. 96 Technology readiness level 2010
Source: QinetiQ



Information, communication and weapons systems will be substantially more capable in 2030. Remote operation will have increased, and cyberspace will be the new battleground. Artificial intelligence will support, or deliver, naval capability. Governance of automated systems will be a key issue.

Directed energy weapons will have matured. Autonomous, self-fixing systems and multiple low cost systems will enhance overall reliability.



Fig. 97 Technology readiness level 2030
Source: QinetiQ



Offshore energy sector

Foreword



diverse and sustainable sources including renewables in a manner that is safe, secure and affordable.

Advances in technology - underpinned by innovation, research and development - will be a key to meet the growing demand from diverse energy sources. This demand will also need to be tempered through efficiency and energy saving technologies.

This chapter describes the global supply and demand trends in oil and natural gas which is expected to address around 60% of the global demand in 2030. The offshore wind and marine renewable energy supply trends are also illustrated. A forecast is made for the number of offshore platforms and renewable energy devices required to meet the energy demand in different parts of the world which also indicates the growing challenges and opportunities to produce offshore oil and gas, and offshore renewable energy.

The University of Strathclyde - as a leading international technological university - together with a consortium of industrial, public, private and academic institutions, has been directly involved in the attraction and establishment

As the population grows to nearly 8 billion, economic output more than doubles and prosperity expands across the globe by 2030 energy demand increases to about 40% higher than today. This energy demand needs to be met by low-carbon fuels and more

of the TSB UK Offshore Renewable Energy (ORE) 'Catapult' Centre with its headquarters in Glasgow. The ORE Catapult aims to become the world's pre-eminent centre of expertise for rapid development and commercialisation of highly innovative technologies that will substantially reduce the cost of offshore renewable energy.

Whilst unexpected economic and geopolitical changes may have significant impacts on energy supply and demand, the global trends illustrated in this chapter forecast tremendous growth opportunities for the global offshore oil and gas and offshore renewable industries.

We are poised at a cusp of global policy decision making, major investment and technological innovation. The opportunity to shape the future low carbon energy systems is before us and there is a need to be bold and act at pace. The material in this chapter seeks to provide insight into a number of technology and resource vectors.

Professor Sir Jim McDonald
Principal and Vice Chancellor
University of Strathclyde



Scenario and global driver impacts on the offshore energy sector

Global Marine Trends 2030 recognises that the global drivers affecting the offshore oil and gas activities and the developments in offshore renewable energy generation are economic and environmental respectively. What do we see over the next 20 years? The answer to that question varies by region, reflecting diverse economic and environmental considerations as well as the evolution of technology and government policies. Everywhere, though, we see energy being used more efficiently and energy supplies continuing to diversify as new technologies and sources emerge.

Demand for coal will peak and begin a gradual decline around 2030, in part because of emerging policies that will seek to curb emissions by imposing a cost on higher-carbon fuels. Use of renewable energies will grow significantly. Oil and gas continue to be widely used fuels, and have the scale needed to meet global demand, driving investment in offshore exploration and related activities to ever greater depth as the search for new offshore reserves around the world continues. The growing use of natural gas which is in abundance is a significant driver for investment and development, and we will see an impressive expansion by 2030.

If 0.1% of the renewable energy available within the oceans could be converted into electricity it would satisfy the present world demand for energy more than five times over. Ocean energy resources include energy from wind, waves, tides, ocean currents, temperature gradients and salinity gradients (osmotic). Offshore wind energy is technologically more mature and we will see increasing investment with resulting large increase in generating capacity world-wide. Apart from offshore wind, other promising ocean energy resources are wave, tidal current and tidal range. Systems developed for harvesting these resources have seen the most technological advancement. Wave energy has the largest potential and it can be captured in a number of different ways including through point absorbers, attenuators, overtopping, oscillating wave surge convertors, and oscillating water columns. Investments in renewable energies from offshore will continue to grow both in terms of project numbers and geographical spread. In doing so, they are making an increasing contribution to combatting climate change, countering energy poverty, energy insecurity and stimulating green jobs.



Global energy supply

The market has prompted explorers, scientists and engineers to find new ways to meet demand when new sources are needed. Their research and development activities today include a revolution in unconventional gas sources; the acceleration in offshore renewables; and an exploration drive in colder and deeper frontiers such as the Arctic.

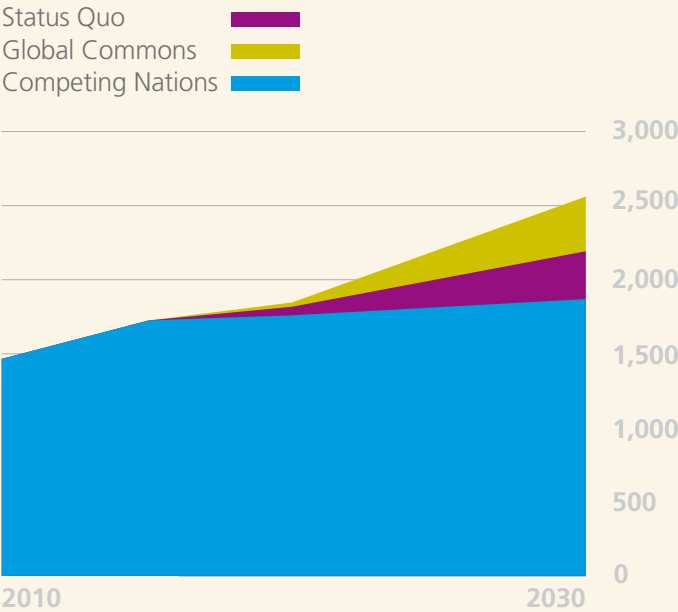


Offshore oil

34% of worldwide oil production occurred offshore in 2004. This is expected to increase to 40% by 2015 and to 48% by 2030. This is mostly due to the increase of production in deep water offshore fields, which should move from 10% share (2004) to 25% (2015) and to 45% in 2030. This will compensate the decline from “traditional offshore” fields. Deep offshore oil production is expected to increase by 11.5% per annum, moving from 2.5 million barrels per day (Mb/day) in 2004 to 8.25 Mb/day (2015), producing as much oil as Saudi Arabia did in 2002.

Fig. 98 Offshore oil supply (million tonnes)

Source: University of Strathclyde



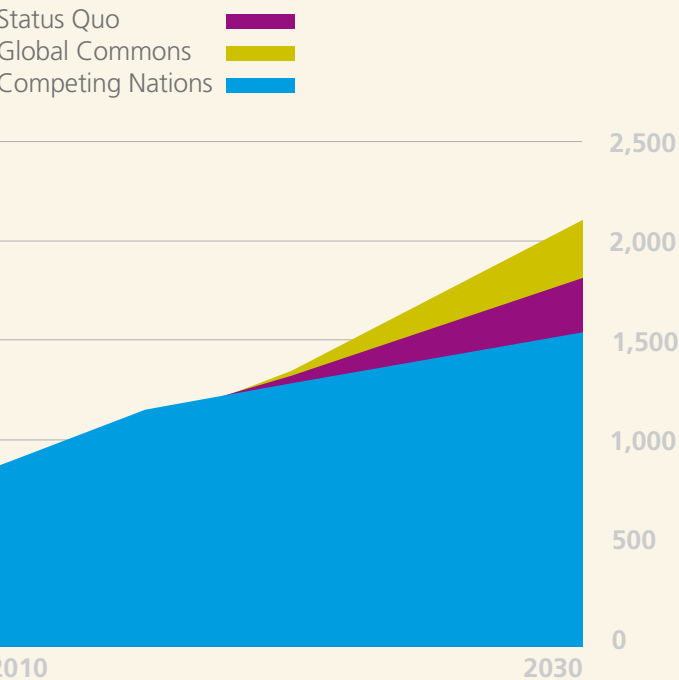
FLNG image courtesy of Shell

Offshore natural gas

Natural gas will be the fastest growing major fuel supply, with demand rising more than 60% by 2030. This rising demand will be met from unconventional natural gas produced from shale and other rock formations. Natural gas production from offshore reserves is expected to increase from 28% of the worldwide natural gas production in 2004 to 34% in 2015 and to 42% in 2030.

Fig. 99 Offshore natural gas supply (million tonnes)

Source: University of Strathclyde



Floating platforms oil and gas platforms

270 Total platforms in 2010

Fig. 100 Number of floating platforms

Source: University of Strathclyde

2010

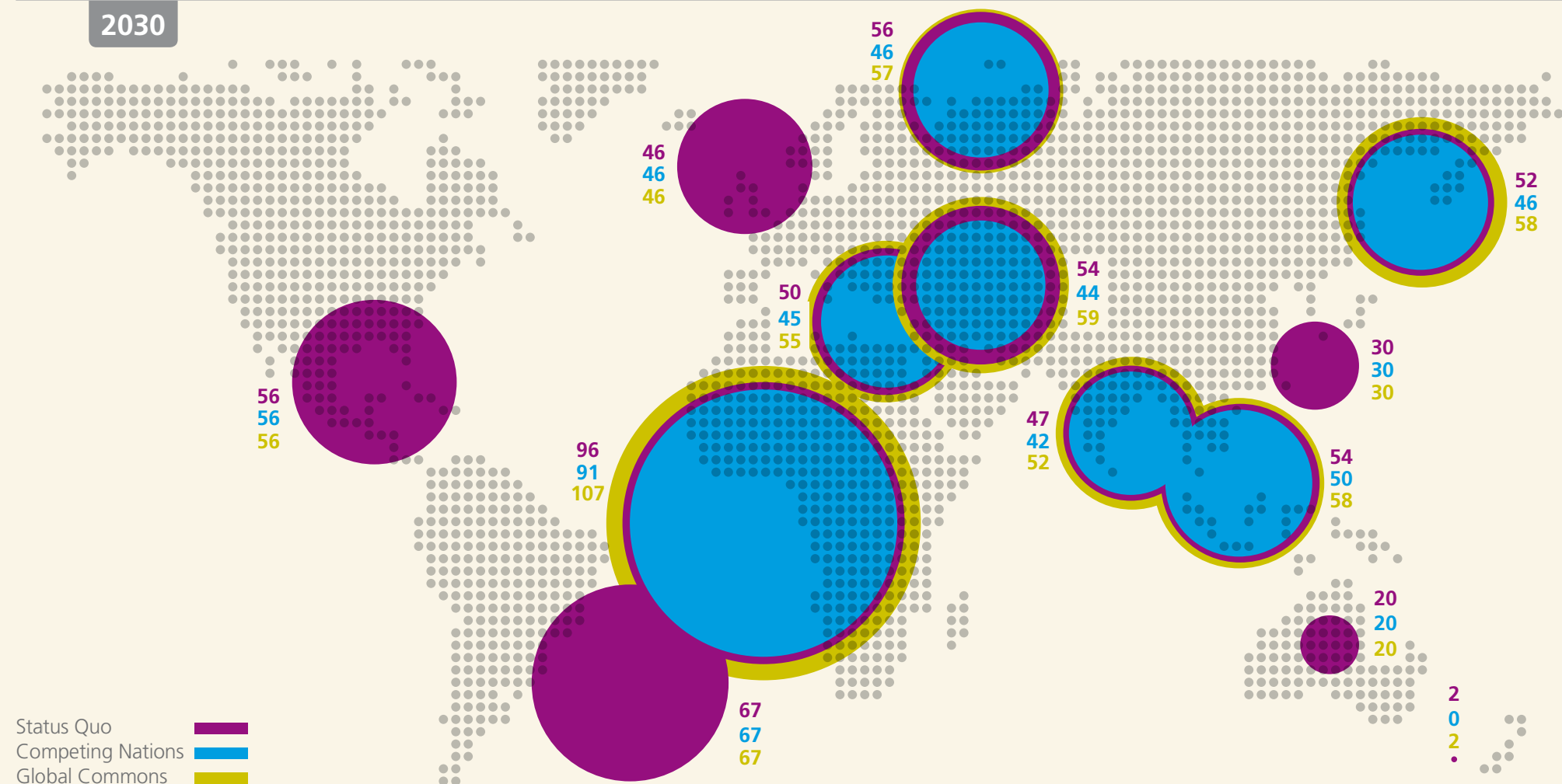


618 Total platforms in 2030

Fig.101 Number of floating platforms

Source: University of Strathclyde

2030



Offshore renewable energy resources

Renewable energy will help the provision of diverse energy sources, protect consumers from fossil fuel price fluctuations, drive economic growth in the renewable energy sector, and keep us on track to meet our carbon reduction objectives for the coming decades. Renewables will be a key part of the decarbonisation of the energy sector necessary by 2030, alongside carbon capture and storage, and improvements in energy efficiency.

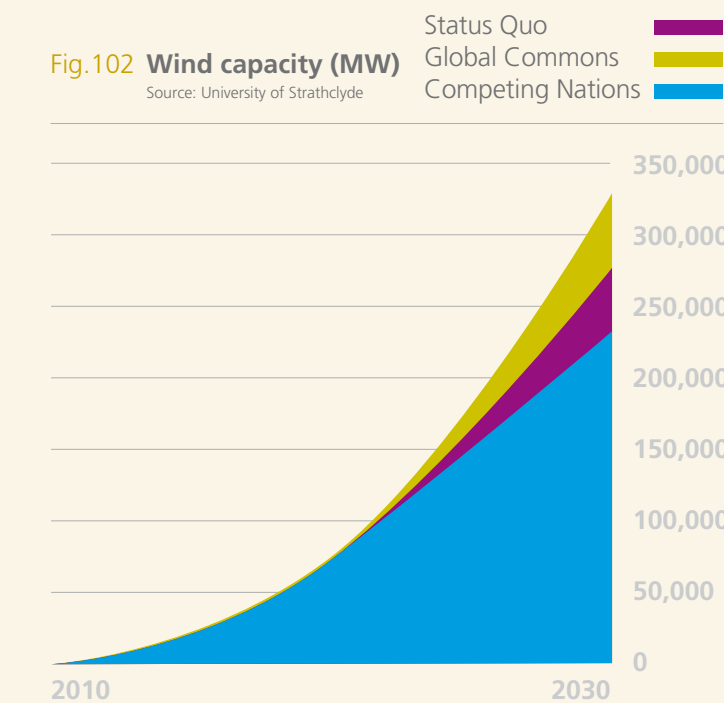
The key offshore renewable energy resources are:

- Wind energy
- Wave energy
- Tidal energy
- Ocean current energy

Photo courtesy of Aquamarine Power

Offshore wind energy

Wind energy is currently at the most advanced stage of development. It is estimated that offshore wind power alone could in the future supply about 5,000 terawatt-hours (TWh) of electricity a year worldwide – approximately a third of the world's current annual electricity consumption of about 15,500 TWh. It is anticipated that European offshore wind energy plants could supply about 340 TWh a year by 2015.



Offshore wind turbines

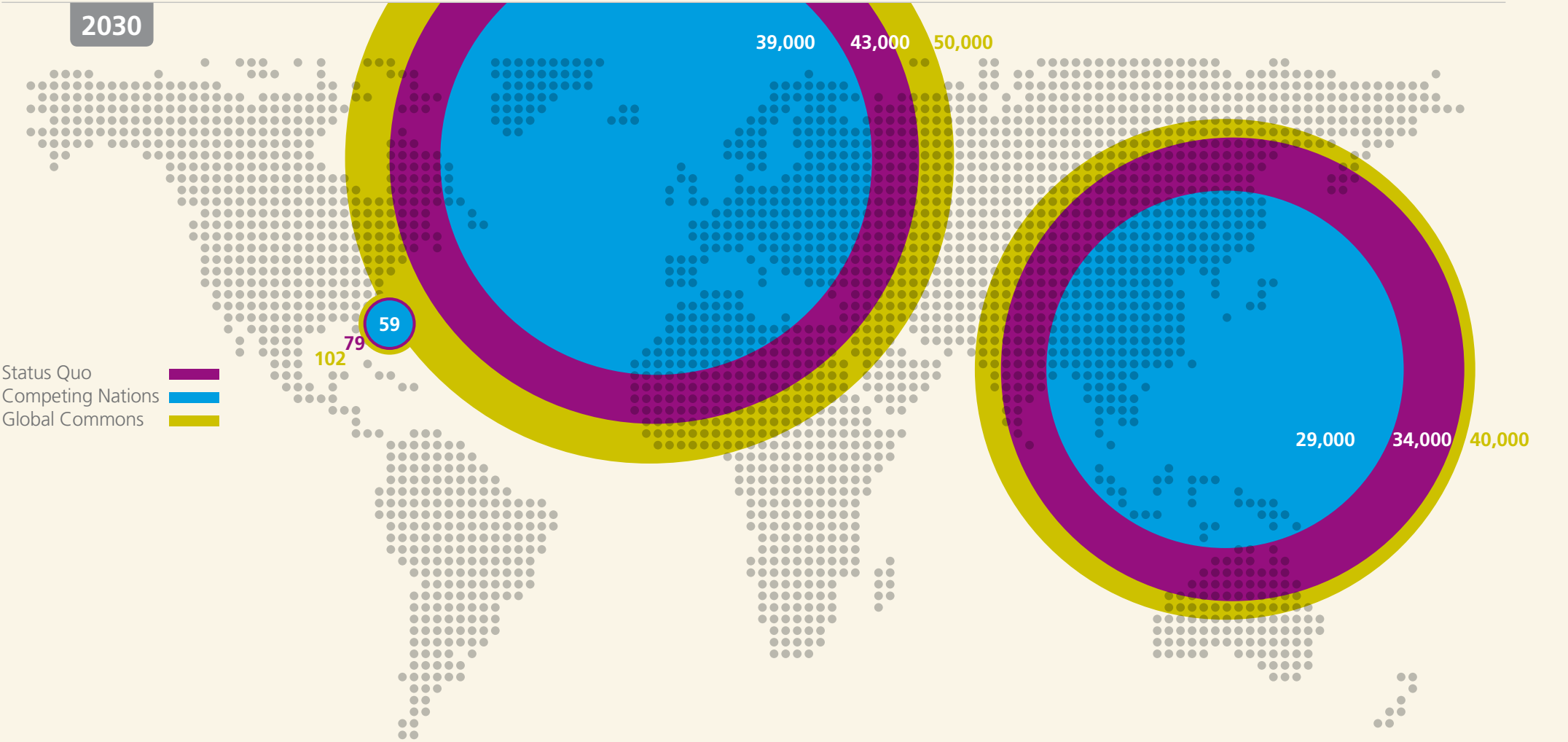
100 times more offshore wind turbines

Fig.103 Number of offshore wind turbines
Source: University of Strathclyde



More than 65,000 wind turbines are required to provide more than 226,000Mw of wind capacity in 2030

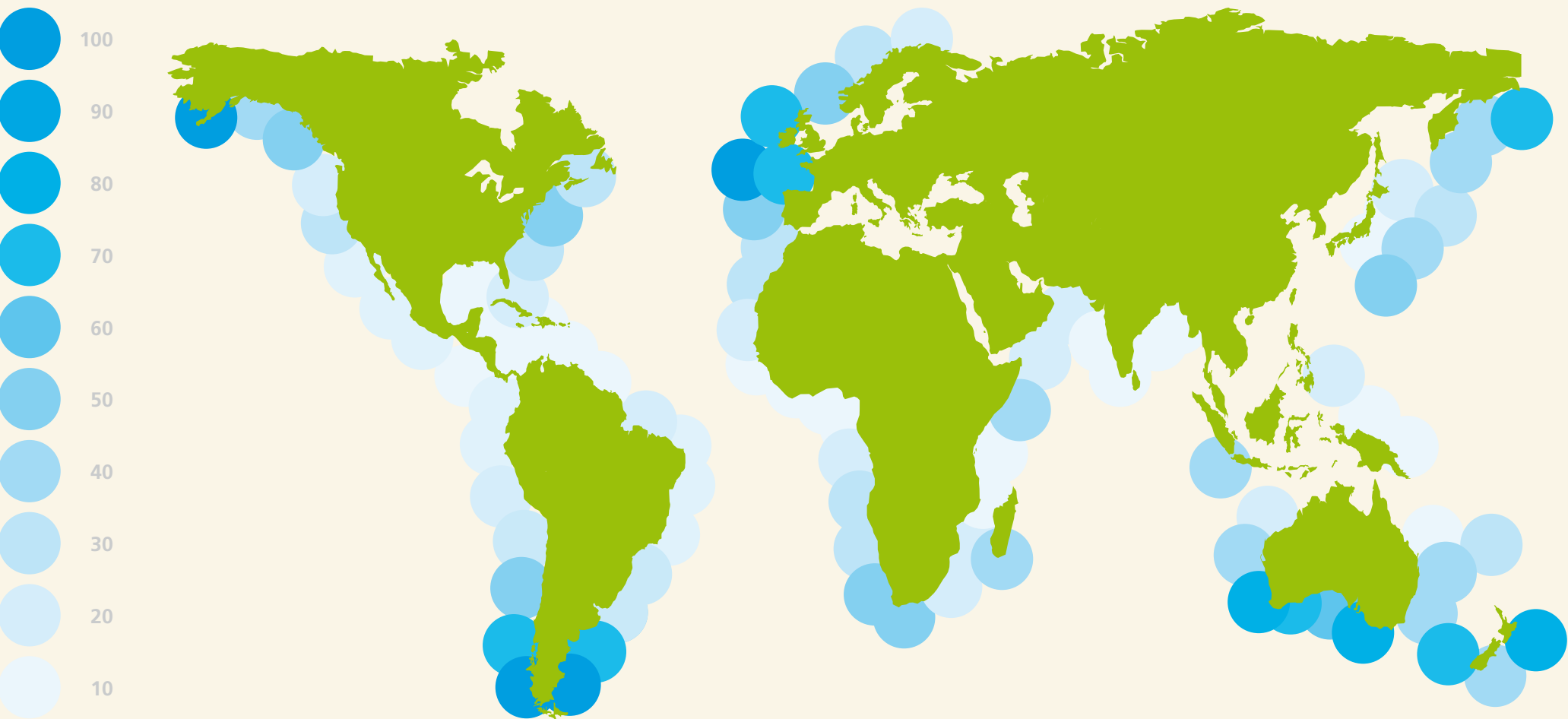
Fig.104 Number of offshore wind turbines
Source: University of Strathclyde



Ocean wave energy

The global technical potential of wave energy is estimated at 11,400 TWh per year. Its sustainable generating potential of 1,700 TWh per year equates to about 10 per cent of global energy needs.

Fig.105 Annual average wave power (kWh per crest width)
Source: University of Strathclyde



22 The number of wave energy devices in 2010
22,000
The predicted number of wave energy devices in 2030

Tidal and ocean current energy

Tidal or Ocean current energy can be harnessed using submerged rotors or oscillating foil type devices which are driven by the motion of the water. It has been estimated that ocean current and tidal energy devices together could harness about 800 TWh of electricity per year worldwide.



11 The number of tidal energy devices in 2010
50 The predicted number of wave energy devices in 2030

Photo courtesy of Ocean Flow Energy

Disruptive forces

Disruptive forces that are game changers

We have described our broad scenarios for 2030 as three different possible outcomes (“Status Quo”, “Global Commons” and “Competing Nations”). We are relatively certain that developing countries, in particular BRIC countries, will become more influential in deciding future economic configuration and trade. In some cases the changes outlined may not happen in the time horizon, especially in relation to the demography, resource and environment global drivers. Other trends are less foreseeable as they depend on intangible factors such as people’s changing aspirations and quality of leadership. In between these three scenarios, we anticipate disruptive events that would generate a step change in the marine industries.

In the following pages, we try to construct a few potential disruptive events that might substantially change the future. There are many other disruptive events which can change the future, and we can only illustrate a small number. The real future, of course, may well be different.

These disruptive events include:

- 1. Russia joins NATO.** This event, if ever it happens, will cause a tectonic re-configuration of geopolitics and military balance.
- 2. Dollar loses its reserve currency status.** This event, if it ever happens in a disorderly manner, will have major implications for the global economy and will cause a major disruption in trade.
- 3. Major pollution accident in the Arctic.** This event, if it ever happens, will cause a major freeze in the exploitation of Arctic resources and for shipping routes. This will in turn cause a disruption in supply of resources to the developed and developing world.
- 4. Rise of the Green Crescent.** This event, if it ever happens, will cause major upheavals in oil supply and geopolitical configurations of the Middle East and potentially will increase the likelihood of armed conflicts with unforeseeable consequences.
- 5. Disruptive technologies.** Technologies are agents for change which are often unforeseeable. For example, the advance of robotics and three dimensional printing will localise manufacturing - reducing container shipping demand (especially on longer routes).
- 6. Global collapse.** The most extreme disruption will, if it ever happens, involve substantial and coinciding instabilities in economics, the environment and geopolitics. These will be sufficient to cause a global collapse of governance and economy, irreversible environmental degradation and huge military conflict.

These events are not inevitable or even necessarily likely; but, as with many other uncertainties, the scenarios are potential game-changers and can have major implications for the marine world.



2028 Russia joins NATO

After the end of the cold war, NATO provided stability for integration of former Soviet Union countries. Russia decided to join NATO in 2028 in response to the invitation by other NATO members. The invitation was intended improve energy security, disarmament and arms control. It countered any perceived Chinese threat to the USA, ended problems in the Middle East, prevented crises in central Asia, and ensure smooth progress in the establishment of democracy for various northern African countries.

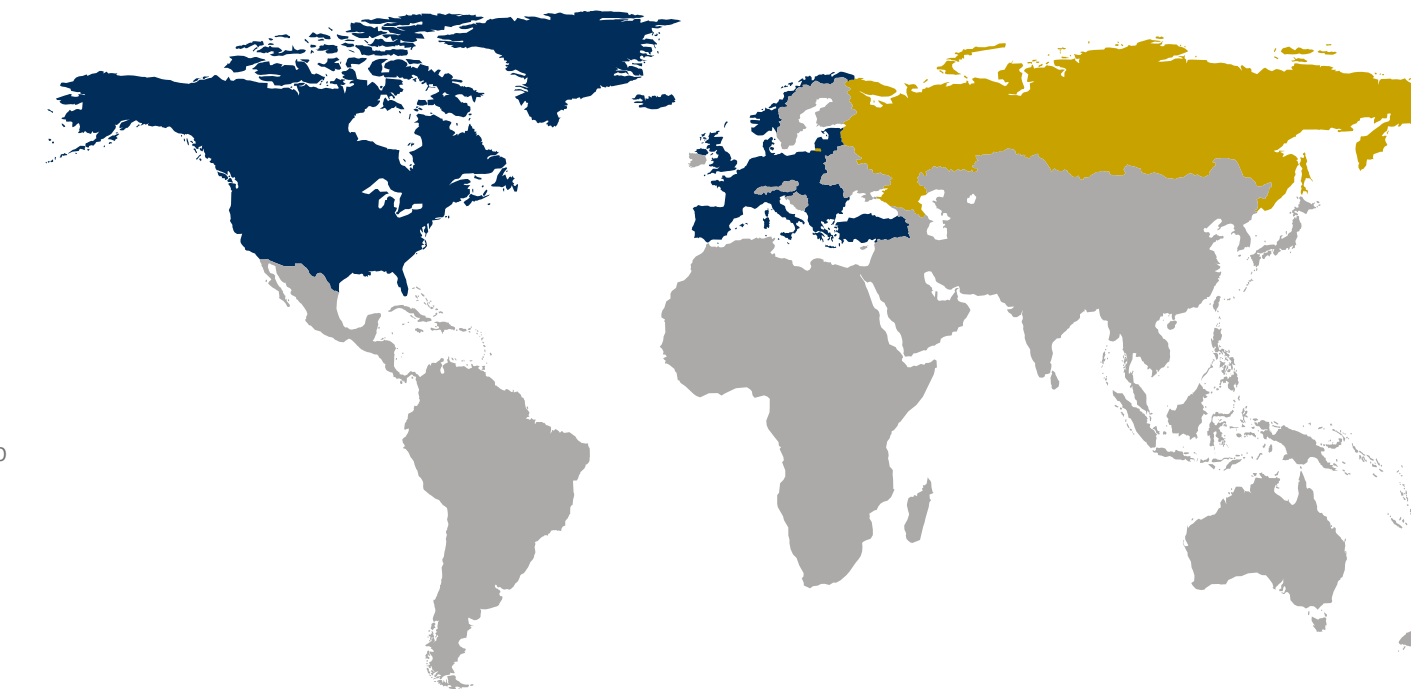
As a member of NATO Russia increased its self-defence against external threats, ended disputes with Georgia, and Japan over Kurile Island, and co-operated in Arctic development for shipping, hydrocarbon exploration and production.

However the consequence included increased tension between NATO members and others. Some countries felt surrounded and threatened, resulting in a further build up of their military, creating new zones of tension.

Fig.106 NATO members and Russia

Source: NATO

■ NATO member countries
■ Russia



2

2022 Dollar loses its reserve currency status

In 2022, China, after a long period of gradualism, decided to make the Renminbi fully convertible under great internal and external pressures. The market lost faith in the dollar and took flight to the yuan which by now has become a major trading currency between China and other large emerging economies. The dollar depreciated rapidly. China and other creditors suffered huge losses.

The roots of this situation are well known. Due to a combination of tax cuts, escalating military burdens, recession, and massive government intervention to bail out financial institutions and to stabilize the economy, the US budget deficit of 2021 fiscal year reached a huge unsustainable level as a percentage of gross domestic product; the largest in peacetime history. Meanwhile, the net external debt of the United States increased by a massive level last year to reach \$13.5 trillion. The United States is borrowing close to \$750 billion a year just to pay interest on the debt.

USA therefore has little choice but to take the time-honoured course for big-time debtors: print more dollars, devalue the currency, and service debt in ever-cheaper greenbacks. In other words, the United States will have to camouflage a slow-motion default because politically it is the easiest way out. Given the political realities, it is the only way out. USA also believes a cheaper dollar could make US products and services more competitive.

At the same time these debts have been financed by external creditors. From 2018 to 2021, there were fears that the dollar might be devalued and the People's Bank of China (PBOC) started shifting to the euro. However, in implementing this policy, the PBOC was also constrained by its position as a large player on the exchange market. So, as the dollar's weakness worsened at the end of 2021, the PBOC was in a trap: it could not continue selling the dollar without precipitating a greenbacks collapse and a huge exchange loss for itself. The only workable option left was to support the dollar. Chinese policy therefore suddenly turned cooperative. PBOC halted the dollar's decline, and even intervened on the market in order to support the US currency.

When the dollar value eventually stabilised, China and other dollar holding creditors suffered massive losses. This time however, given the speed at which markets reacted, the transition to a new global currency regime has been faster and more destabilizing.

This new global currency regime has changed everything, including the prices for every product and service, the location of manufacturing and R&D, flows of capital and trade, composition of monetary reserves, behaviour of investors, and the distribution of economic and political power. The world as we have known it for many decades will be radically altered, with a new distribution of winners and losers.

3



2019 Major pollution accident in arctic region

Two crude carriers have collided on the western Arctic Ocean transit route. Both flagged in the same country, its official opposition politicians claim that the ship management company was following Government instructions to ignore Canadian licencing - as part of a wider attempt to exert power over this strategic waterway. A Government warship was “coincidentally” close to the two tankers.

With growing costs for certain natural resources, the UNCLOS based debate over ownership of Arctic resources had been developing towards agreement between the major claimants (Russia and Canada). With domestic political fallout from the collision, and unable to negotiate a strong position for a slice of the rich resources under the ocean, the Government had become sidelined, and was getting desperate.

One of the ships had become firmly wedged onto rocks close to Illuit island. The problem would take months or even years to clean up. Rescue services were not expecting the problem. Warnings from Canadian authorities were ignored.

Canada swiftly deployed massive resources to clean up the oil, but the new systems for ice waters were slow. The Government could expect a large bill. Canada took the world’s press and Greenpeace to Illuit to see the environmental (and political) disaster. In exasperation, Canada announced a new bilateral agreement with Russia to manage the whole Arctic Ocean, split simply down the 15th and 160th meridians.

The implications were significant. The Government became further weakened, as new “Global Grown-up” politics strengthened. Canada and Russia became firmer allies around the Arctic. Shipping reliability increased in the region, assuring a short route from Europe to China, avoiding choke points and canals. The Arctic alliance clarified effective ownership of the mineral resources of the Arctic, so investors could place their bets.

Fig.107 Arctic map

Source: QinetiQ

- The 200 mile line
- Agreed borders
- Summer ice extent Summer 2011
- Canadian claimed territory
- Russian claimed territory
- Transit routes



4



2024 The rise of the Green Crescent

2017 saw the eruption of the Middle East. The North African states had settled from the Arab Spring in 2010-12, and moved to more open and fair democratic elections (supported by European countries). However, European countries had formally withdrawn from the second cycle of elections (many happening at the same time), and (with an on-going Sunni-Shi'a religious dispute) fundamentalists gained power. "Open and fair" had applied to the formal voting system, but not to tribal influence.

Two Islamic oriented states had realised that it could be possible to re-establish a Caliphate across the Middle East, and some neighbouring countries were willing to support a more extensive entity in the region. Building on the Istanbul Cooperation Initiative, an Islamic oriented political and economic region was about to be formed, with the largest customer offering encouragement.

The way that the conflict develops does not matter for now.

The outcome is that the whole Middle East reverts to Islam. Growing political understanding and capability, and quite a lot of external support, enables the region to form an effective economic development region, equivalent in geographic size, if not population, to Europe. Expectations of economic growth start to improve, so the Caliphate (rich in resources, and spanning North Africa, Arabia, the Eastern Med and the 'stans) starts to look like a new global power player. Trade increases in the Indian Ocean.

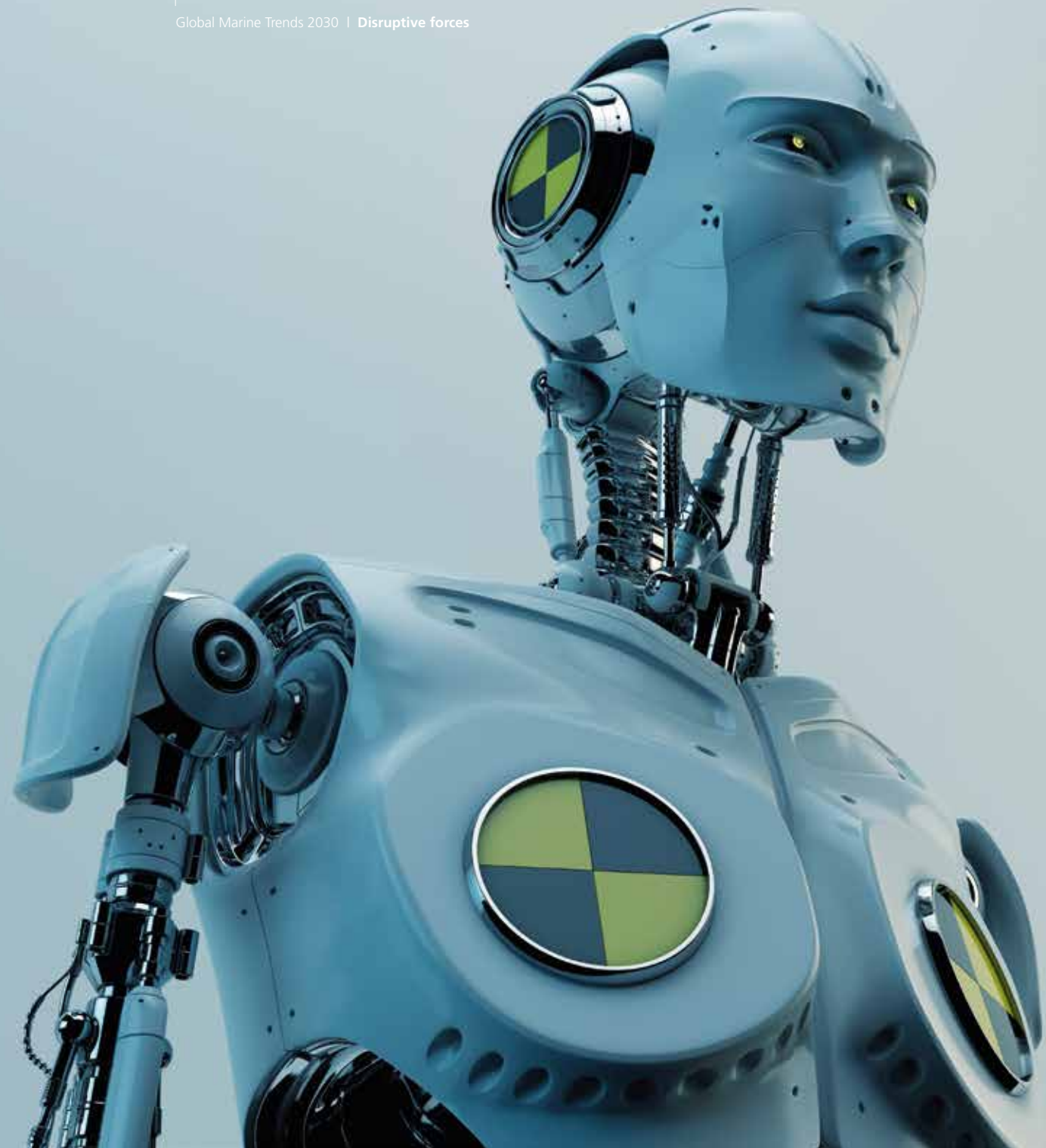
The result would be a huge upheaval for the marine world. The Suez canal is critical to East-West trade. The Arctic and Atlantic trade routes could increase in importance.

Such a dramatic change in geo-political power would significantly reduce GDP for the USA, India and the EU. Russia and India might align to Western counterparts (eg NATO) for protection against a perceived rising Sino-Caliphate economic threat.

Such a scenario would lead to a significant increase in naval power required by Middle East countries, to protect the new multi-polar geo-political system. It would potentially encourage other countries to increase naval power in response. The reduced growth would constrain merchant shipping demand growth. The new geography could lend itself to wide area electricity grids on shore taking solar power from the Middle East to economic centres in the Green Crescent, and even to China. This would reduce the need for offshore sourced energy.

Fig.108 The Caliphate





2029 Disruptive technologies

The desire to reduce dependency on imported oils drives investment by China, the United States and other countries to invest in clean coal technologies.

Clean coal technologies include various combinations of carbon capture sequestration and coal gasification into syngas. Carbon capture sequestration can reduce or possibly eliminate greenhouse gas emissions from a coal plant. Coal gasification improves efficiency when generating electricity and emits fewer pollutants relative to coal burning plants. The syngas can also be a feedstock for transportation fuels and industrial chemicals that replace petroleum-derived products.

Major advances have been made in the early 2020s in biofuels technology which is used to produce ethanol from ligno-cellulosic materials for fuels and cultivate high-growth microalgae for conversion to biodiesel and other biofuels. The investment pays off by 2029 for the successfully accelerated and rapid deployment of clean coal technology. A large-scale investment to produce bio-fuels has yielded results in 2031. The mass and rapid deployment of both technologies by China and USA, later followed rapidly by EU, India and Japan, posed a major challenge to conventional hydrocarbon. Oil prices crashed and major oil producing countries suffer massive losses of revenues as a result.

In the marine world, investment in deep water exploration is halted as it has become uneconomical. Tankers, workhorses of oil trade and nearly one third of the world tonnage for international trade, suffered heavily with loss of shipping revenues and excessive tonnages.

A parallel development is happening in three dimensional printing, robotics and related technologies.

Security and safety applications, healthcare or home care for ageing populations, and the desire to improve manufacturing productivity drive the technology investment. Germany and Japan invest heavily in robotics and a large number of enabling technologies including hardware such as sensors, actuators, micro-power systems and software platforms including advanced systems that incorporate behavioural algorithms and artificial intelligence. These technologies enable a wide variety of remote controlled and completely autonomous robotic systems to be built.

The investment paid dividends around 2030. Japan built the world's first fully autonomous factory making consumer products. Service robots are produced for domestic use and commercial use. In domestic settings, widespread use of the technology leverages man-power; disrupts unskilled labour markets and immigration patterns, and changes care for a growing elderly population. Germany built the world's first three dimensional printing plants for auto parts for the motor industries.

High end products are produced by bespoke three dimensional printing technologies, while low end jobs are done by autonomous robots. There are major implications for the developing countries. They have cheap and excessive labour forces that require low skill jobs and they need to move up to the high skill jobs. Massive dislocations for developed and developing countries result in the localisation of manufacturing and bespoke products manufacturing being the norm. Container shipping suffered greatly with less demand for international shipping.

The advance of robotic and related technologies has huge military applications. A new generation of naval ships are designed for nearly autonomous operation. In 2033, USA demonstrates the world's first robotic soldier that can operate autonomously.

The world enters completely new and unknown territory with massive consequences for all manner of human activities, whether it is in peace or at war.

2030 Global collapse

This world is very different from the three scenarios. Consistent with population growth forecasts, global population has increased, mostly from developing countries, to an unsustainable level. Demand for food has grown by more than 40% and for water by 30%. As developing countries industrialise, especially China and India, demand for energy has grown by 40%. Their dependence on imports of food and fossil fuels has caused inflation, social tensions and mass dislocation of societies internally and externally. Oil is no longer affordable for the masses, even citizens of developed countries.

The need for development in poorer countries, and for competitiveness in richer ones, puts a brake on humanity's ability to reduce energy usage intensity per unit GDP. Efforts to reduce greenhouse gas emissions fall far short of the target necessary to stop or reverse climate change. World average temperature has risen 0.5°C with unpredictable weather patterns around the globe, extreme floods and droughts. Global food production is under severe pressure due to the change in weather patterns. Food prices swing and export restrictions by some countries cause chaos for food importers. A sense of insecurity prevails across the globe.

Massive trade deficits, high energy prices and unsustainable debt in developed countries with ageing populations, cause the economy to stagnate - resulting in unacceptable levels of unemployment. Social tension is on the rise and protectionism is on the march. Citizens demand protection and government responses to the problems.

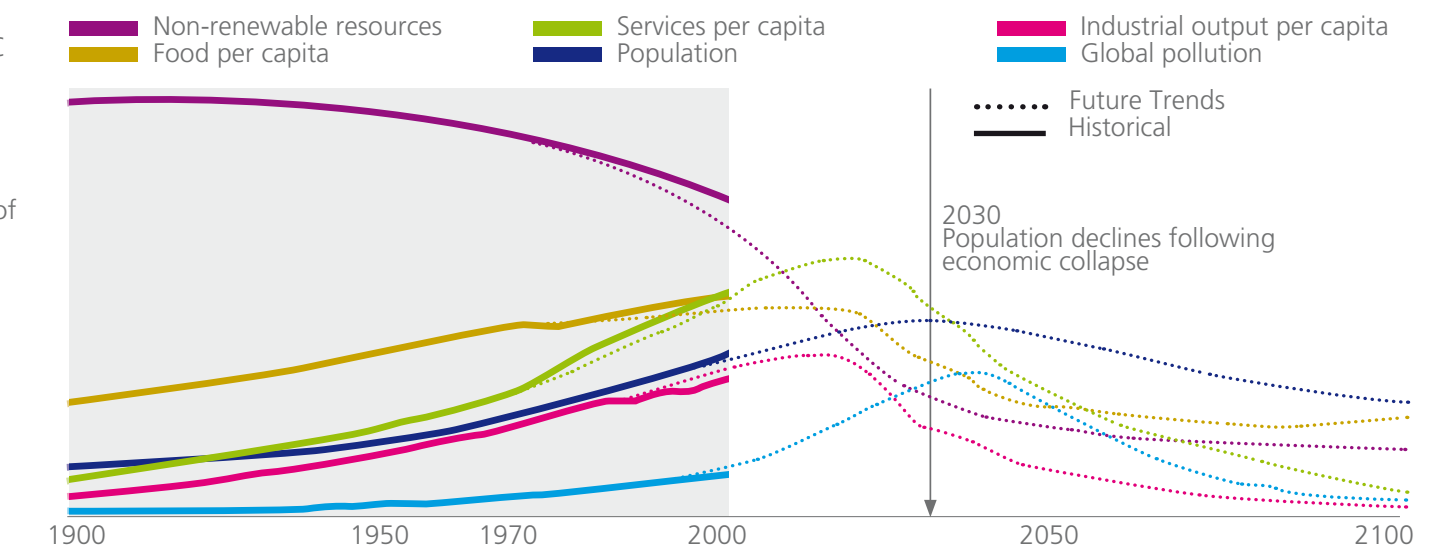
The deteriorating world financial situation, climate change, rising energy prices, scarcity of water, food and other resources, internal unrest and mass starvation destabilise the world. Civil unrest has toppled governments in more than a dozen countries in the past year and a dozen more are fighting major insurgencies. As a consequence, the tide of refugees is expanding, causing distress in surrounding countries and fueling nationalistic sentiment. Even large developing and developed countries are at risk. Competitive access to resources and markets is causing international tensions around the globe and the potential for conflicts even amongst major powers rises.

By 2030, in this scenario, the world is in crisis. The lack of leadership, coupled with demographic pressure, environmental degradation and developmental stresses cause the collapse of international institutions such as the UN, which have failed to find solutions. Every country is left on its own to fight for self-interest and survival.

The world economy contracts, global trade collapses and military build-up intensifies. Civilisation itself is in retreat.

Fig.109 Global collapse

Source: Donella H. Meadows, Dennis L. Meadows, Jørgen Randers and William W. Behrens, III, "Limits to Growth", 1972
G. Turner "A Comparison of the Limits to Growth with Thirty Years of Reality", CSIRO Working Paper 2008-09



Postscript



Predicting the future is arguably the most important, hard, and necessary discipline facing decision makers in every industry. It is particularly challenging in the marine industry, with its dependency on the global economy.

The global drivers of politics, demography, technology, environment, macroeconomics, and other long-term forces are beyond the control of even the most powerful industry players. The most eye-opening implications typically lurk at the intersections where multiple trends interact with one another, often in complex and subtle ways.

The scenarios described here are not predictions, but stories about possible futures. These stories are plausible, challenging and rigorously constructed to address the most critical questions that decision makers need to face. Working with other marine leaders, we have created quantitative, actionable, and unbiased scenarios for what might happen in the next twenty years. Well-constructed scenarios, in turn, can help companies challenge conventional wisdom, pressure test existing business models and identify market opportunities.

What do we hope to achieve with this publication? I hope the scenarios will spur you into discussion and action; encouraging marine industry stakeholders from diverse backgrounds to engage in a productive discussion of a shared vision of the future; helping you to identify risks and opportunities, and to develop more robust strategies.

They could help to raise awareness and understanding within the marine communities of the complex interplay of underlying global drivers and critical uncertainties. They could help to enhance the robustness of strategies by identifying and challenging underlying assumptions. This could contribute to robust and pre-emptive positioning.

Today's decisions create tomorrow - and these scenarios raise crucial questions about the strategic decisions that will shape the future of our industry.

We are making the Marine Global Trends 2030 freely available to the wider public to encourage people from diverse backgrounds to engage in a productive discussion of their shared vision of the future, helping them to identify risks and opportunities in their respective areas at different levels.

Tim Kent
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Ivy is working as a specialist in the Strategic Research Group of Marine Business, Lloyd's Register Group Limited. Ivy is a chemical engineer and is involved with many technical research projects and topics aiming for applications in the long-term horizon for shipping.



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Patrick Carnie

Patrick is Strategy Manager for QinetiQ's Maritime business, and for the UK Marine Industries Leadership Council.

Glossary

Economy: GDP measurement

GDP is the market value of final products and services produced within a country. GDP of a country can be measured and compared in nominal, real and PPP (Purchasing Power Parity) terms.

Nominal GDP measures the value of output during a given year using the prices prevailing that year (current prices). However it is usually preferred to remove the change in the value of money (the effect of inflation or deflation) while comparing GDP measurement between different years. The GDP measurement with such adjustment is called real GDP, calculated in constant prices.

PPP adopts an exchange rate between currencies based on representative goods. A representative basket of goods in country A costs the same as in country B if the currencies are exchanged at PPP rate.

We used 2010 as the base year for both real and PPP GDP measurement.

Annual expenditure: All expenditure incurred by individuals during 1 year.

Trade

Doha Round/ Doha Development Round is the current trade negotiation round among the WTO members, aiming to reduce trade barriers and improve the international trade.

Oil, Crude Oil, and Product Oil

The term “oil” in the document tends to capture the general petroleum/oil market. Crude oil is a complex liquid mixture of hydrocarbons and organic compounds found naturally. Product oil is “processed oil” derived from oil refineries.

Tanker Size Definition

Handy/Panamax: 5-69,999 dwt
Aframax: 70-124,999 dwt
Suezmax: 125-199,999 dwt
VLCC : 200,000 dwt plus

Primary and transhipment lifts

For example, if a container is shipped from Hai Phong (Vietnam) to Rotterdam (Netherlands) while stopping at Singapore during the journey, there are two primary lifts (Hai Phong and Rotterdam and two transhipment lifts (in Singapore).

Bulk Carrier Size Definition

Handy: 5-49,999 dwt
Panamax: 40-79,999 dwt
Small Cape: 80-149,999 dwt
Large Cape: 150,000 dwt plus

Naval fleets are grouped by geography

Representative Western Fleets USA, Russia, UK, France, Italy, Germany, Greece, Brazil, and Canada.

Representative Eastern Fleets China, Republic of Korea, Japan, Singapore, Malaysia, Thailand, and Vietnam.

Naval systems

Machinery, electrotec & propulsion, command and control, sensors and weapons systems.

Technology Readiness Level (TRL)

TRL (1-9) is a measure used by some United States government agencies and many of the world’s major companies (and agencies) to assess the maturity of evolving technologies (materials, components, devices, etc.) prior to incorporating that technology into a system or subsystem. TRL-1 being the least mature.

Acronym Description

ADB	Asia Development Bank
ASEAN	The Association of Southeast Asian Nations
BMD	British Maritime Doctrine
BRIC	Brazil, Russia, India, and China
dwt	Deadweight tonnage
EIA	U.S. Energy Information Administration
EU	European Union
GDP	Gross Domestic Product
GMT2030	Global Marine Trends 2030
GT	Gross Tonnage
IEA	International Energy Agency
IMB	International Maritime Bureau
IMF	International Monetary Fund
kWh	Kilowatt hour
LNG	Liquefied natural gas
LR	Lloyd’s Register Group Limited
MESA	Middle East and South Asia
MSI	Maritime Strategies International Ltd. (www.msilt.com)
NATO	North Atlantic Treaty Organization
NPI	Naval Power Index
NS	National Statistics
OECD	Organisation for Economic Co-operation and Development
PBOC	People’s Bank of China
PPP	Purchasing power parity
SIPRI	Stockholm International Peace Research Institute
TEU	Twenty-foot Equivalent Unit
toe	Tonnes of oil equivalent
TWh	Terawatt hours
ULCV	Ultra Large Container Vessel
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
USGS	U.S. Geological Survey
VLCC	Very large crude carrier
WEC	World Energy Council
WEU	Western Europe
WTO	World Trade Organization

Region definition (See map below)

Middle East (Mde)

Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, The Palestinian Territories, Turkey, United Arab Emirates, Yemen.

South Asia

Bangladesh, India, Maldives, Nepal, Pakistan, Sri Lanka.

East Asia

China, Hong Kong, Macao, Taiwan, Japan, South Korea.

Southeast Asia

Brunei, Cambodia, East Timor, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam.

Oceania

Australia, New Zealand.

Latin America and Caribbean (LAm)

Countries in South, Central America and the Caribbean, including Mexico.

North America

USA, Canada.

Europe

Countries in the Europe Continent, excluding Russia and Turkey.

Africa

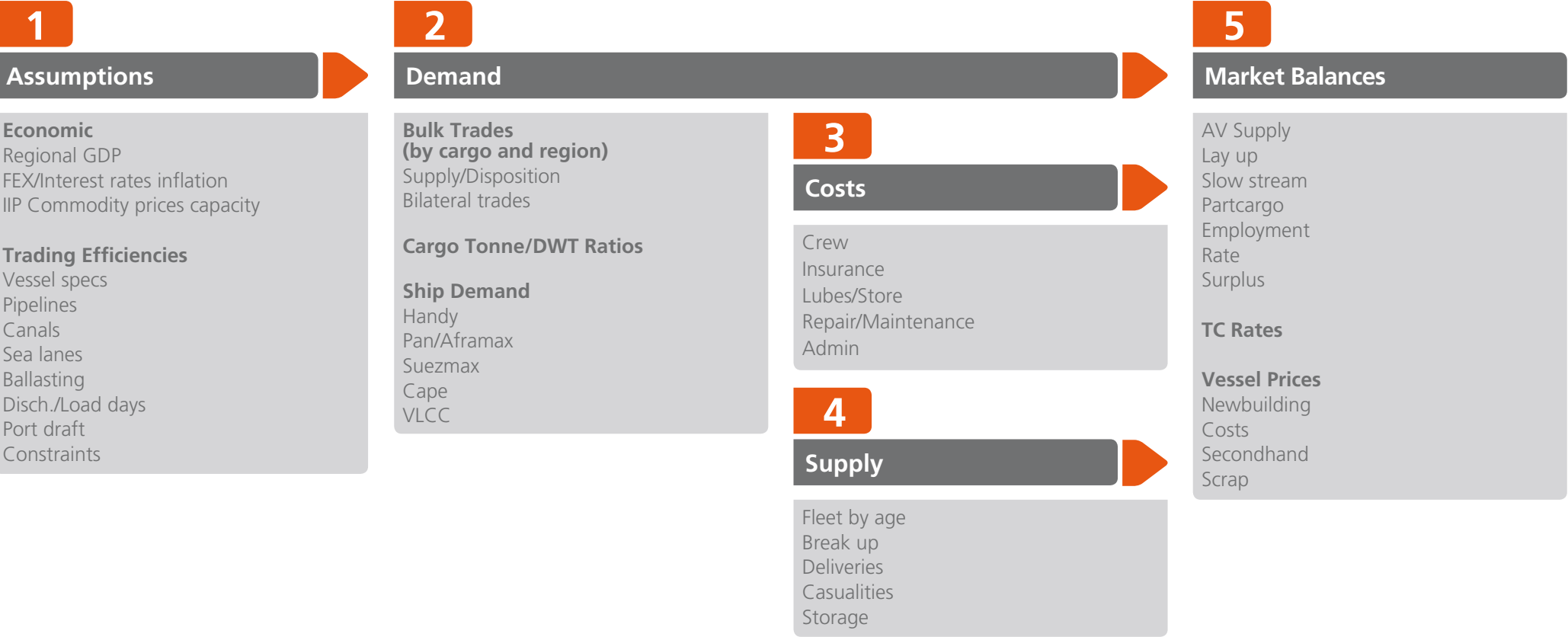
Countries in the African Continent.

Commonwealth of Independent States (CIS)

Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan.



MSI illustrative model overview: structure and inter-relationships



Global Marine Trends 2030

Global Marine Trends 2030

QinetiQ

**Lloyd's
Register**

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Global Marine Trends 2030

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IMechE Hong Kong Branch
Activity Sub-Committee
Education and Training Group

TECHNICAL SEMINAR Global Marine Trends 2030

Hong Kong Branch

Institution of
**MECHANICAL
ENGINEERS**



Date: 15 November 2017
Time: 19:00 to 20:30
Venue: HJ302, The Hong Kong Polytechnic University

Free admission

For detail, please visit IMechE webpage or scan the adjacent QR code:

<http://nearyou.imeche.org/near-you/north-east-asia/hong-kong/events>

What will 2030 look like for the marine industry as such forces as population change, shifts in economic activity, the demand and allocation of resources and the impact of the environment gather momentum and transform the world around us? Together with HKIE-MMNC Division, HKJB and HKIMT, IMechE Hong Kong Branch is privileged to invite Lloyd's Register to inspire the industry in Hong Kong the future of the maritime world.

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