



Sea & Energy: Which new Horizons?



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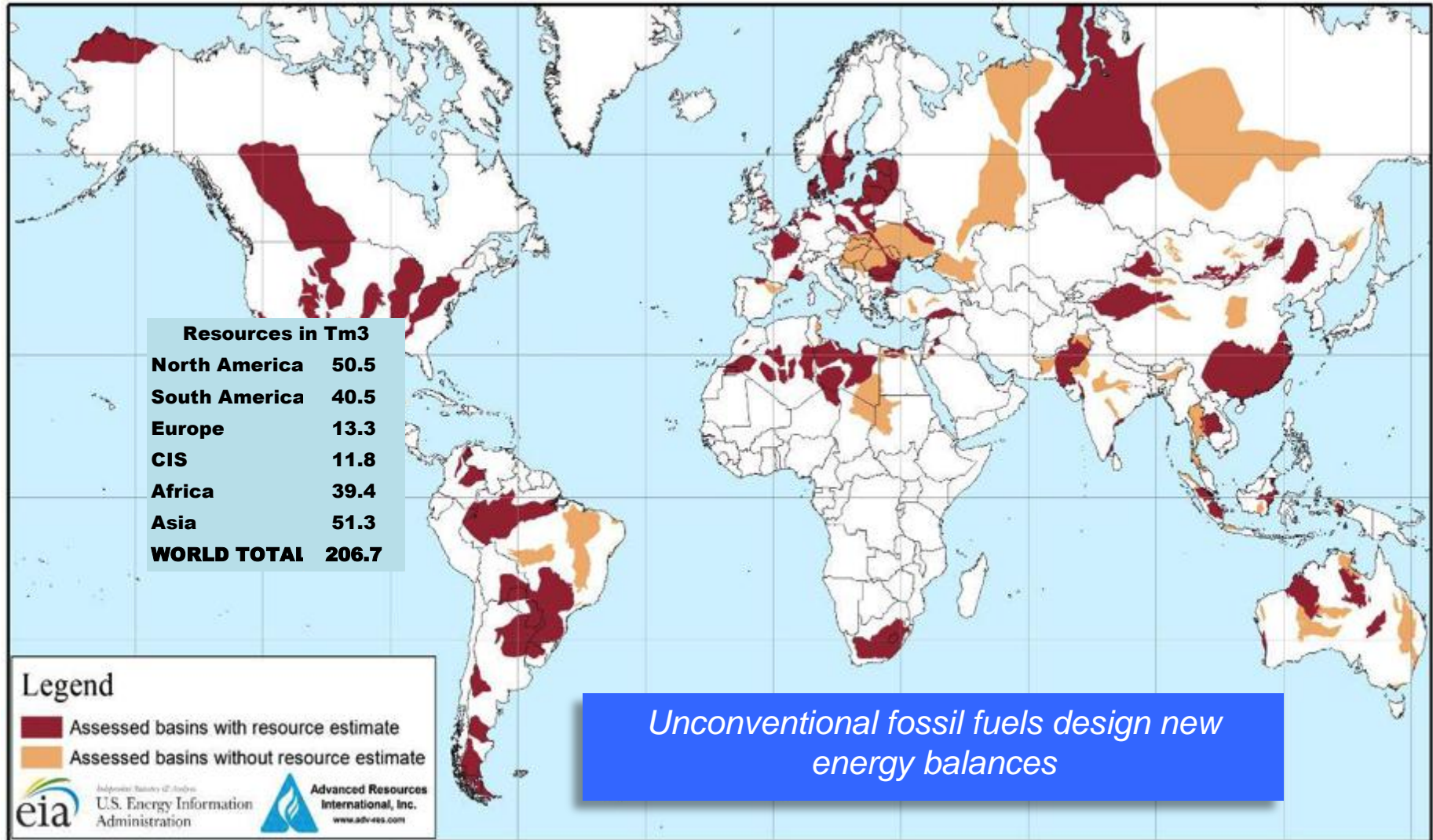




Outline

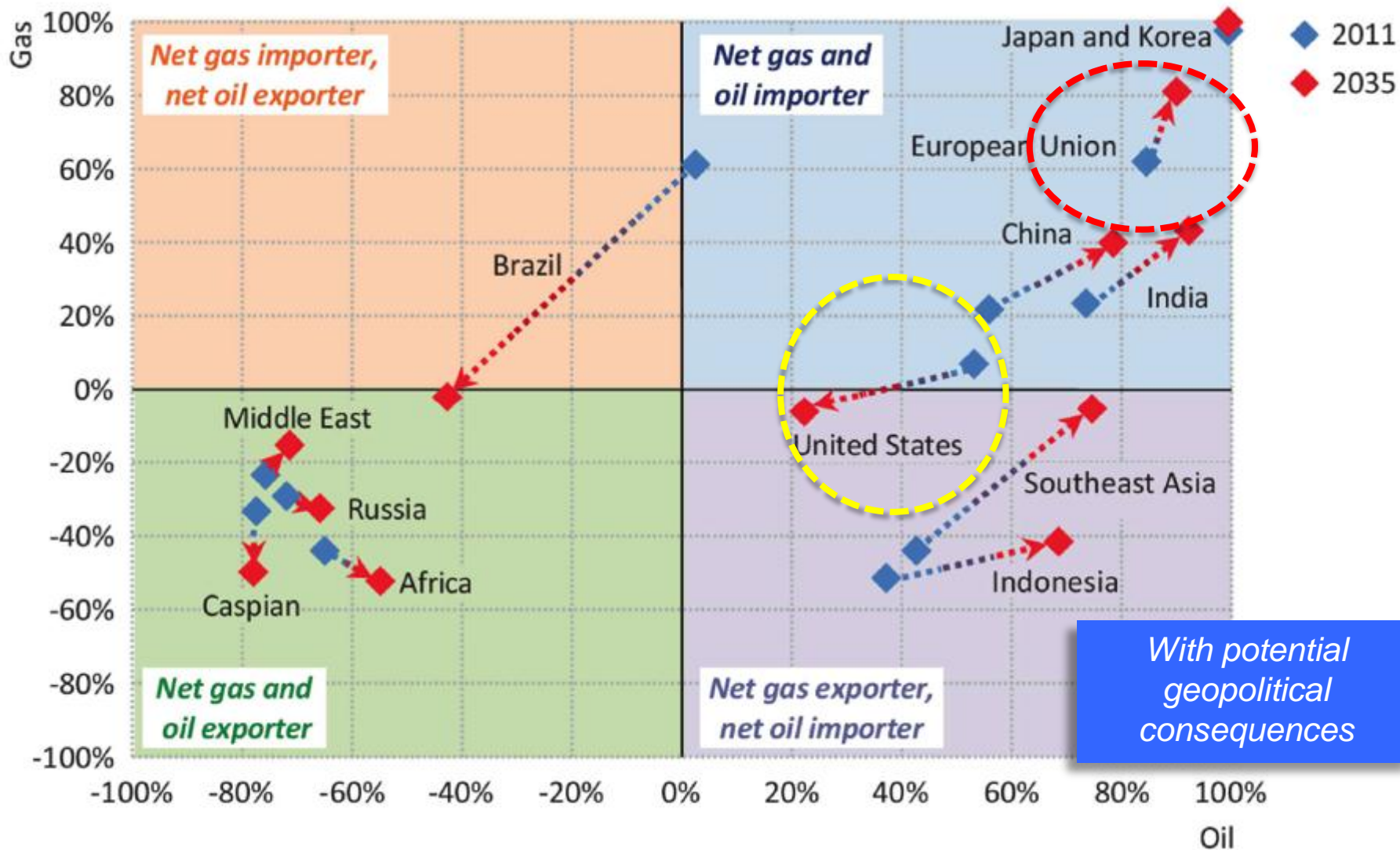
- ➔ **The new fossil fuels landscape and routes**
- ➔ The portfolio of future ocean renewable energies
- ➔ Facing new challenges with climate change
- ➔ Conclusion: new horizons ... unveiling new risks to be covered

A new and unconventional fossil fuel world...



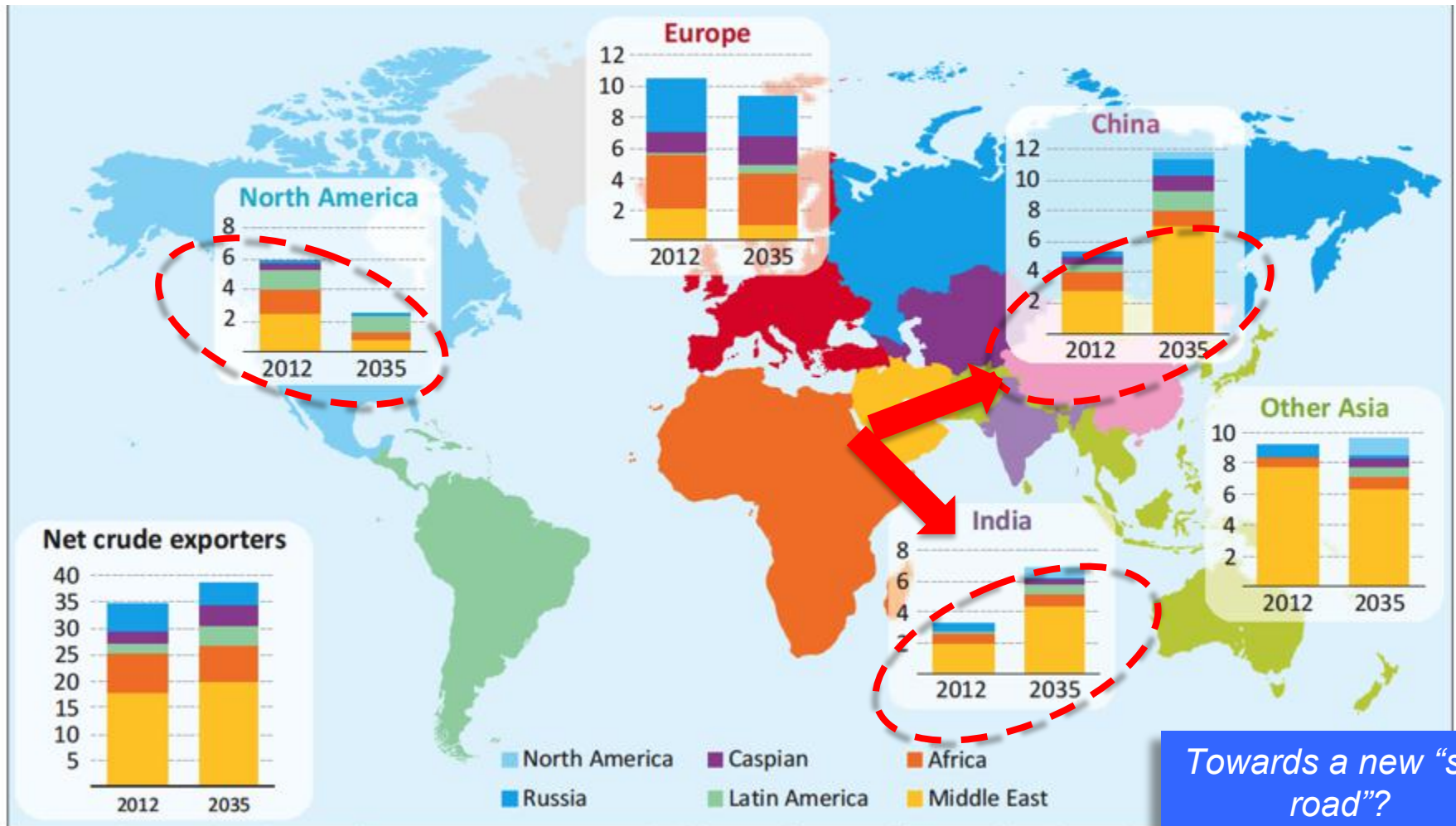


...impacting the future energy flows and routes (1/2)





...impacting the future energy flows and routes (2/2)

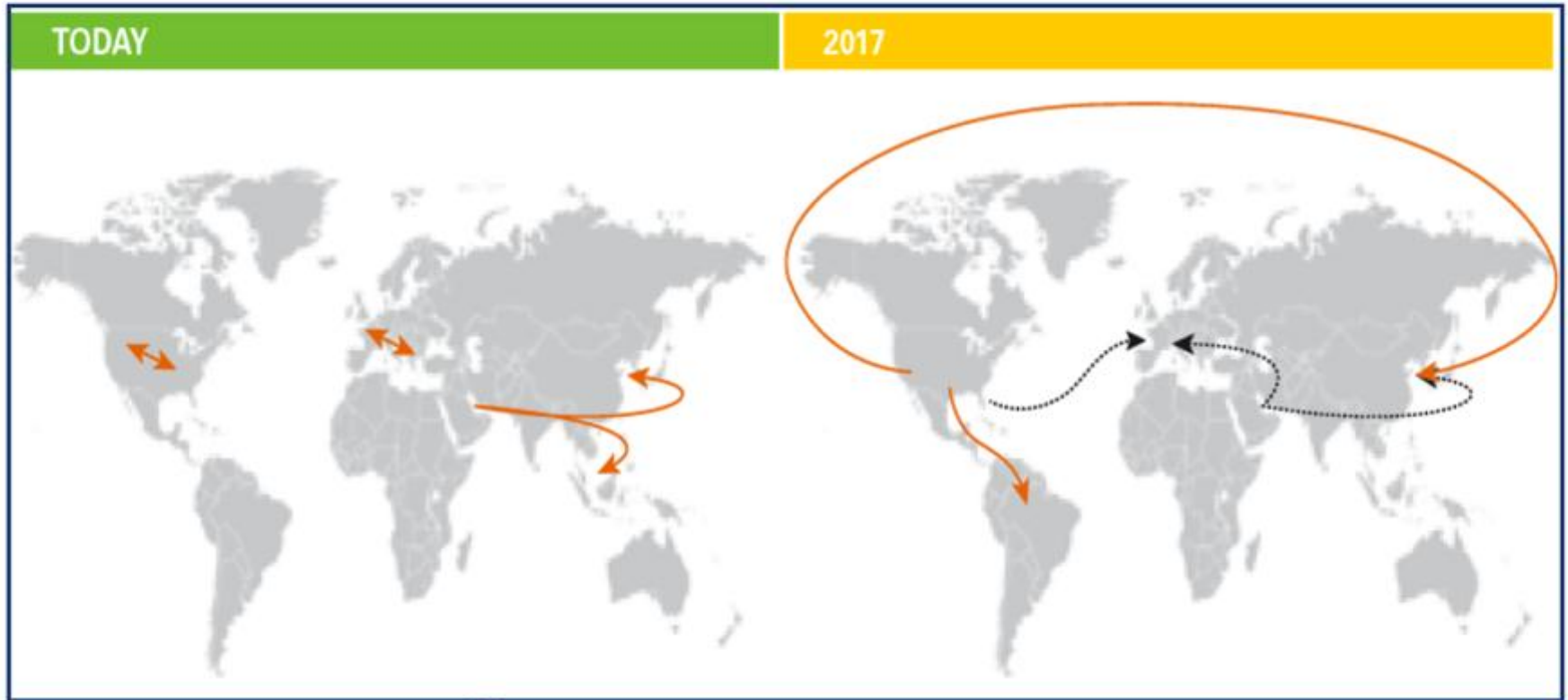


Towards a new "silk road"?

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

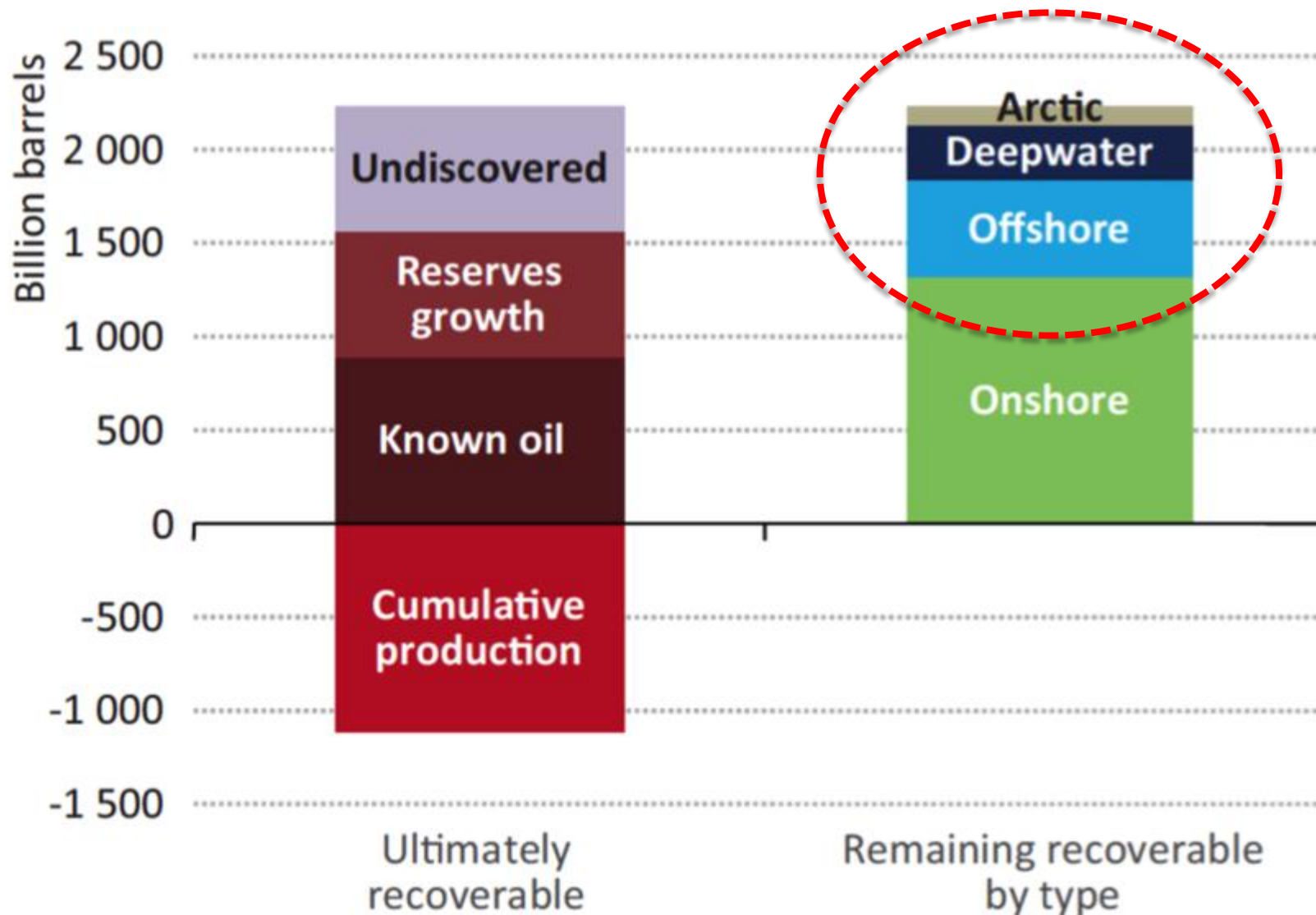


As well as for chemical products



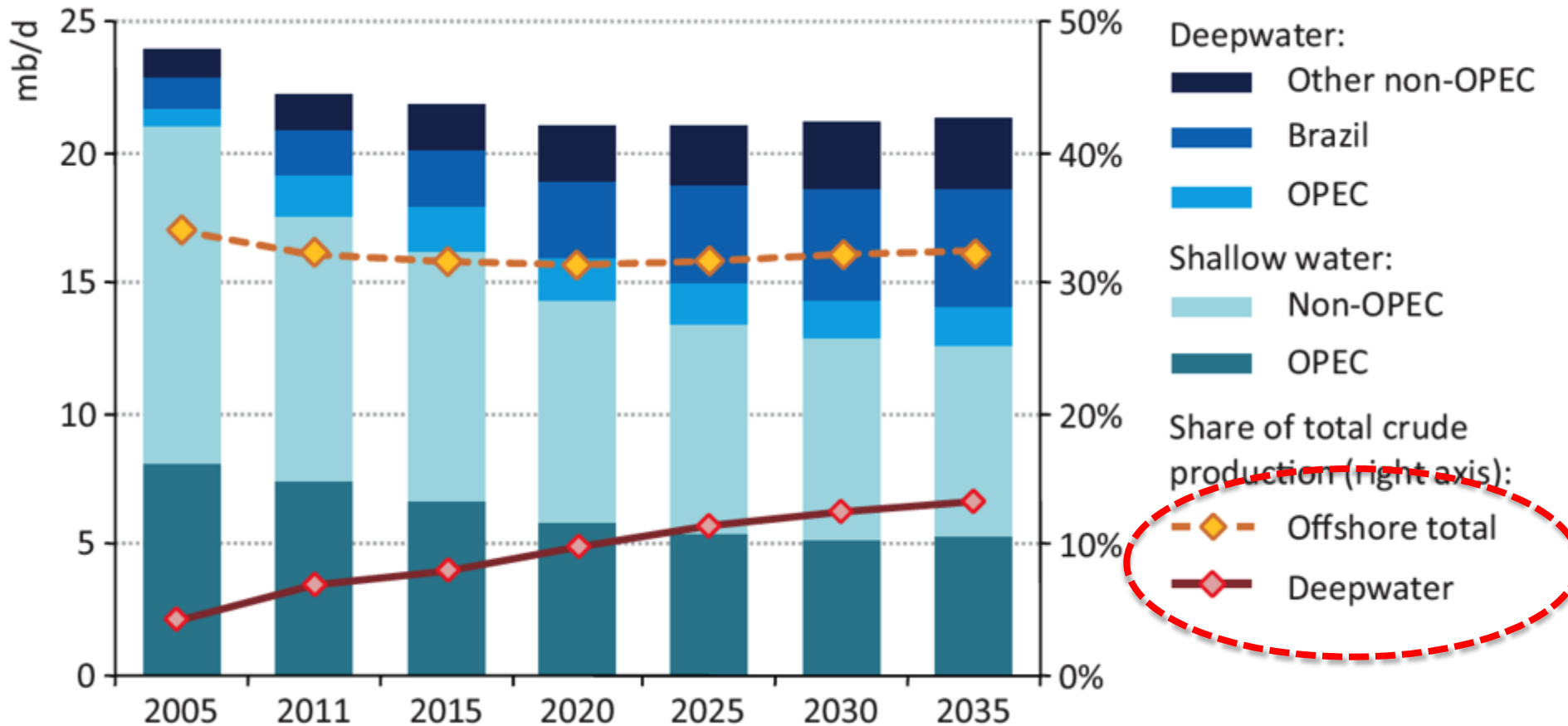


Offshoring and deepwater (1/2)

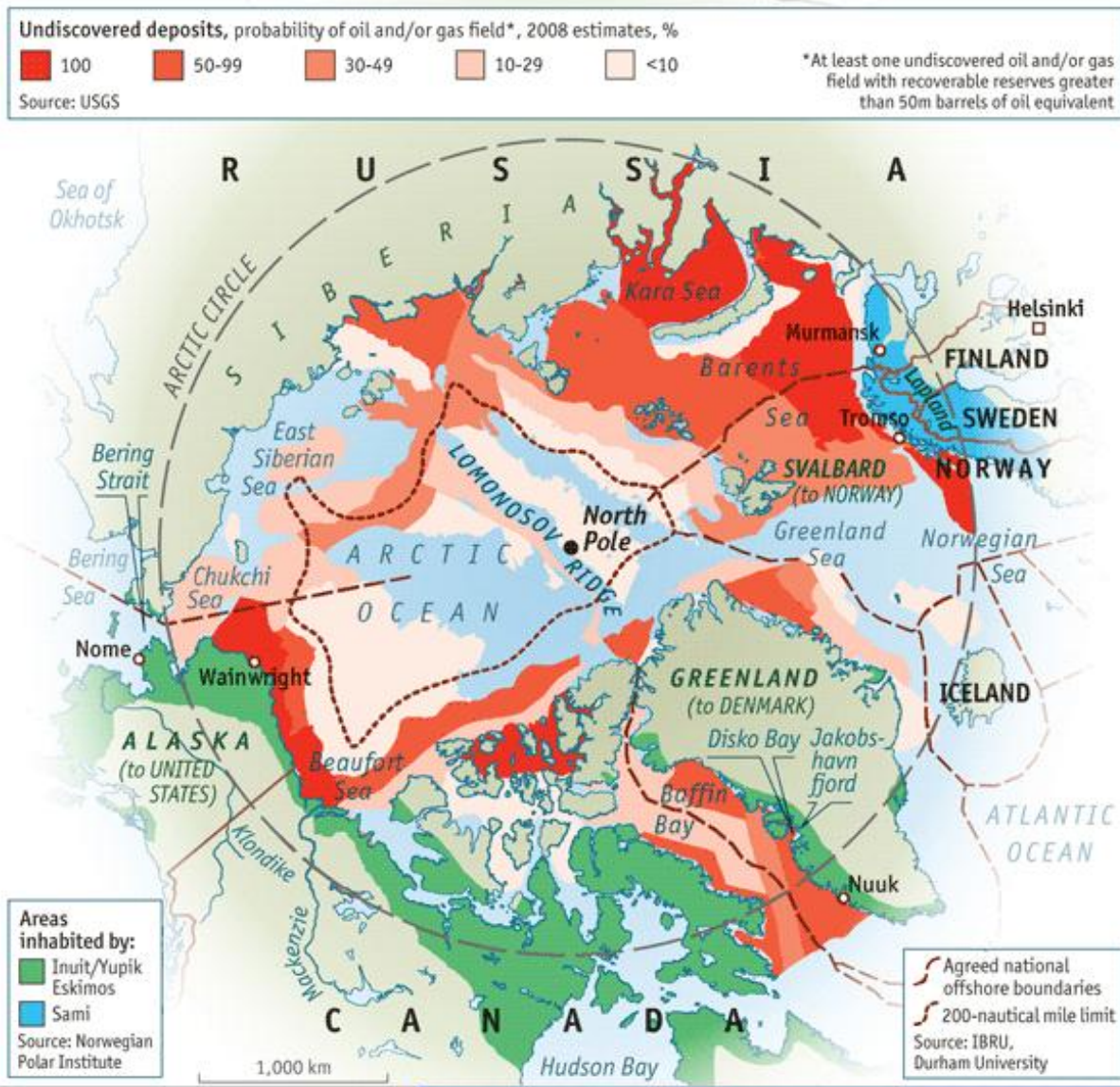




Offshoring and deepwater (2/2)



Potentially extreme (and risky) conditions





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Oceans as energy laboratories (1/2)...

OCEAN CURRENTS



"Ocean currents can provide vast potential for power generation - some are five times as energy-dense as the world's best wind power sites."
- Florida Atlantic University's Center of Excellence in Ocean Energy

WAVE ENERGY

Ocean Power Delivery's Pelamis wave device operating today off Portugal's coast.



"The total power of waves breaking on the world's coastlines is estimated at 2 to 3 million megawatts. Each day the oceans absorb enough heat from the sun to equal the thermal energy contained in 250 billion barrels of oil" - DOE's Energy Efficiency and Renewable Energy website

OFFSHORE WIND



"Today wind power provides 20% of Danish electricity consumption; it is to increase to 50% by 2025, mostly offshore."
- Denmark Ministry for Transport and Energy

OTEC ENERGY



"The U.S. Department of Energy concluded in 1976 that OTEC could produce twenty million kilowatts by the year 2000, an amount three-and-a-half times the U.S. energy demand." - U.S. Department of Energy

An OTEC facility on Keahole Point, Hawaii produced 50,000 watts in 1993 outpacing a Japanese system's 40,000 watts in 1982.

TIDAL ENERGY

The world's largest tidal power plant is now under construction today off South Korea's west coast.



"The Rance (France) Tidal Power Plant has operated for over 30 years without major incidents or breakdowns for 160,000 hours and has generated 16 billion kWh at a price lower than our non-tidal generation costs."
- Electricite de France (The French Government's Electric Utility)

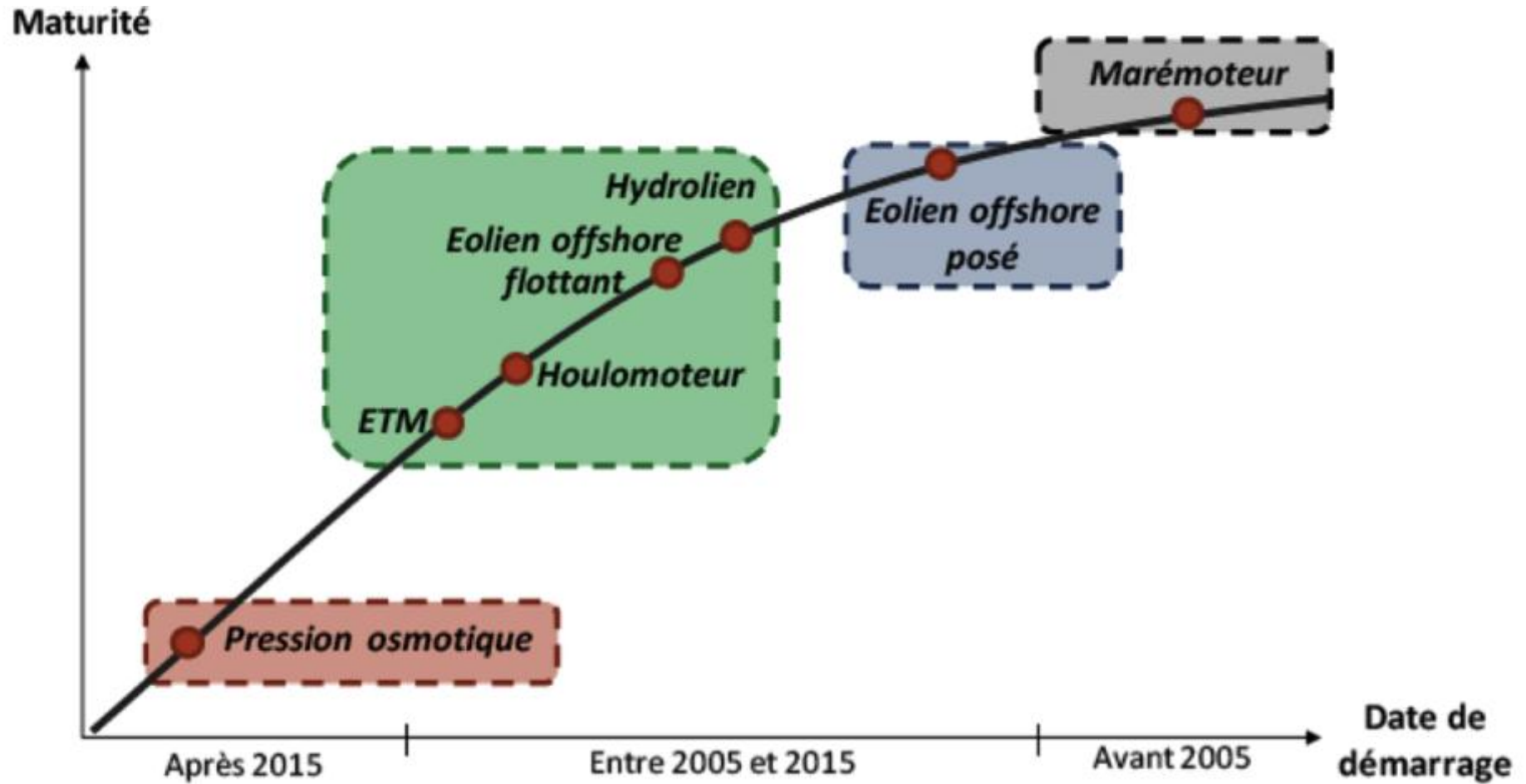


Oceans as energy laboratories (2/2)...

- **Offshore wind:** refers to the construction of wind farms in bodies of water to generate electricity from wind. Better wind speeds are available offshore compared to on land.
- **Tidal power:** the potential energy associated with tides can be harnessed by building a barrage or other forms of construction across an estuary.
- **Tidal (marine) currents:** the kinetic energy associated with tidal (marine) currents can be harnessed using modular systems.
- **Wave power:** the kinetic and potential energy associated with ocean waves can be harnessed by a range of technologies under development.
- **Temperature gradients:** the temperature gradient between the sea surface and deep water can be harnessed using different ocean thermal energy conversion (OTEC) processes.
- **Salinity gradients:** at the mouth of rivers, where freshwater mixes with saltwater, energy associated with the salinity gradient can be harnessed using the pressure-retarded reverse osmosis process and associated conversion technologies.

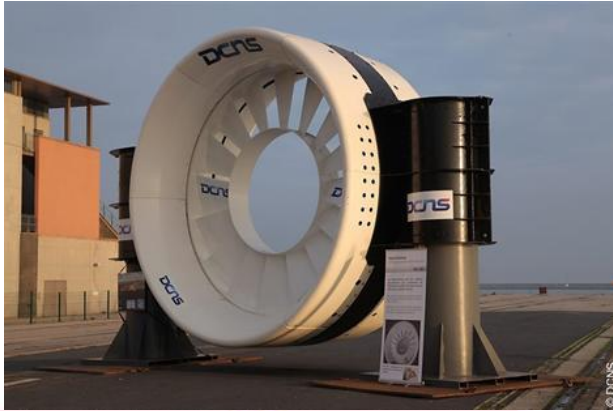


...with diverse levels of maturity





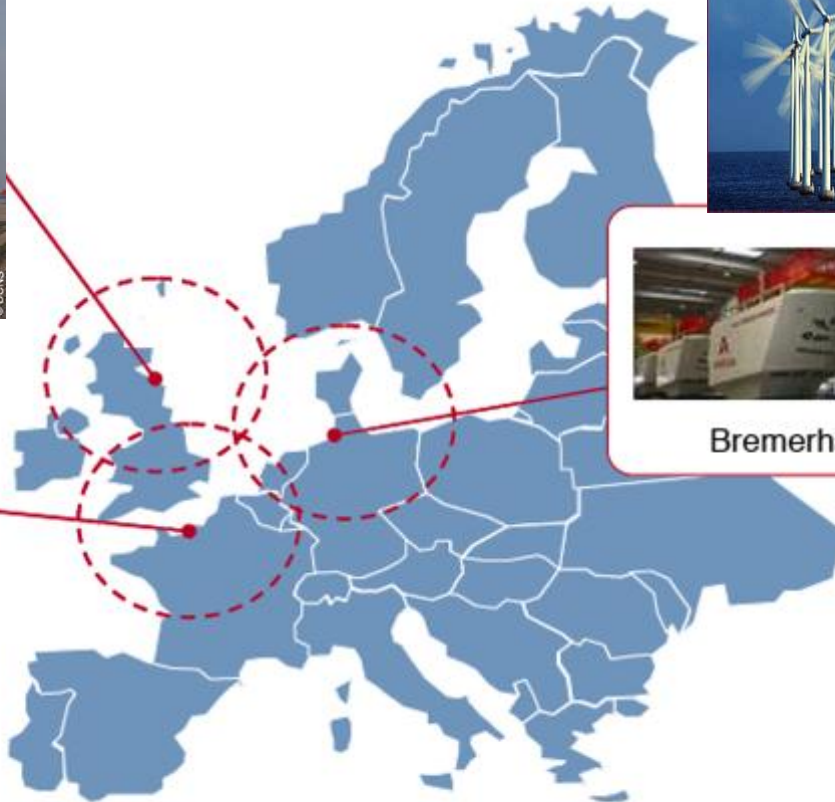
A potential game changer for the ports' business models (1/2)



Le Havre

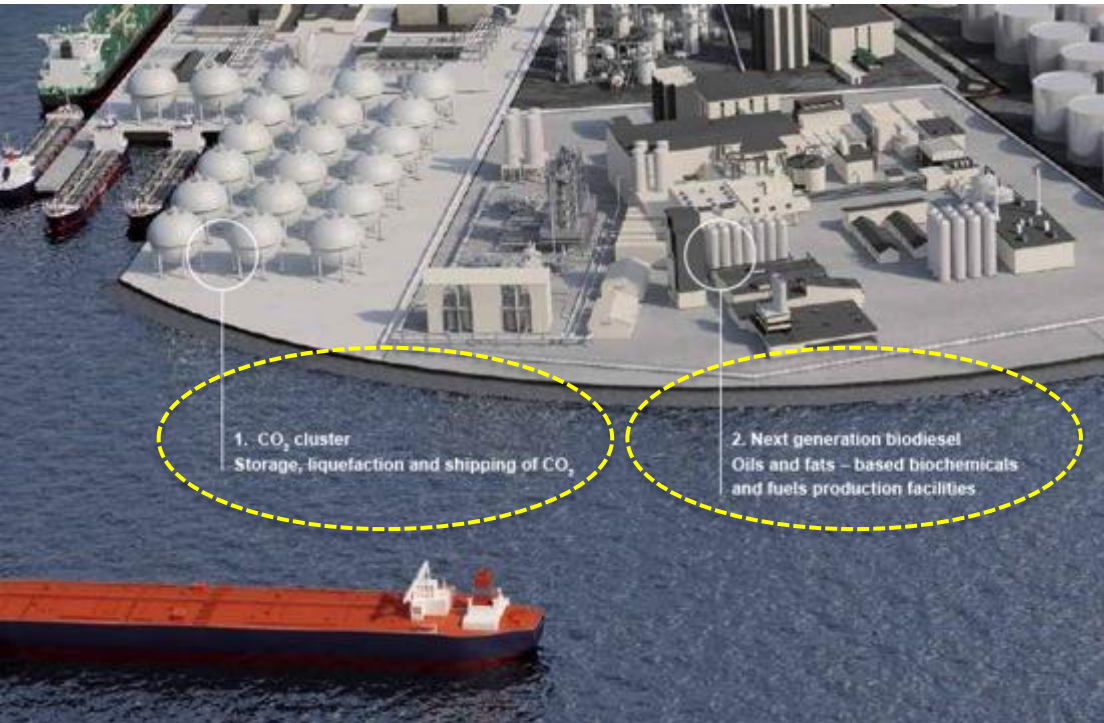


Bremerhaven - Stade





A potential game changer for the ports' business models (2/2)

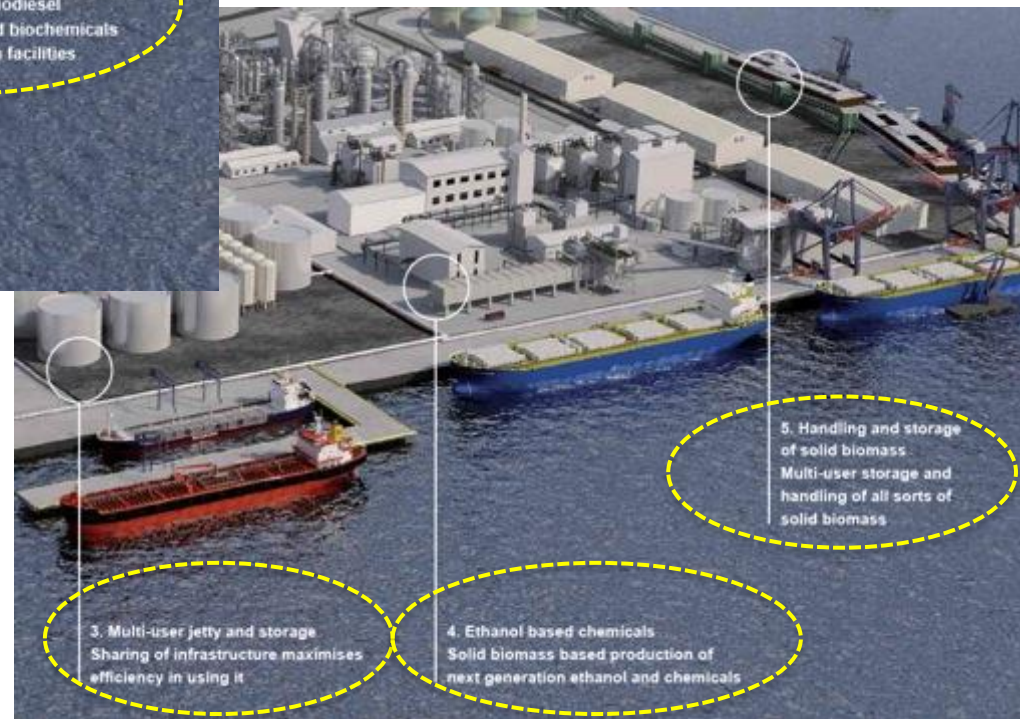


1. CO₂ cluster
Storage, liquefaction and shipping of CO₂

2. Next generation biodiesel
Oils and fats – based biochemicals
and fuels production facilities



Focus on Rotterdam



3. Multi-user jetty and storage
Sharing of infrastructure maximises
efficiency in using it

4. Ethanol based chemicals
Solid biomass based production of
next generation ethanol and chemicals

5. Handling and storage
of solid biomass
Multi-user storage and
handling of all sorts of
solid biomass

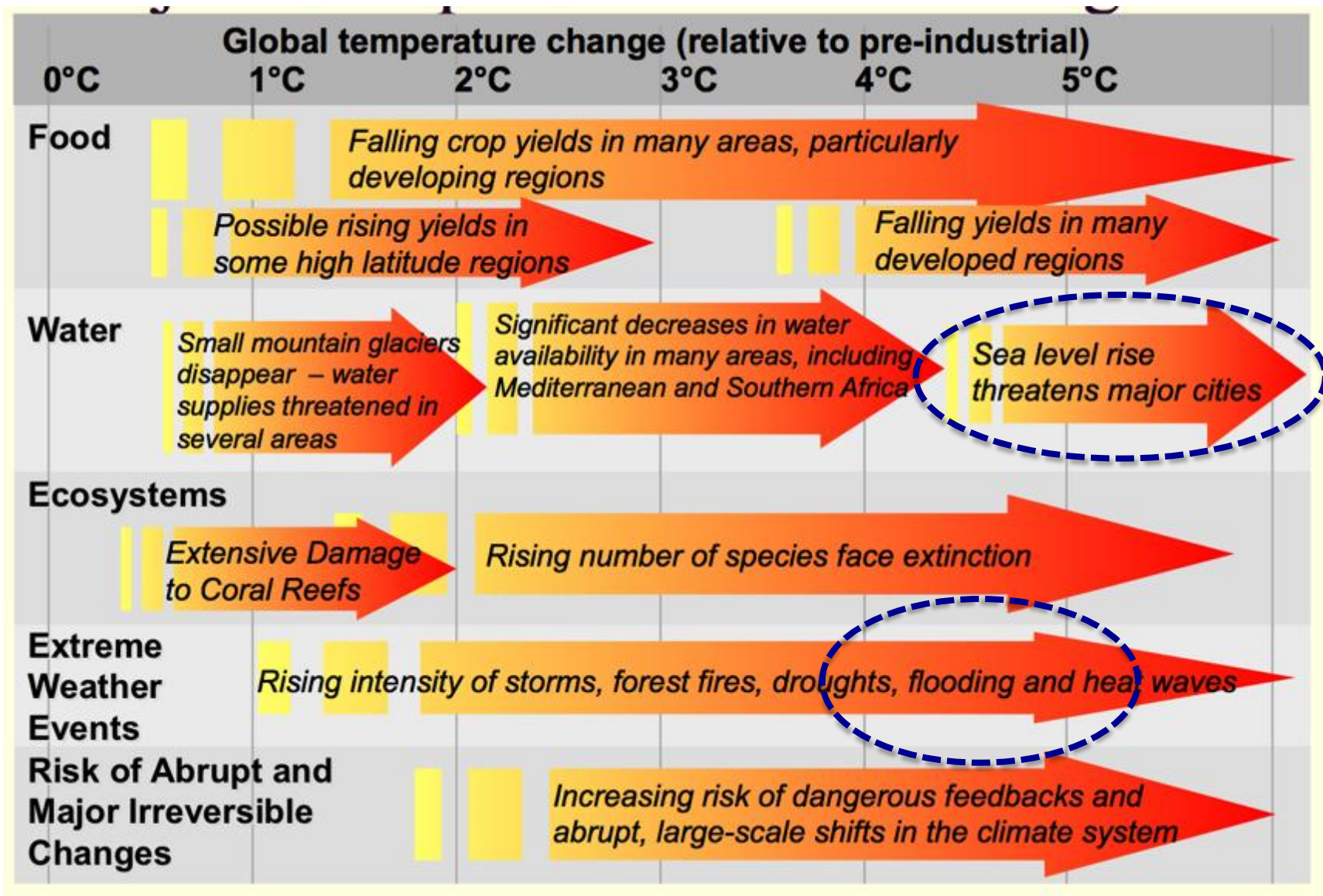


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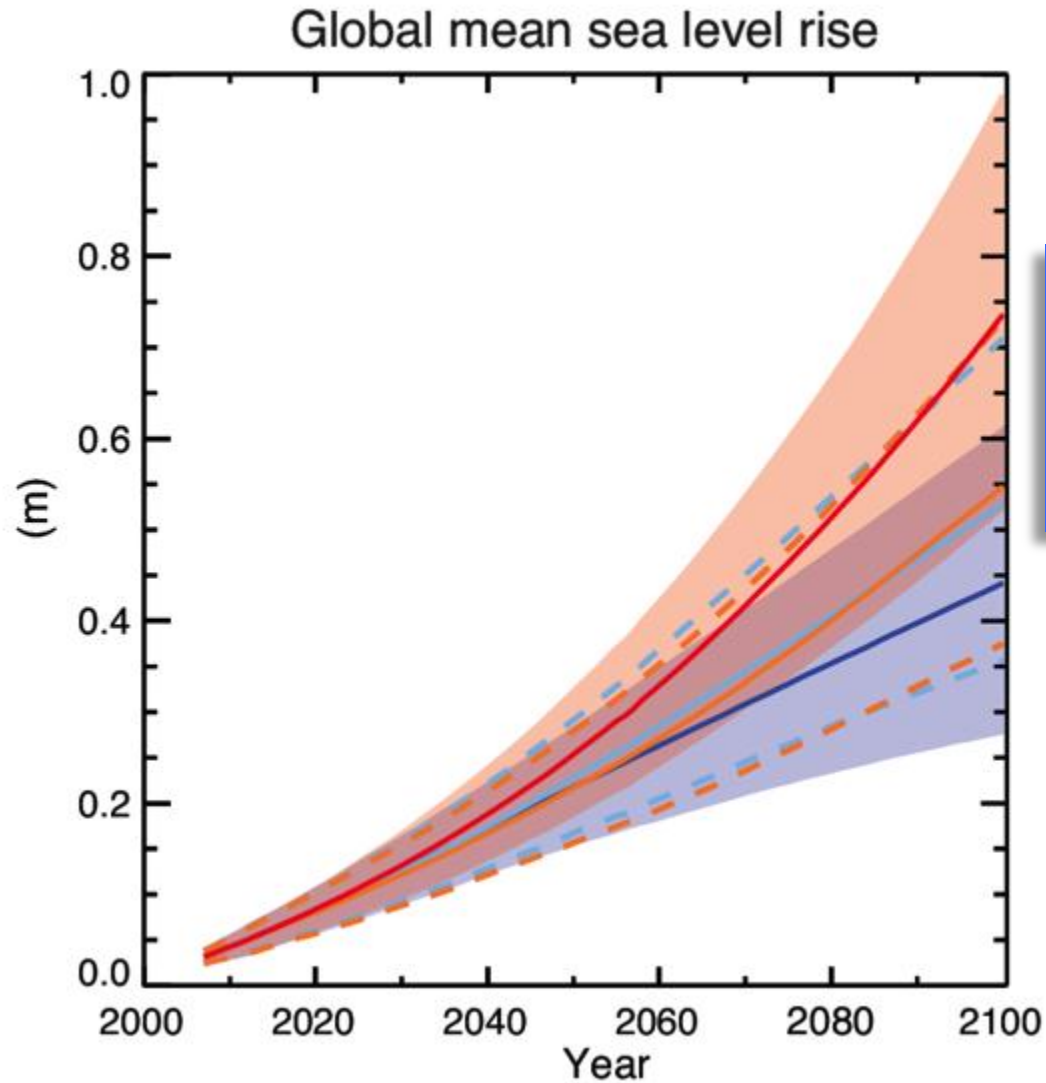


Potential effects of climate change





Focus on the sea level rise

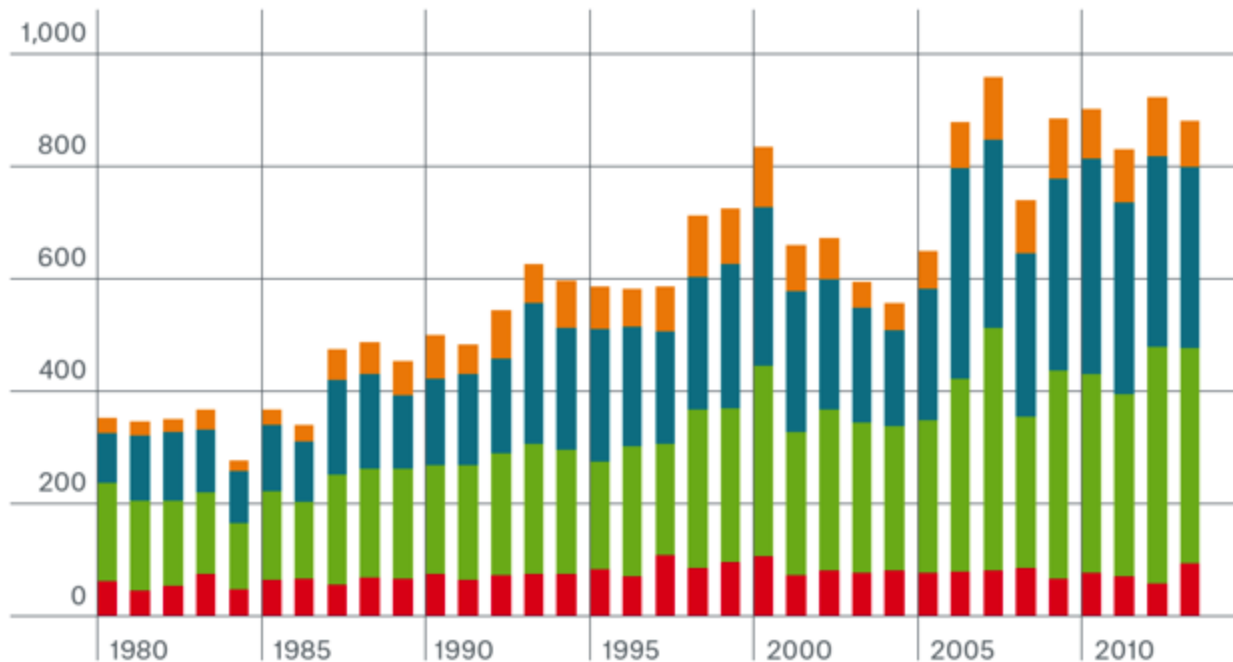


*Up to +1
meter in
2100*



New risk are already present (1/2)

Number of loss events 1980-2013

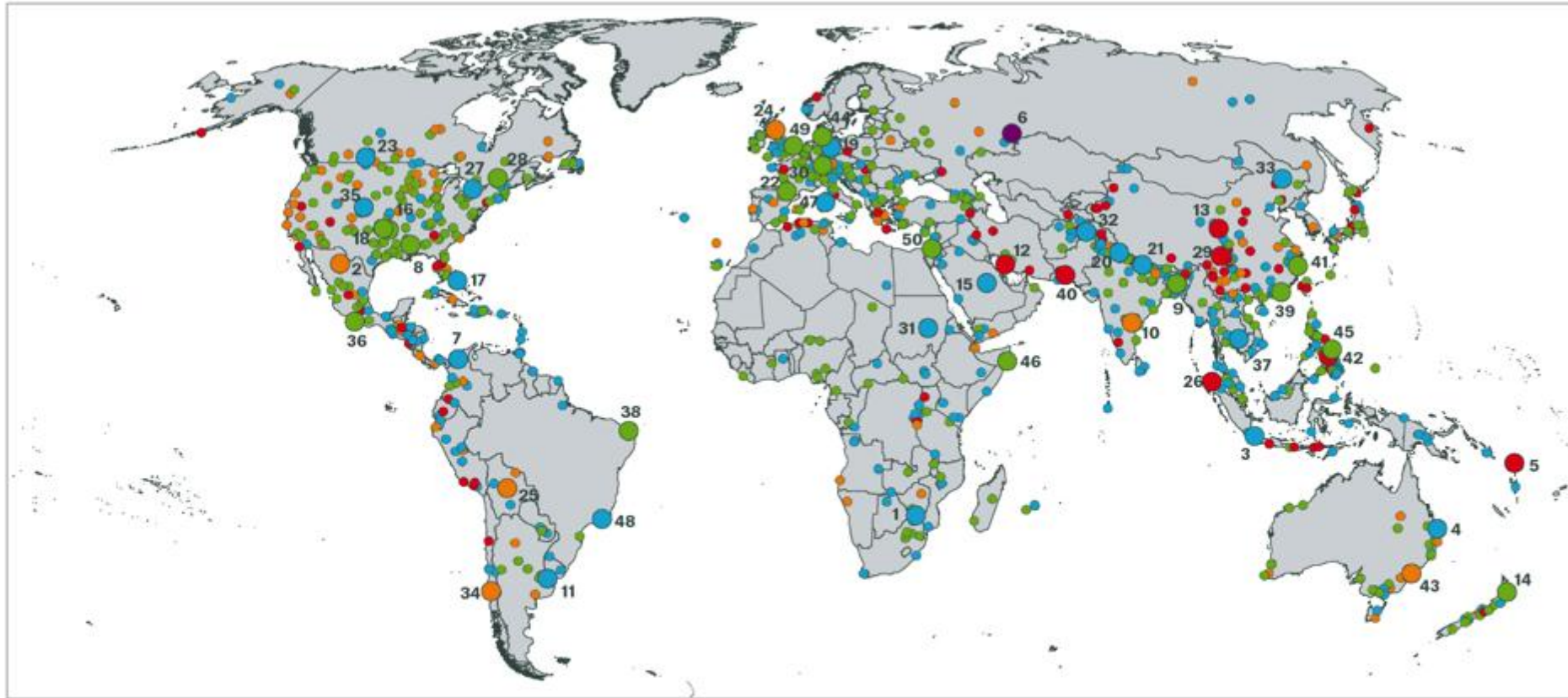


- Geophysical events:
Earthquake, tsunami,
volcanic eruption
- Meteorological events:
Tropical storm, extratropical
storm, convective storm,
local storm
- Hydrological events:
Flooding, mass movement
- Climatological events:
Extreme temperatures,
drought, wildfire

Source: Munich Re



New risk are already present (2/2)



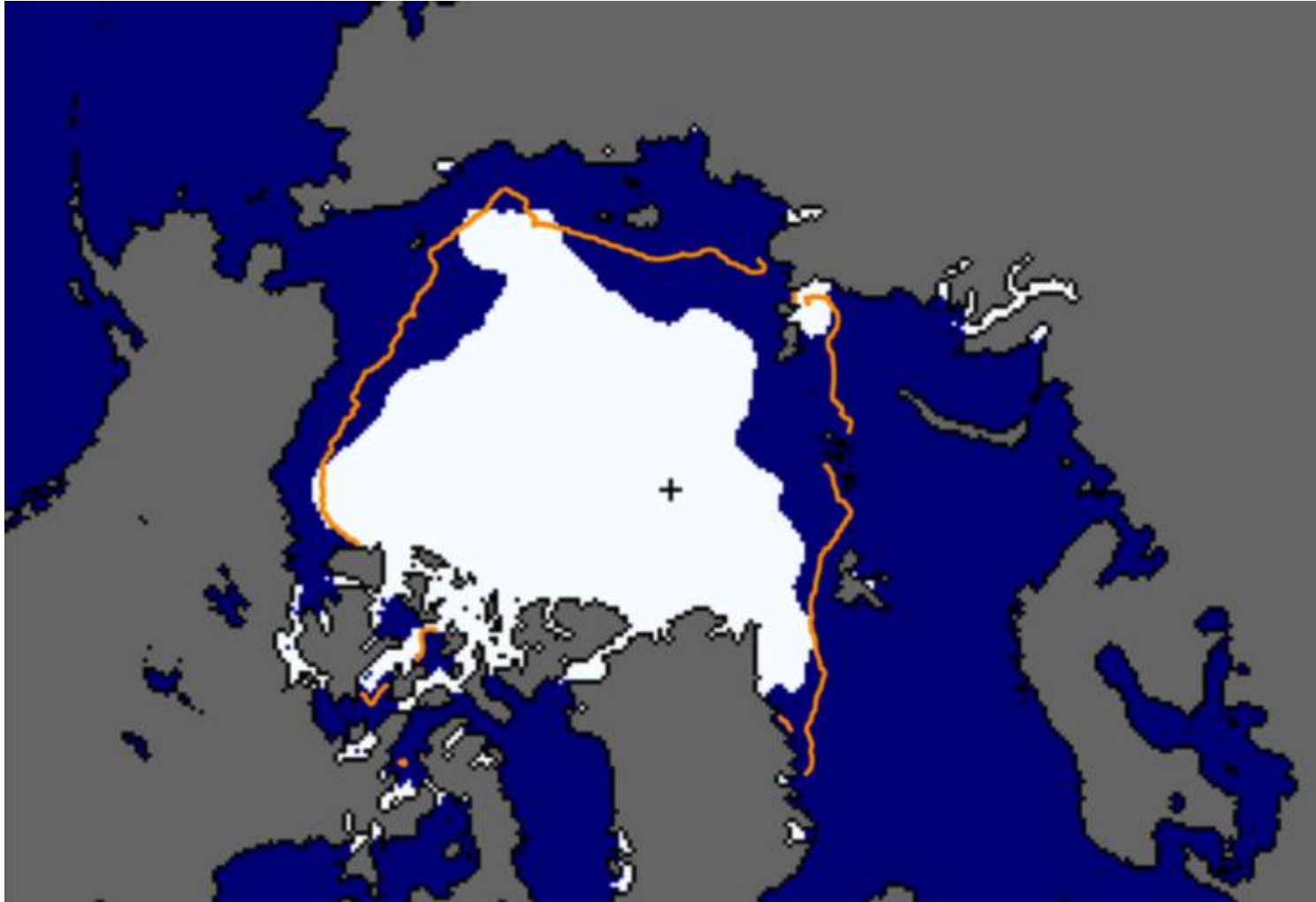
890 natural hazard events, thereof

○ 50 major events (selection)

- Geophysical events: Earthquake, tsunami, volcanic eruption
- Meteorological events: Tropical storm, extratropical storm, convective storm, local storm
- Hydrological events: Flooding, mass movement
- Climatological events: Extreme temperatures, drought, wildfire
- Extraterrestrial events: Meteorite impact

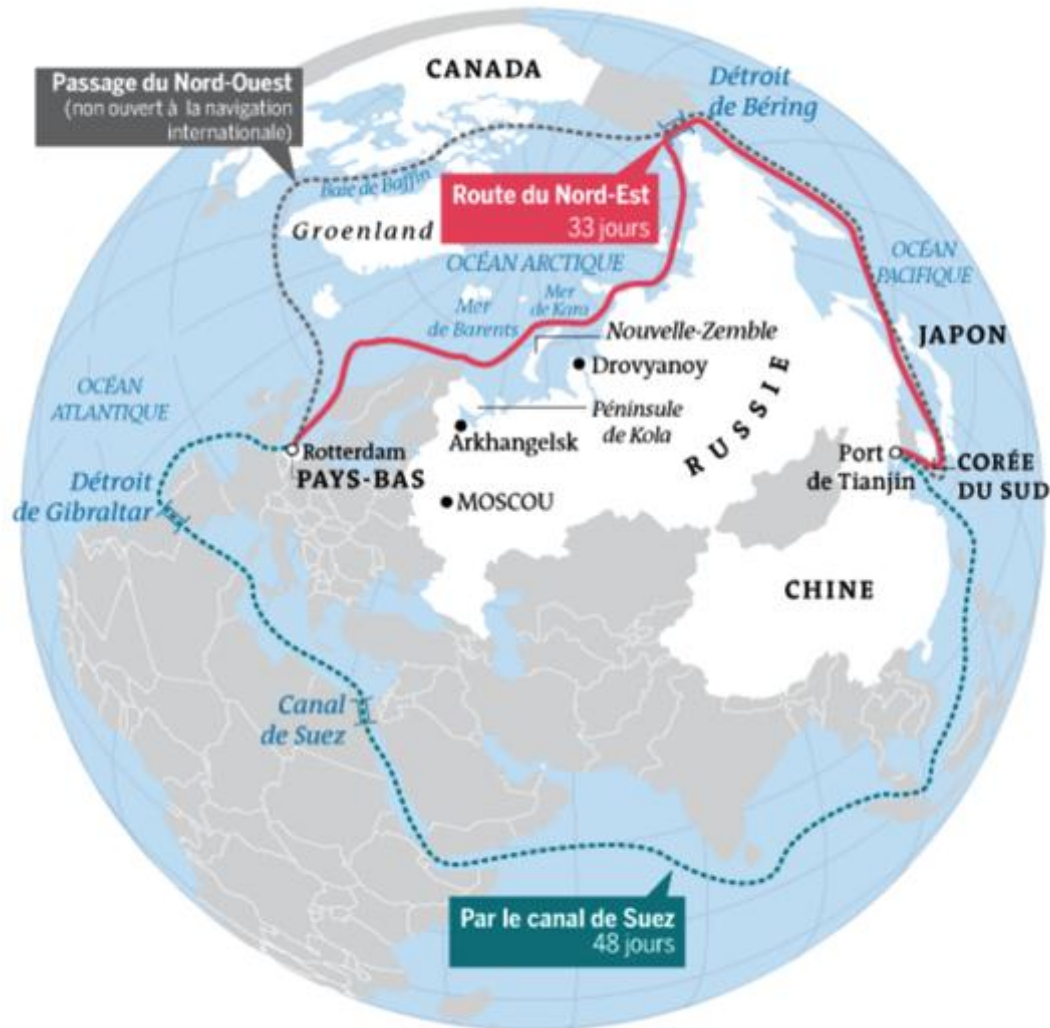


Climate change will also open new trade routes (1/2)



Size of Arctic in 2013, compared to the 1980-2012 average

Climate change will also open new trade routes (2/2)



SOURCES : PNUE - NATIONAL SNOW AND ICE DATA CENTER - IARC-JAXA ; ROSATOMFLOT
INFOGRAPHIE LE MONDE



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A kaleidoscope of new risks (and markets)



The complexity of the energy landscape will (mechanically) induce new kinds of risk and need for insurance services