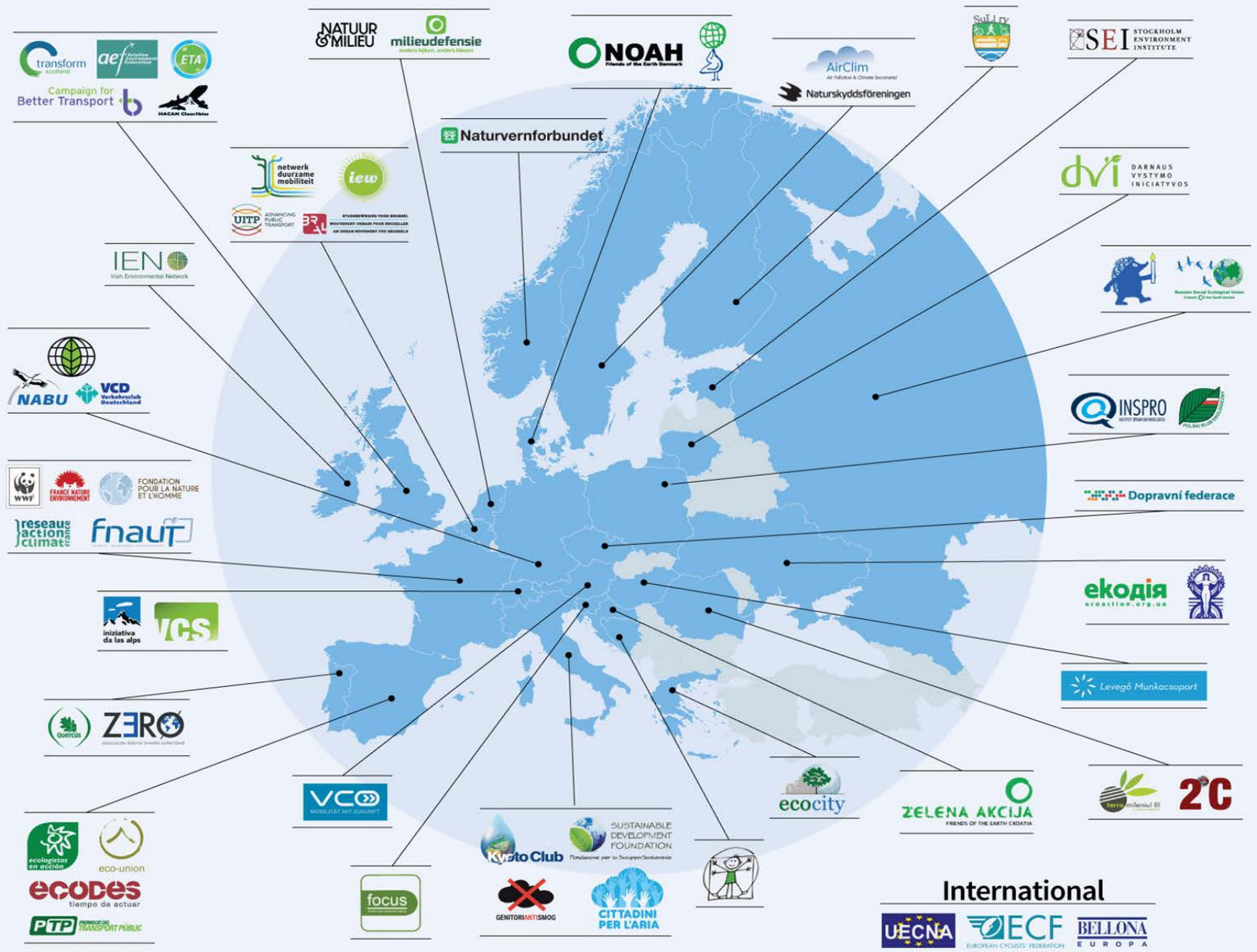


Air pollution from shipping Mediterranean ECA

Bill Hemmings

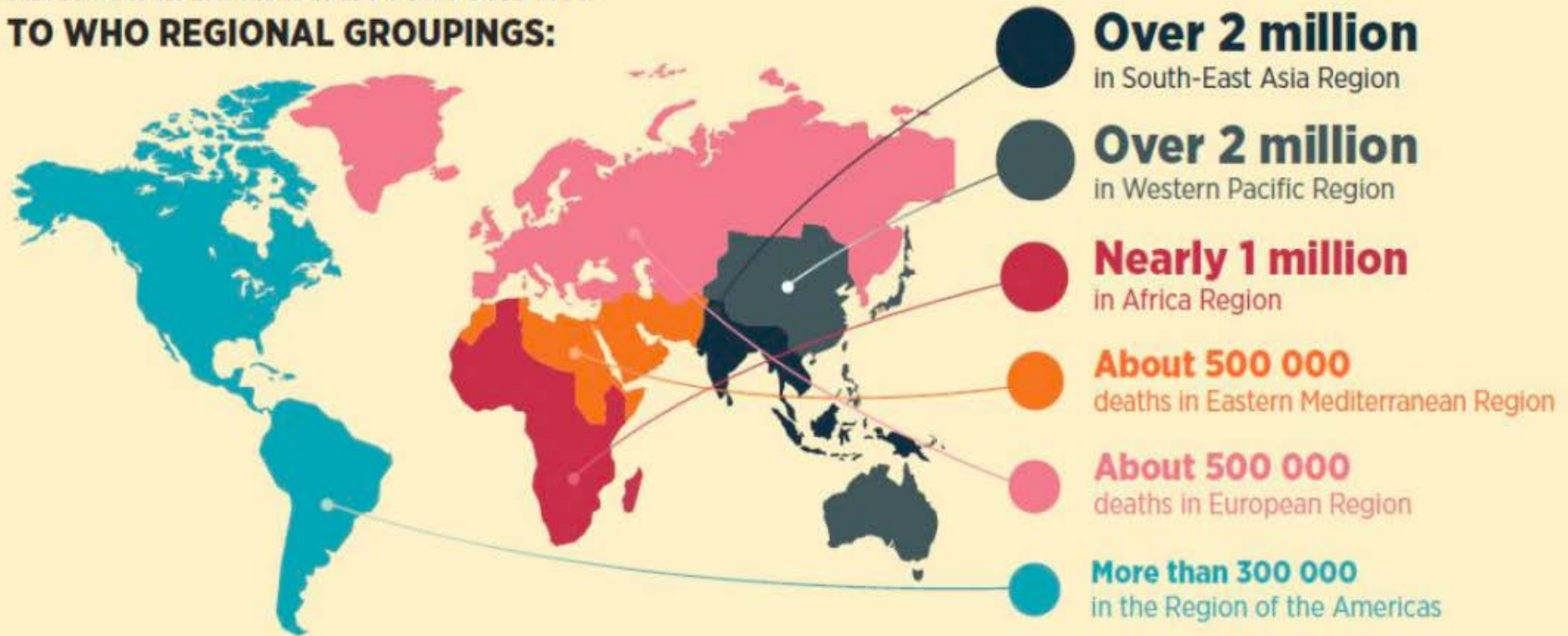
TRANSPORT & ENVIRONMENT

2



Air pollution is the 'new tobacco', warns WHO Time to tackle this epidemic

REGIONAL ESTIMATES ACCORDING TO WHO REGIONAL GROUPINGS:



Air pollution levels remain dangerously high in many parts of the world. World Health Organization (WHO) data shows that 9 out of 10 people breathe air containing high levels of pollutants. Updated (2018) estimations reveal an alarming death toll of 7 million people every year caused by ambient (outdoor) and household air pollution

PM pollution cuts global average life expectancy by 1.8 years

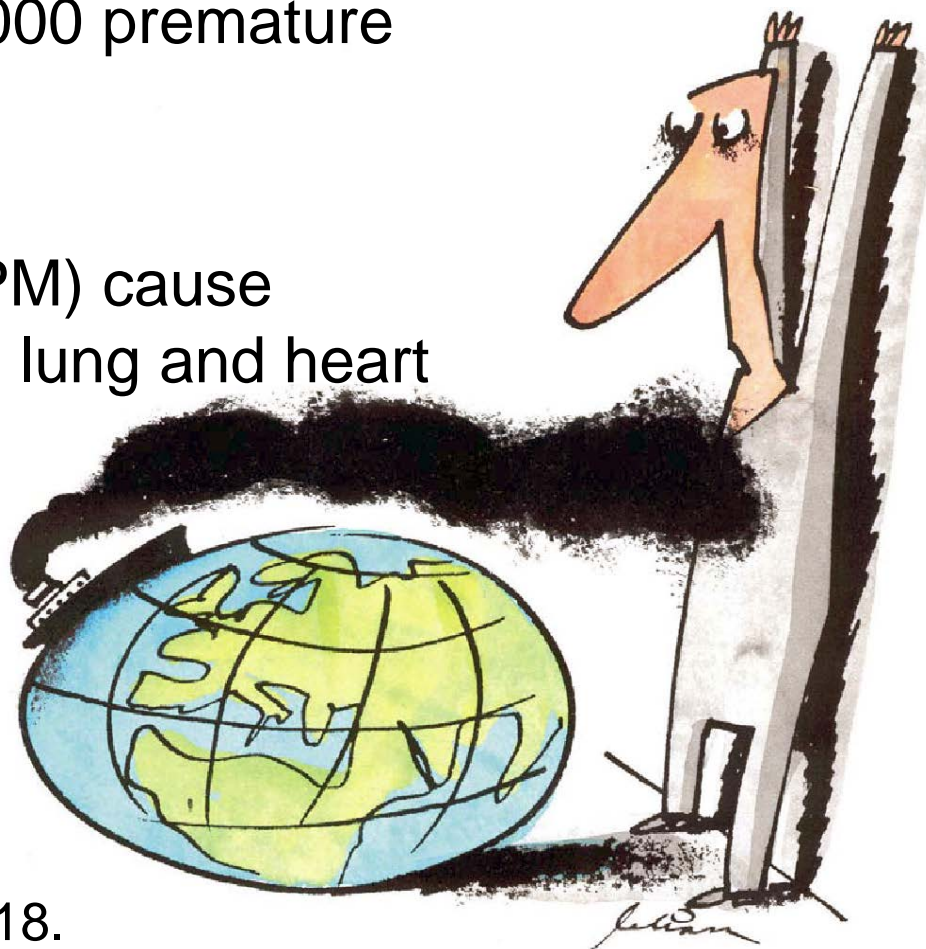


Average Life Expectancy Lost Per Person



400,000 good reasons to cut shipping air pollution

- Air pollution from international shipping is estimated to cause 400,000 premature deaths per year globally.
- Tiny airborne particles (PM) cause premature death through lung and heart disease.
- 6.4 Million childhood asthma cases

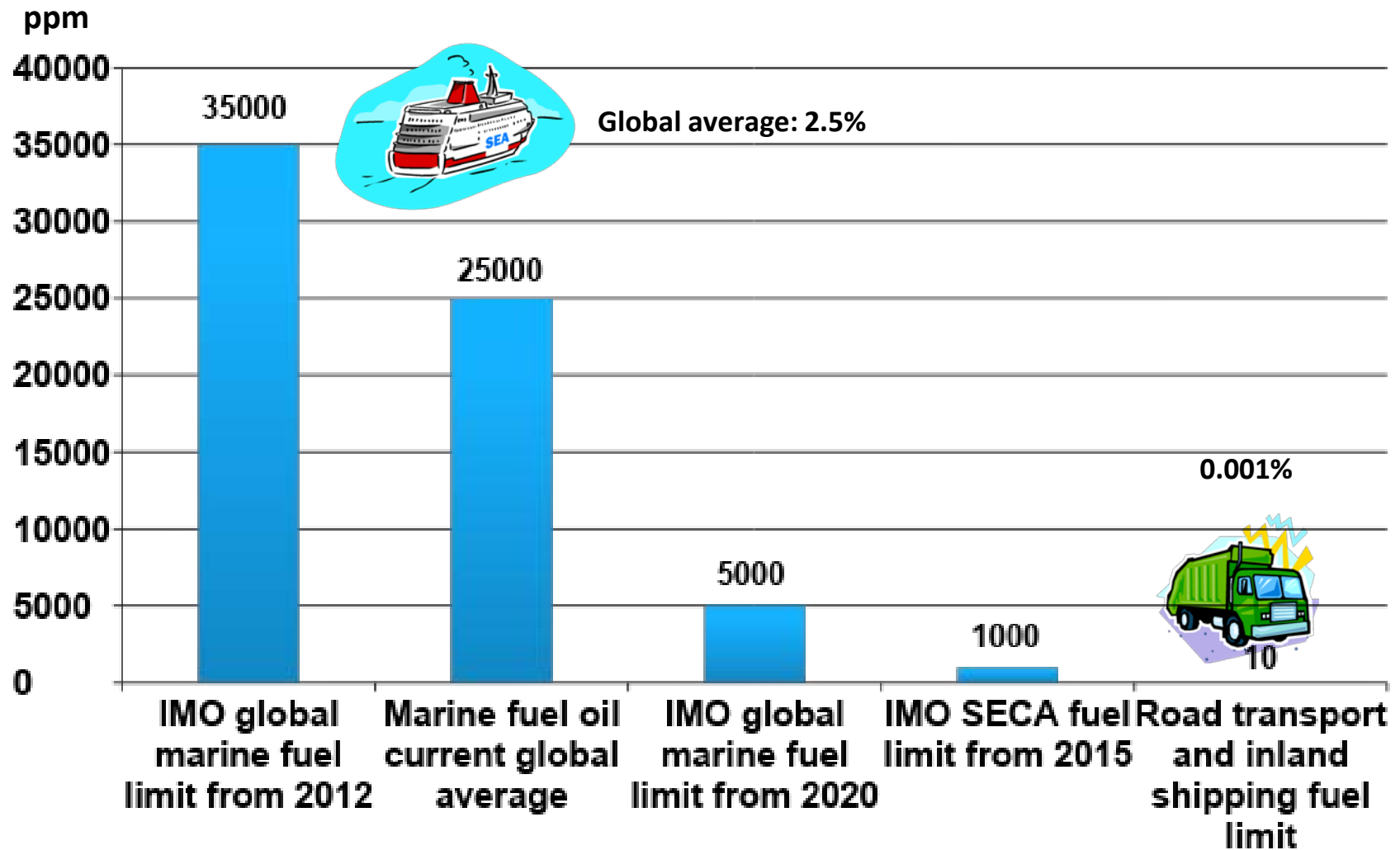


Source: Sofiev et al. Nature 2018.

Ship Air pollution

- The 15 largest ships produce as much air pollution as all the world cars ([Economist 2017](#))
- Ships burn world's dirtiest fuel - Heavy fuel oil
- produces SO_x, NO_x, Black carbon and GHG emissions
- SO_x, NO_x, PM all have significant health impacts
- Ships pollute near coasts but spreads inland
- Emissions alter pH of the water and erode facades / structures made of limestone
- Cruise ships = 3 times more emissions than similar sized cargo ships due high onboard energy use

SULPHUR CONTENT OF TRANSPORT FUELS

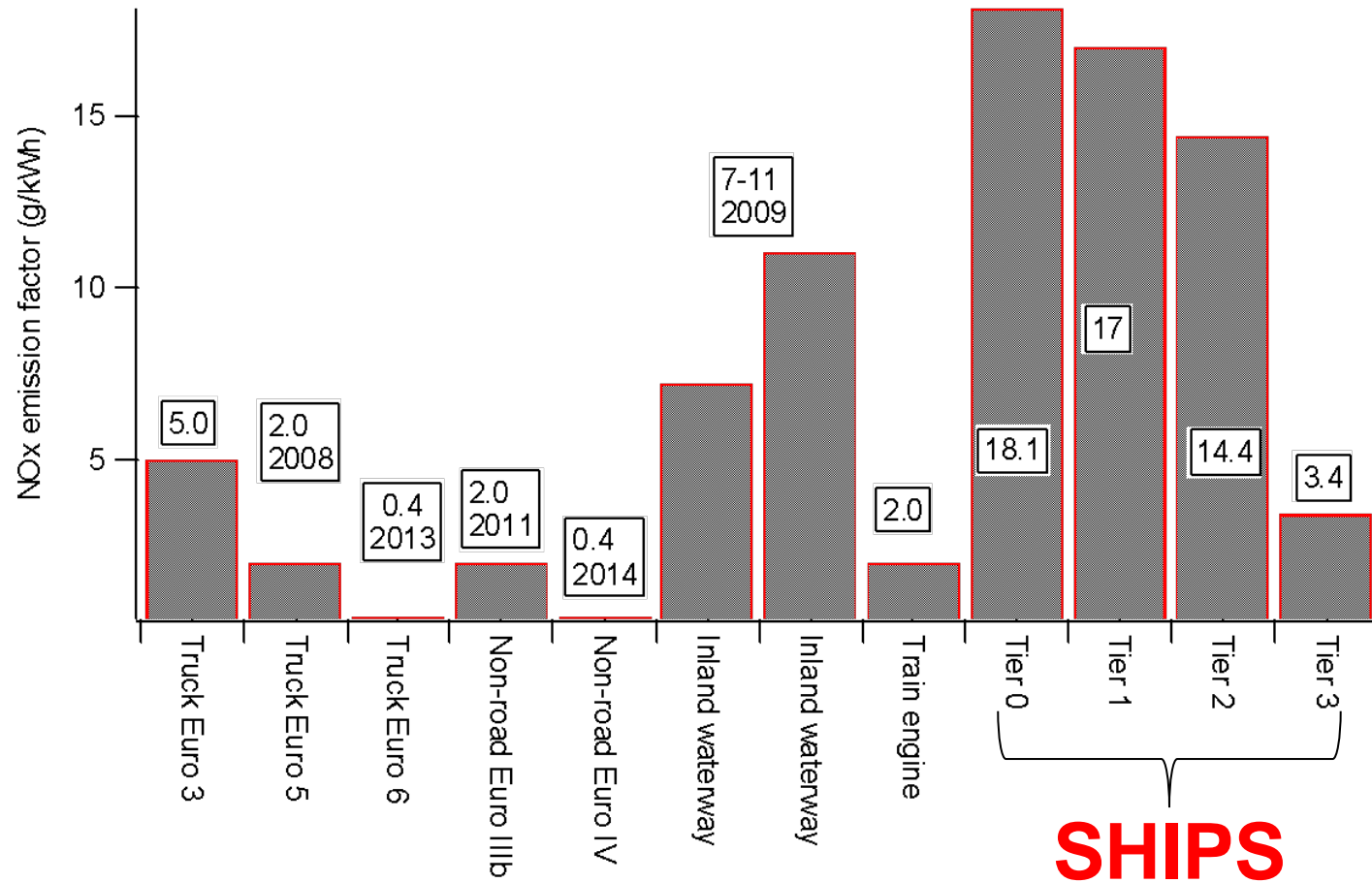


NITROGEN OXIDES

- Formed in engine cylinders at high temperatures from N_2 and O_2 in the air as NO
- Oxidised to NO_2 in the atmosphere
- NO_2 has health risks
- Secondary particles and ozone formed in the air
- Eutrophication and acidification

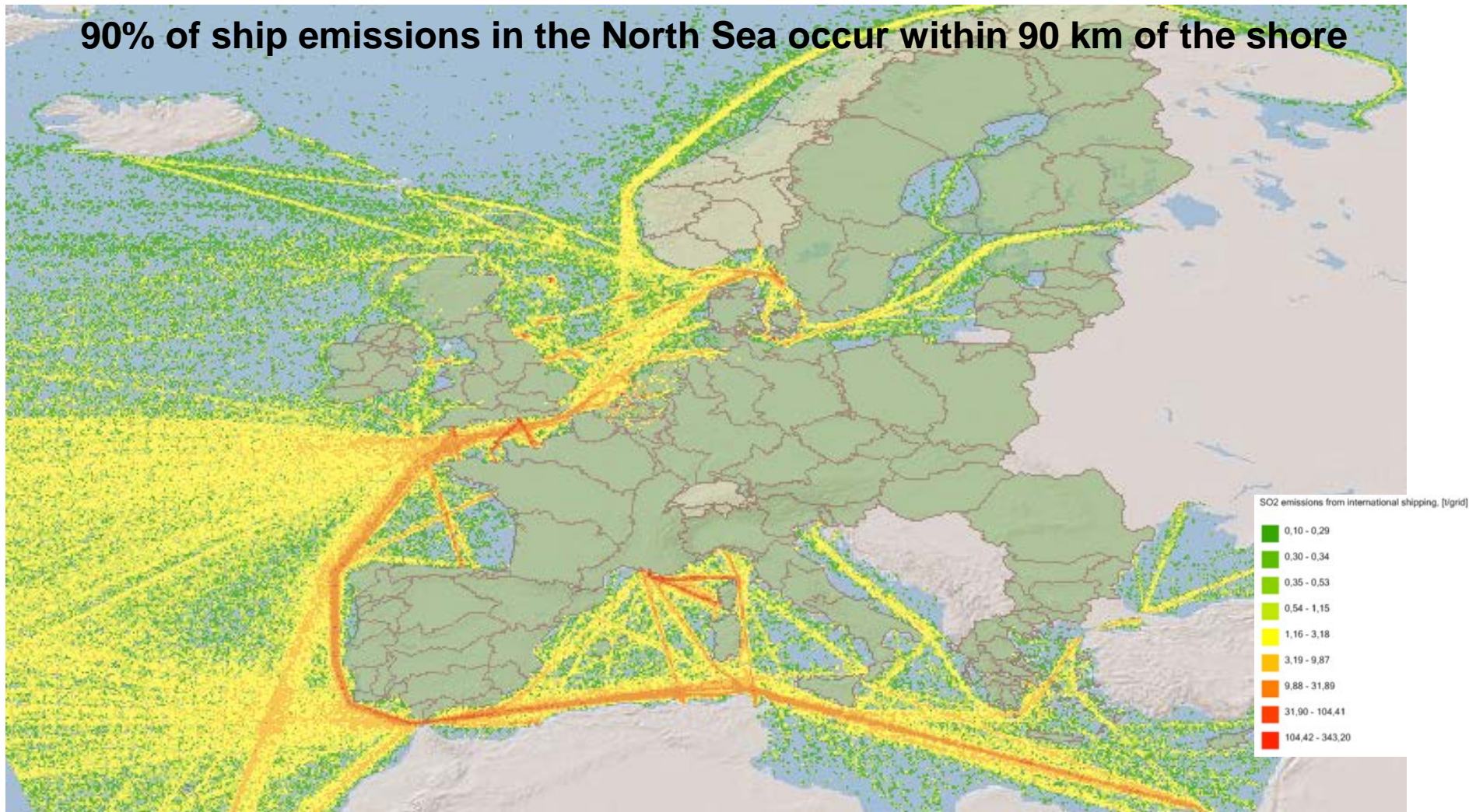


NOX EMISSIONS – DIESEL ENGINES



Air pollution is transboundary

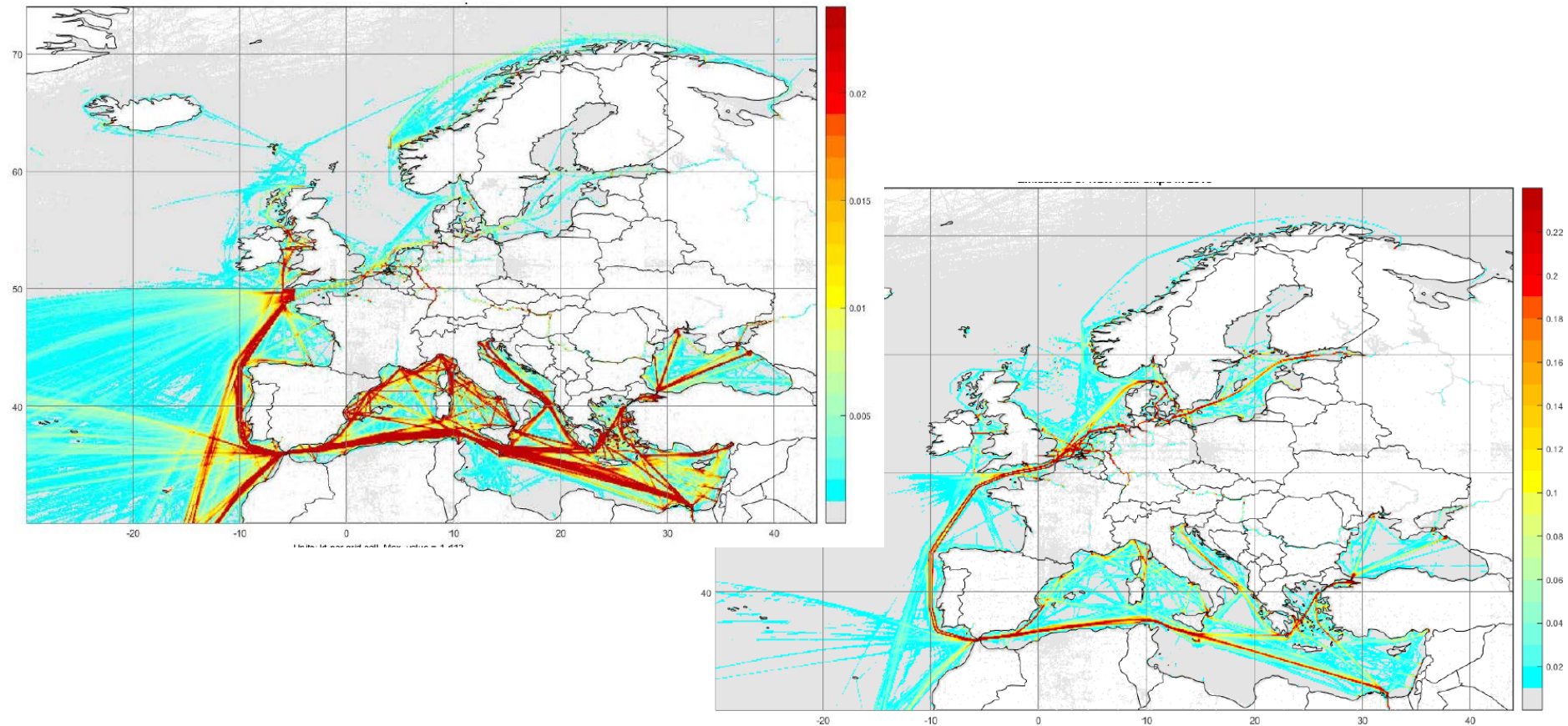
90% of ship emissions in the North Sea occur within 90 km of the shore



The European Pollutant Release and Transfer Register (2011) - <http://prtr.ec.europa.eu>

Ship emissions close to shore

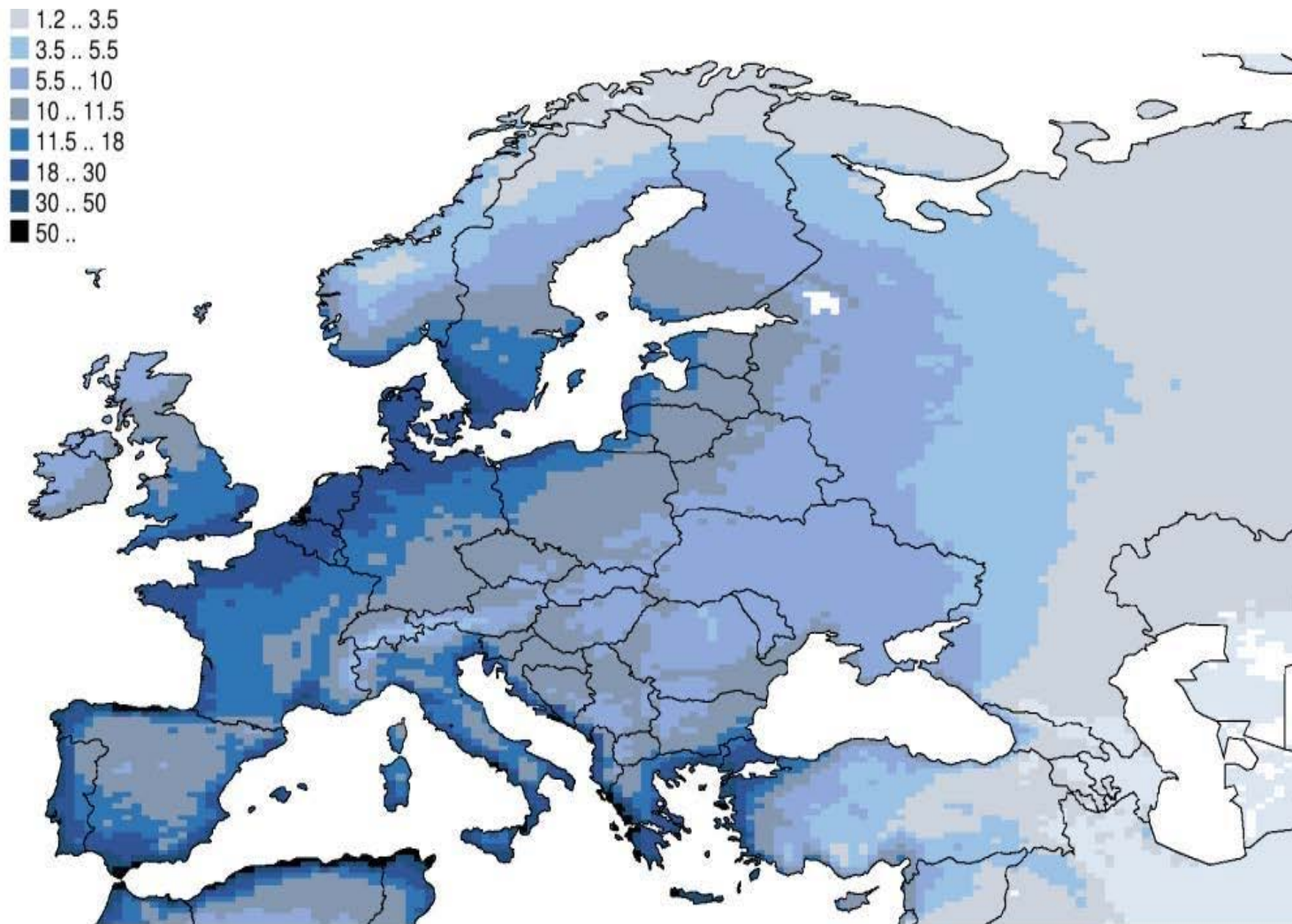
Gridded emissions 2015: At left SO₂ and at right NO_x (thousand tons/grid)



Globally, 70-80% of ship emissions take place within 400 km from shore

Sources: IIASA (2018), ICCT (2007)

SHIPPING NO_x DEPOSITION IN EUROPE (2005)



Source: *Campling et al. 2013 report to DGEnvironment, EC*

Shipping is part of Dieselgate solution not just cars and trucks!

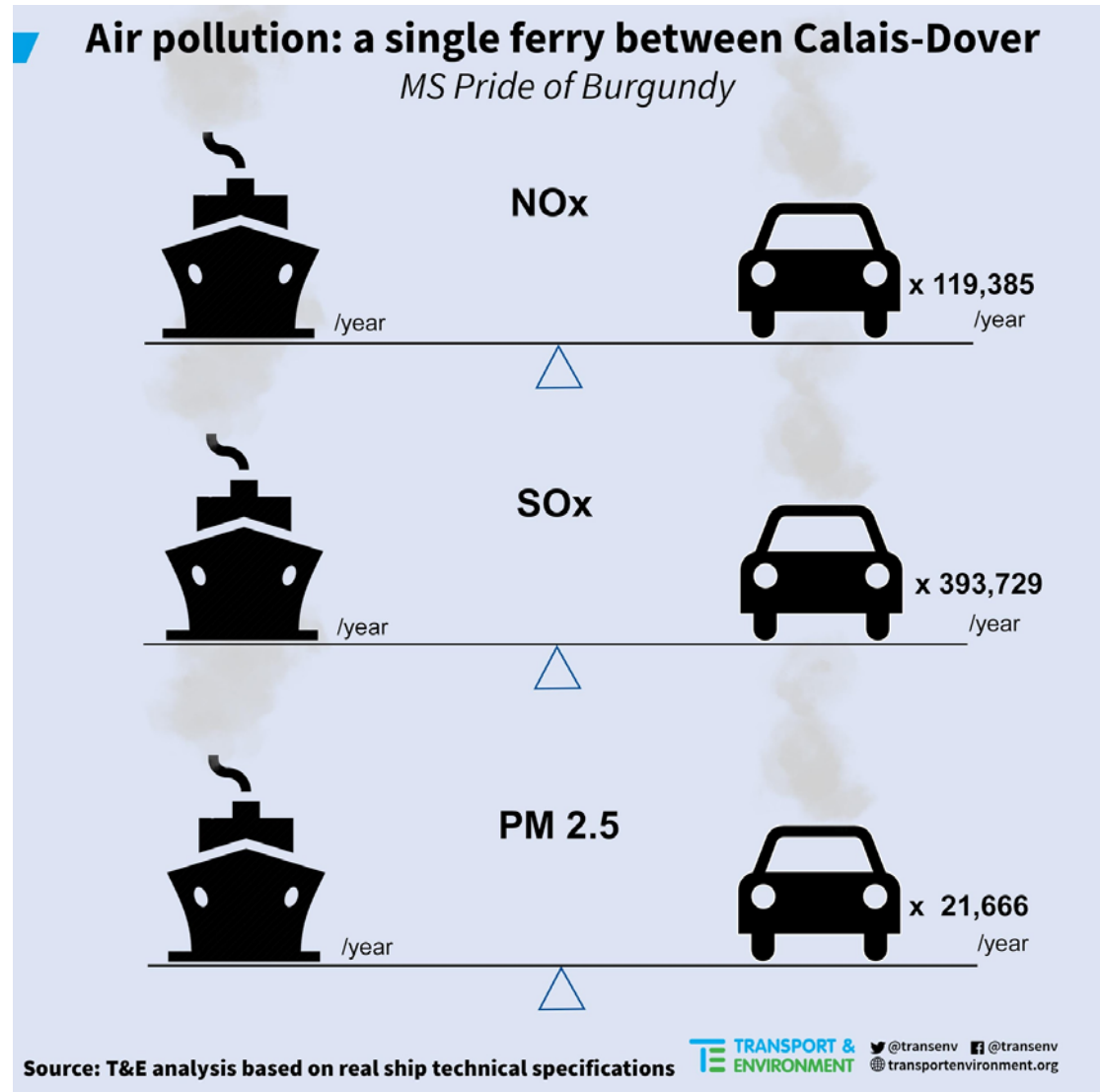
Journey: Calais-Dover

Ship: Pride of
Burgundy (~1420 pax,
530 cars)

Distance: 21 n-miles

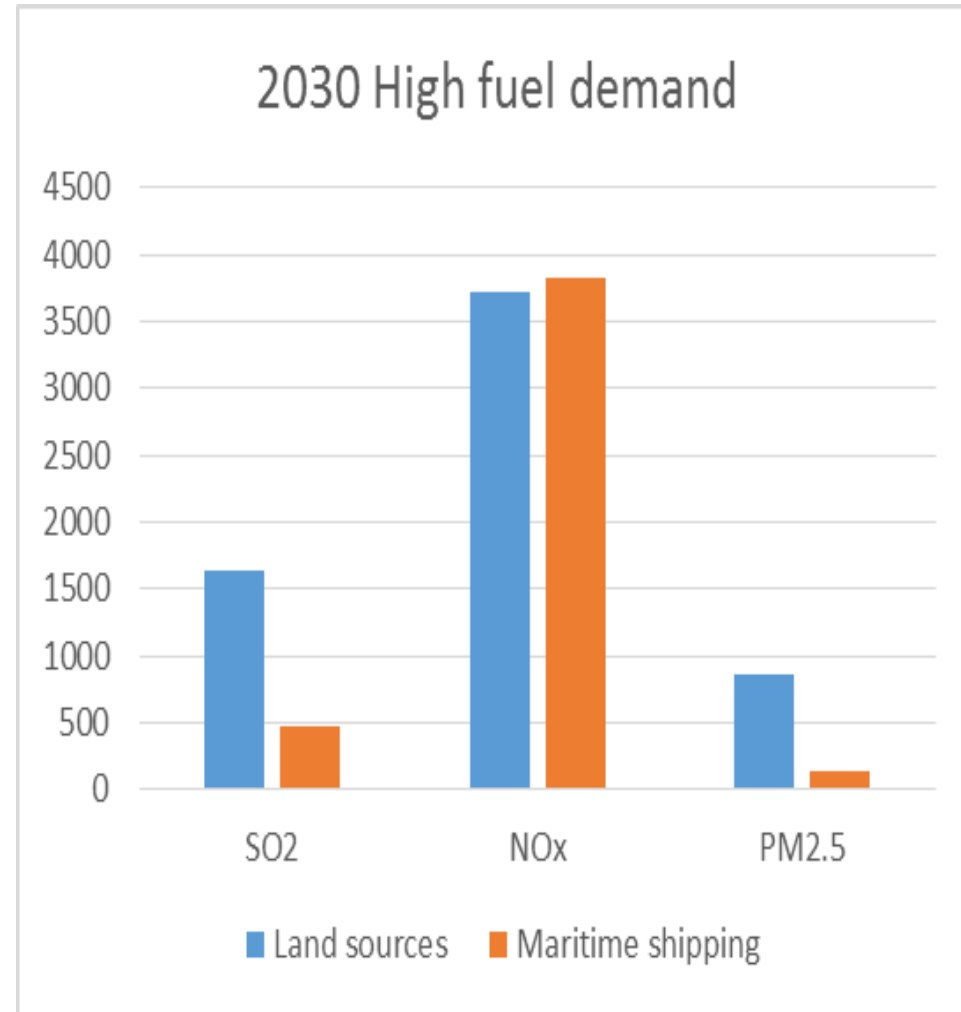
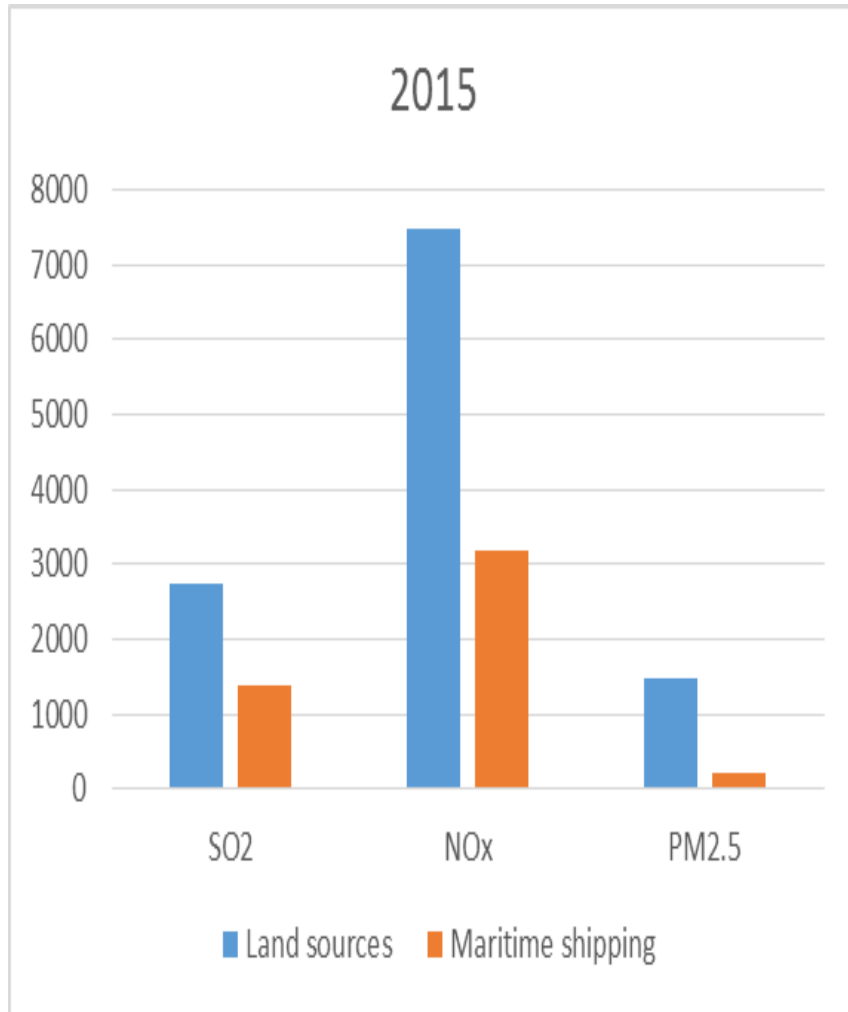
Operational profile:
209 days/year
6 journeys/day

Fuel: MGO, 1000ppm
sulphur standard



Shipping (Current laws) vs. land-based sources

(thousand tons)

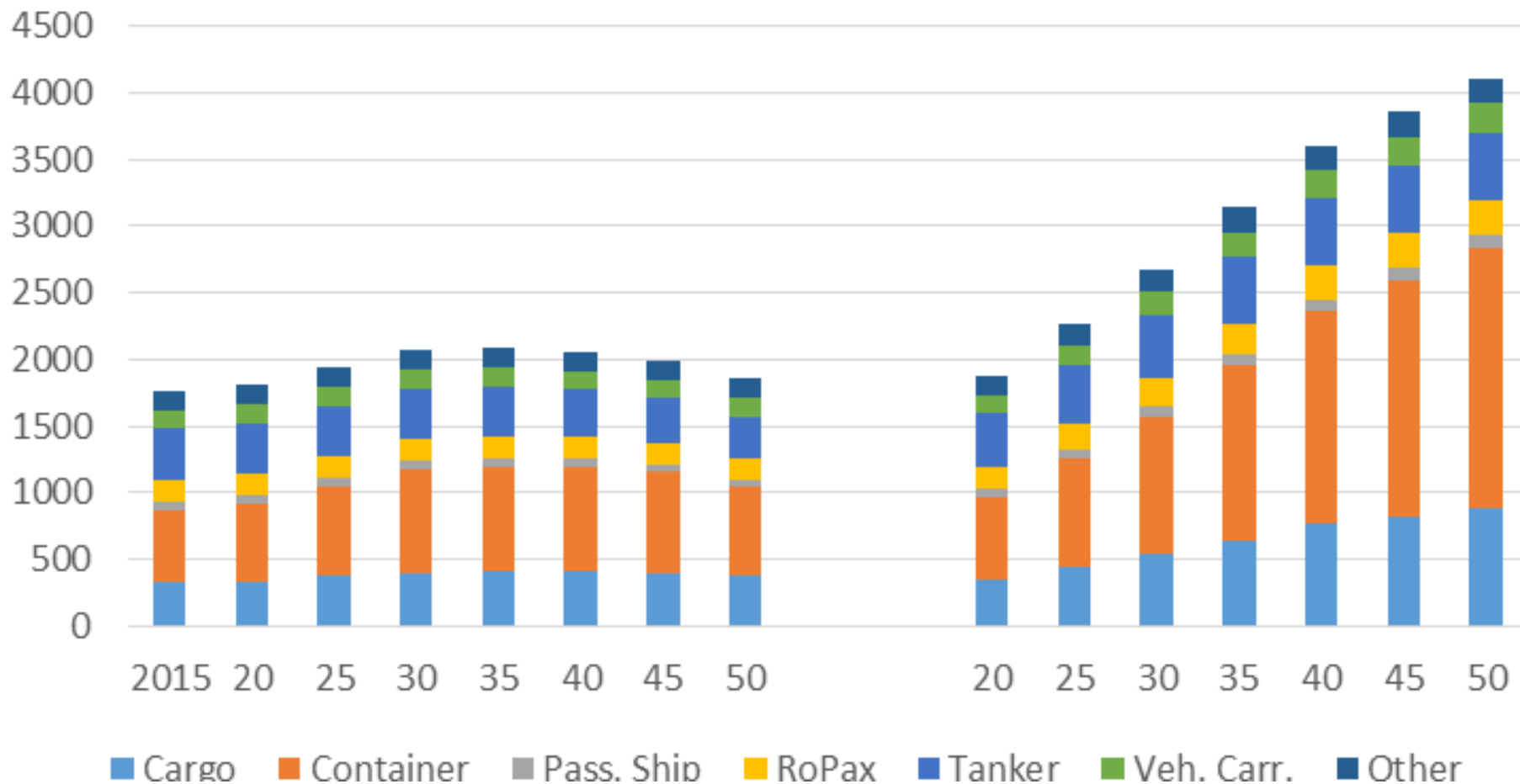


Source: IIASA (March 2018)

Fuel consumption by vessel type (PJ)

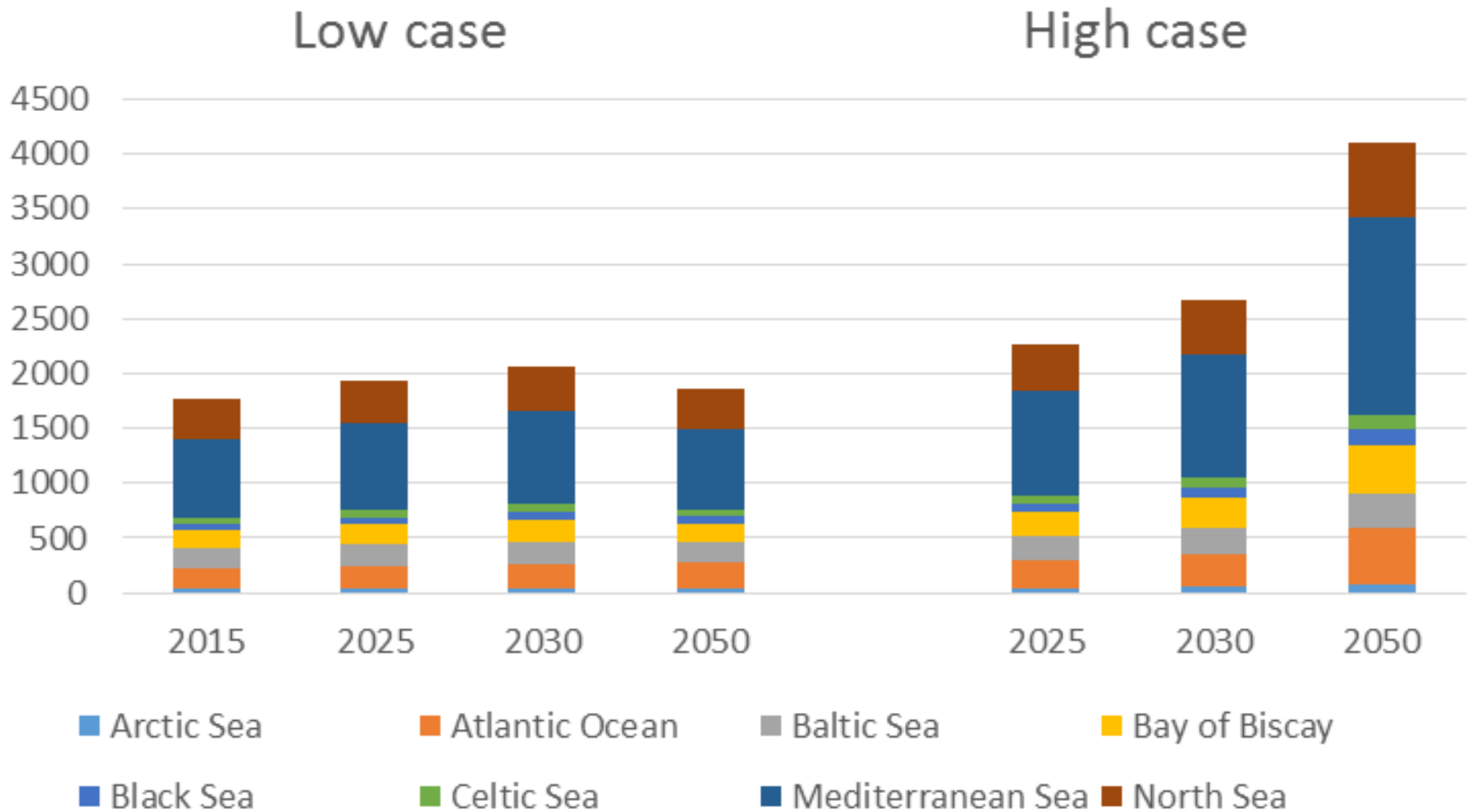
Low case

High case



Source: IIASA (March 2018)

Fuel consumption by sea region, PJ



TECHNICAL METHODS TO REACH TIER III

Selective catalytic reduction (SCR). Aftertreatment with catalyst and urea as reducing agent.

- Advantages: tested technology, can be retrofitted
- Disadvantages: urea consumption, requires high exhaust temperatures, replacement of catalysts, space

Exhaust gas recirculation (EGR). Part of exhaust returns to engine

- Advantage: tested on trucks, no chemicals (if high quality fuel)
- Disadvantages: requires scrubbing (if HFO is used), wear, space

Other fuels: mainly liquified natural gas (LNG)

- Advantage: low sulphur , no PM, no abatement needed
- Disadvantages: availability of fuel, methane slip, still a fossil fuel!

Technologies for Tier III exist - also for existing ships!

NOX POLICY INSTRUMENTS

1. **NECA**—new ships only
2. **Stand-alone NOx levy** - revenues not earmarked.
3. **NOx levy with fund** - revenues are used to fund uptake of NOx abatement measures.
4. **Regulated slow steaming with NOx levy and fund as alternative compliance option** - revenues are used to fund uptake of NOx abatement measures.

T&E published study (2016) from IVL and CE Delft for further details

MARPOL ANNEX VI

SOx Emission Control Areas

2010: SOx < 1.0%
2015: SOx < 0.1%

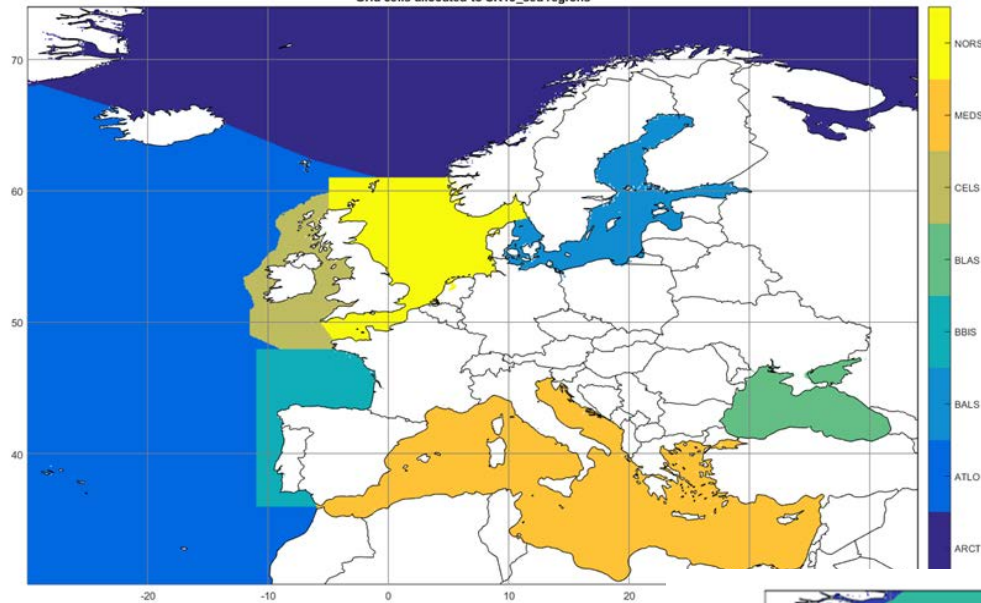
English Channel

North Sea

Baltic Sea

Source: International Maritime Organization

European seas: regions/zones



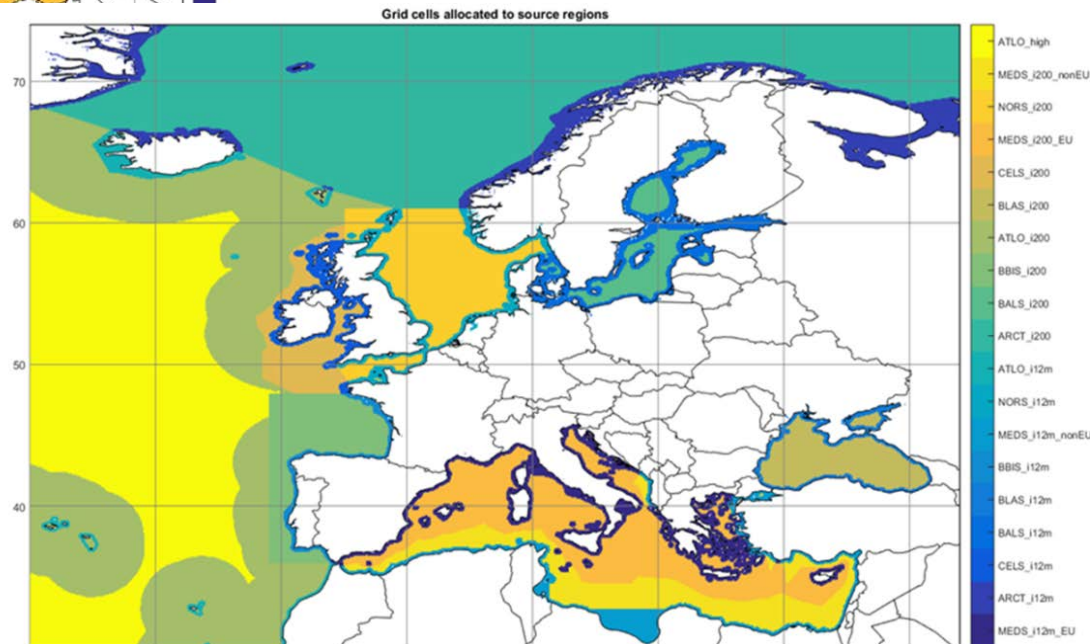
Sea regions:

- Arctic (ARCT)
- Atlantic Ocean (ATLO)
- Baltic Sea (BALS)
- North Sea with English Channel (NORS)
- Celtic Sea (CELS)
- Bay of Biscay (BBIS)
- Mediterranean Sea (MEDS)
- Black Sea (BLAS)

Zones:

- Ports/berth
- Territorial waters
- Exclusive economic zones
- High seas
- For MEDS EU and non-EU waters treated separately

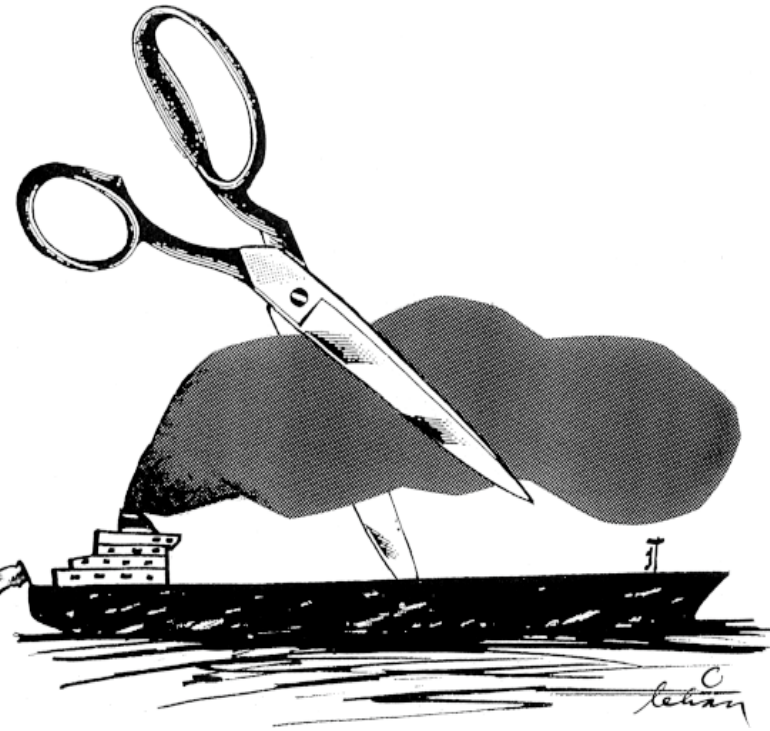
Source: IIASA (March 2018)



IIASA study on ECAs in EU sea areas

Study for European Commission by
IIASA, MET.NO and EMRC:

- Gridded emission inventory for 2015 based on AIS data
- Projections to 2030 and 2050 based on two fuel demand scenarios: Low & High
- Emission factors, abatement costs & health benefits
- Special focus on Mediterranean Sea



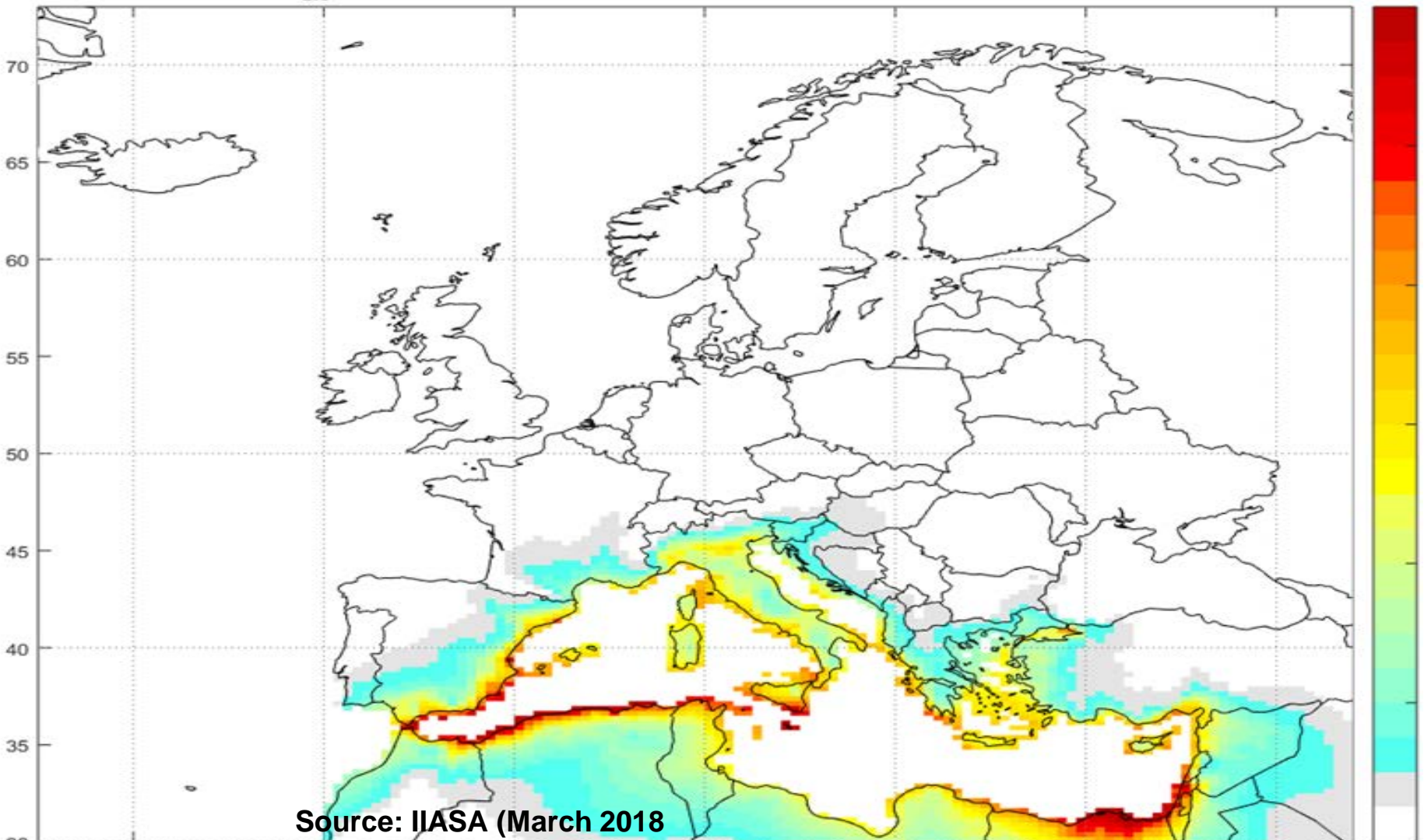
Emission control scenarios to 2030/2050

- **Current legislation (CLE):** IMO global S limit 0.5% from 2020;
Tier II new vessels from 2010;
0.1% S from 2015 in SECAs;
Tier III new vessels from 2021 in NECAs
- **SECA/NECA** for seas/zones/regions from 2021 or 2025
- As above but with **retrofits of SCR** for existing vessels
- Special focus on the **Mediterranean Sea**: several variants with different configurations of ECAs in EU and non-EU seas
- EU waters = 2/3 of fuel consumption in 2015
- Health impacts quantified and valued => Benefits-to-cost-ratios

2050 change PM_{2.5} concentrations

ECA Mediterranean Sea, high fuel demand vs CLE

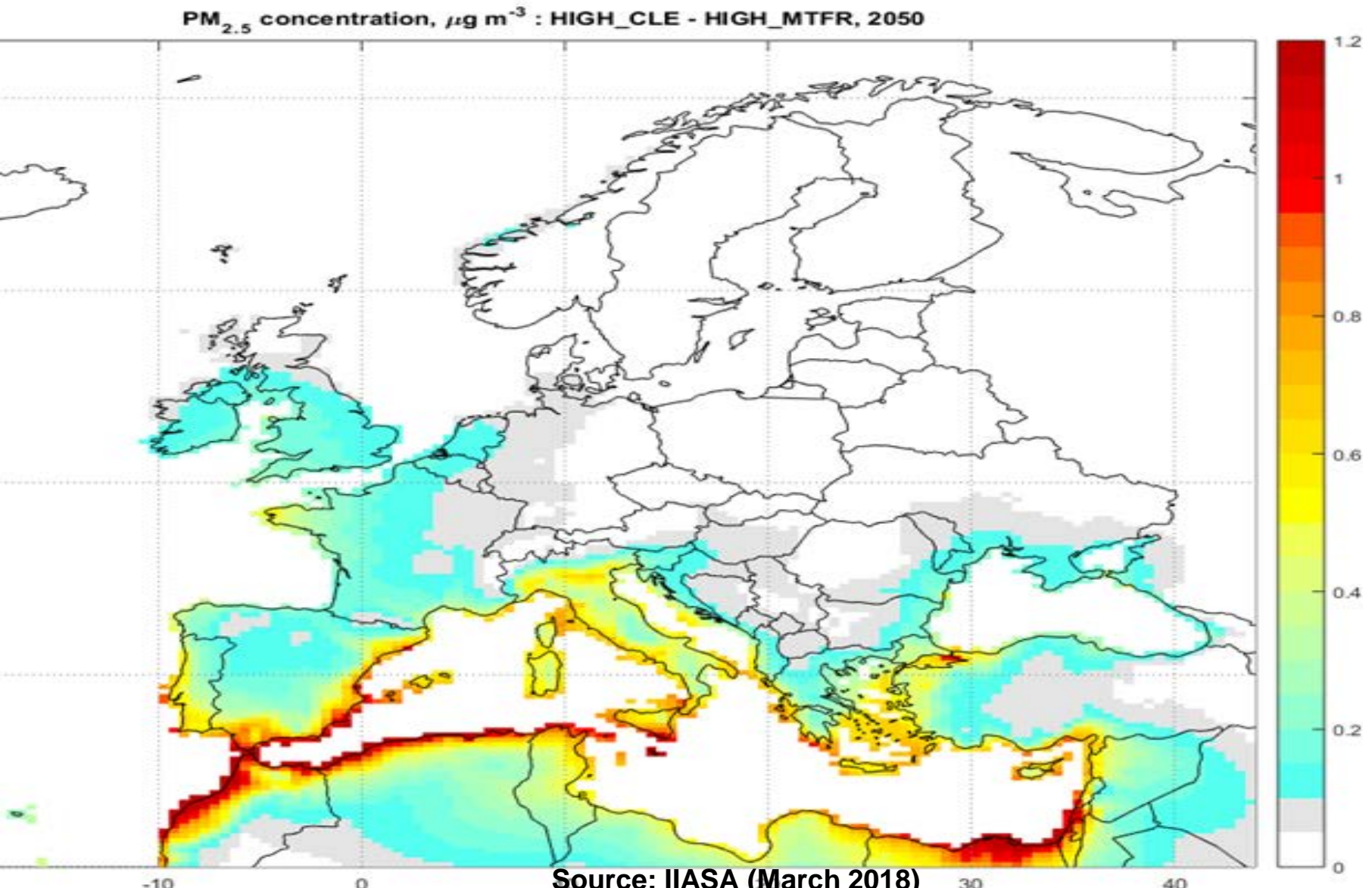
PM_{2.5} concentration, $\mu\text{g m}^{-3}$: HIGH_CLE - HIGH_SNECA_MEDS_ALL, 2050



Source: IIASA (March 2018)

2050 change PM_{2.5} concentrations

ECA all seas, high fuel demand rel. to CLE



Med ECA - Benefits

- premature deaths caused by PM; 2 – 5000 cases reduced/year
- Biggest absolute impact, FR, IT, ES, N Africa, Egypt
- equivalent to about 10-30% of benefits from NEC Directive
- To achieve health & environmental targets (such as EU Air Quality Directive and WHO standards) requires additional emission cuts;
- Still significant benefit after 2020 0.5% sulphur
- land-based sources have already done big reductions, so more difficult and expensive in most other land-based sectors
- High benefit-to-cost ratios - i.e. health benefits alone are much, much higher than the costs

Zero Emission Vessels in operation



SCANDLINES car ferry (DK SE | 2015)

- 4126 kWh battery
- Pure electric propulsion
- recharge in 15 mins

KAROLINE fishing cutter

(Norway | 2016)

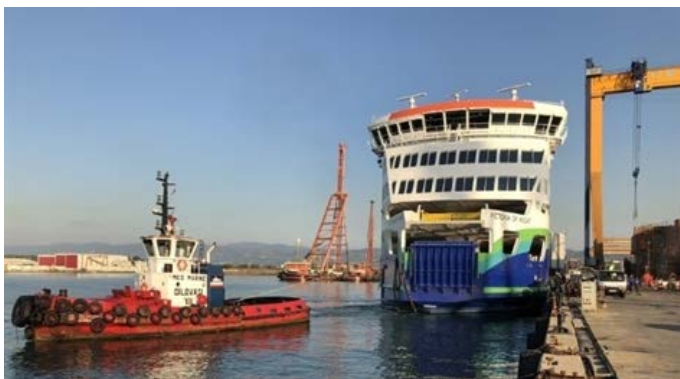
- 12 hours autonomy - 8 h working day
- Power backup – diesel generator



ELFRIDA electric boat (Norway | 2017)

- 100% battery – 8 h working day

Hybrid vessels



MV Hallaig - Car ferry (2012)

- Skye & Raasay



Wight Link - Car ferry (2018)

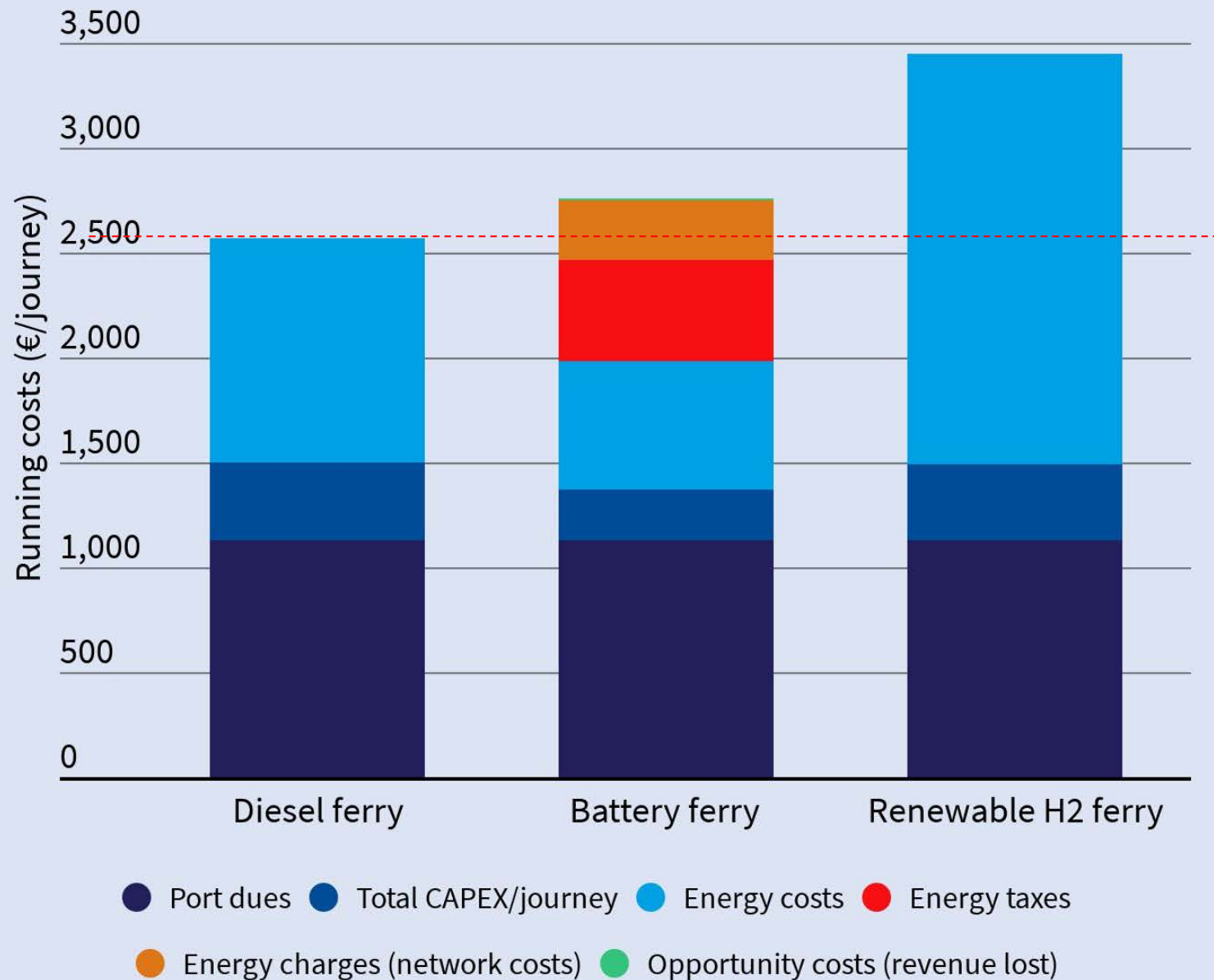
- Isle of Wight



Xin Ya Zhou - Container vessel (2007)

- Switches to Shore Power to enter Los Angeles Port

Zero Emission Channel Ferry (future technology)



KEY ACTIONS

- Support EU wide and **Mediterranean ECA**
- Incentivise **Zero Emission Vessels**
 - **removes tax on electricity** for on shore power and electric bunkering / compulsory plug-in in Port
 - invest in **alternative fuels like Hydrogen & Ammonia**
 - don't waste public money on LNG - deadend
 - Make On Shore Power supply a condition of **port planning permission**
 - On **Public Service Contracts** require Zero Emission Vessels
 - Discounted **port fees** for cleaner ships