

CBA of NO_x control for ships

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CO₂ SO₂ NO_x
PM

SOS



50,000 deaths/year in Europe

In Europe, emissions from international shipping is estimated to cause some 50,000 premature deaths per year due to PM_{2.5}

Tiny airborne particles (PM_{2.5}) cause premature death through lung and heart disease



Ship emissions are a major cause of eutrophication and acidification

Examples of countries with a high proportion of air pollutant fallout from ship emissions (2013)

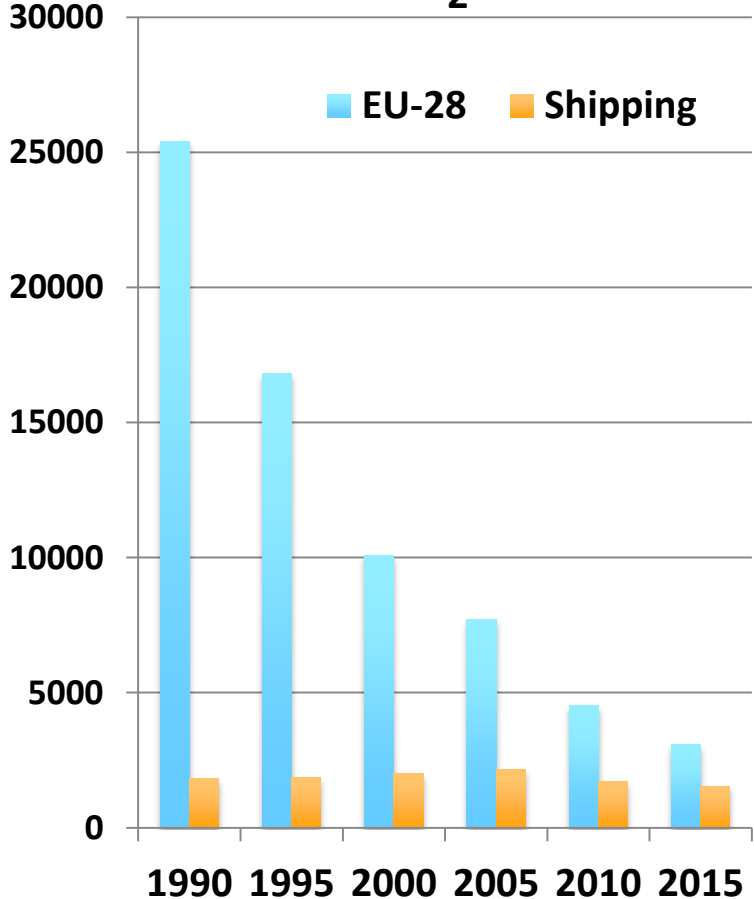
<u>NO_x-N</u>		<u>SO₂-S</u>	
Norway	28%	Portugal	26%
Sweden	26%	Denmark	24%
Denmark	26%	Netherl.	22%
Portugal	24%	Ireland	20%
Ireland	23%	Norway	19%
Netherl.	19%	Spain	18%
Finland	18%	Sweden	17%
Spain	18%	France	15%
UK	18%	UK	13%
Italy	15%	Italy	13%

Source: EMEP (2015)



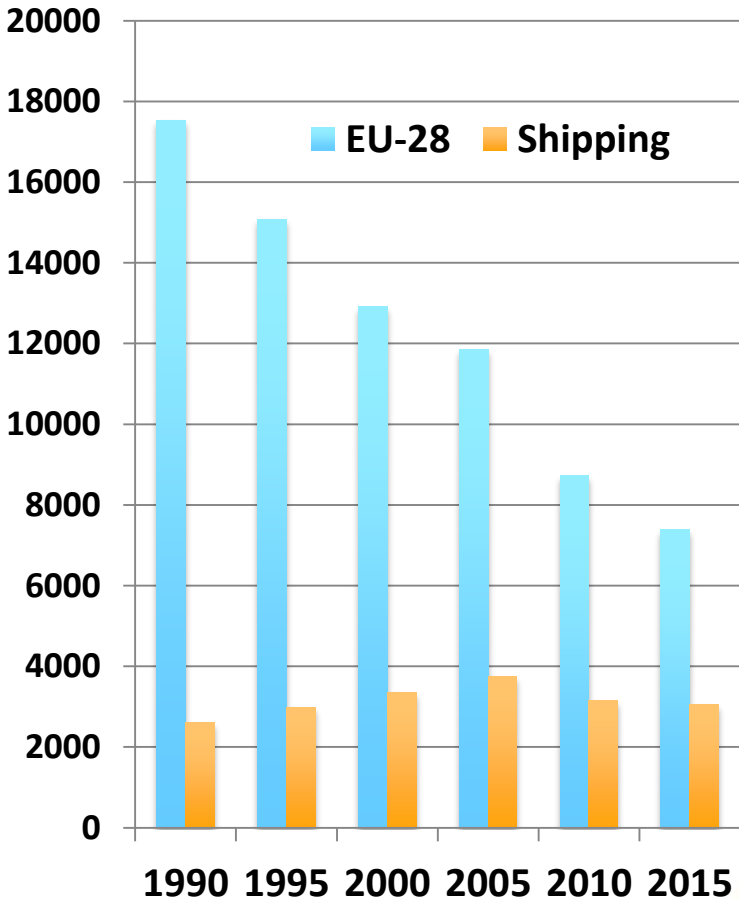
EU28 land-based vs. shipping around Europe 1990-2015 (kton)

SO₂



Land-based SO₂ cut by 89% 1990-2015

NOx

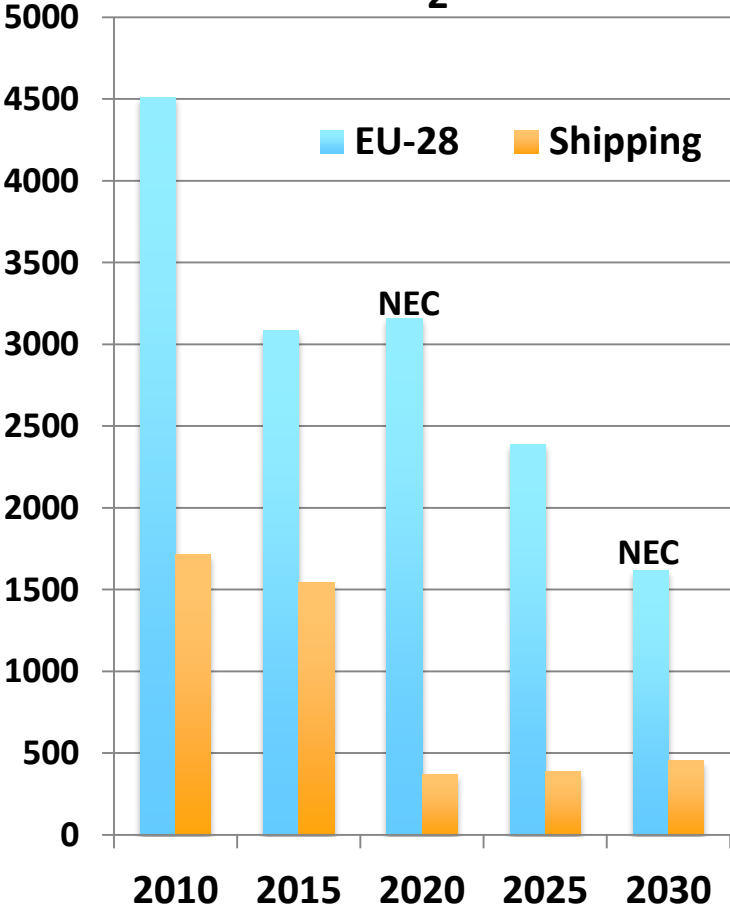


Land-based NOx cut by 56% 1990-2015

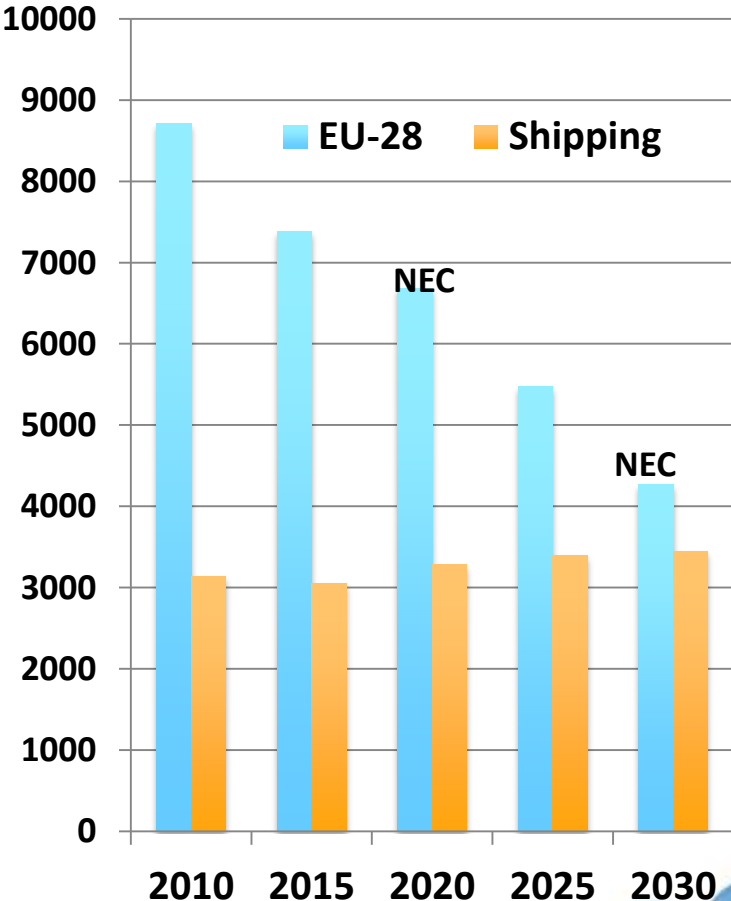


EU28 land-based vs. shipping around Europe 2010-2030 (kton)

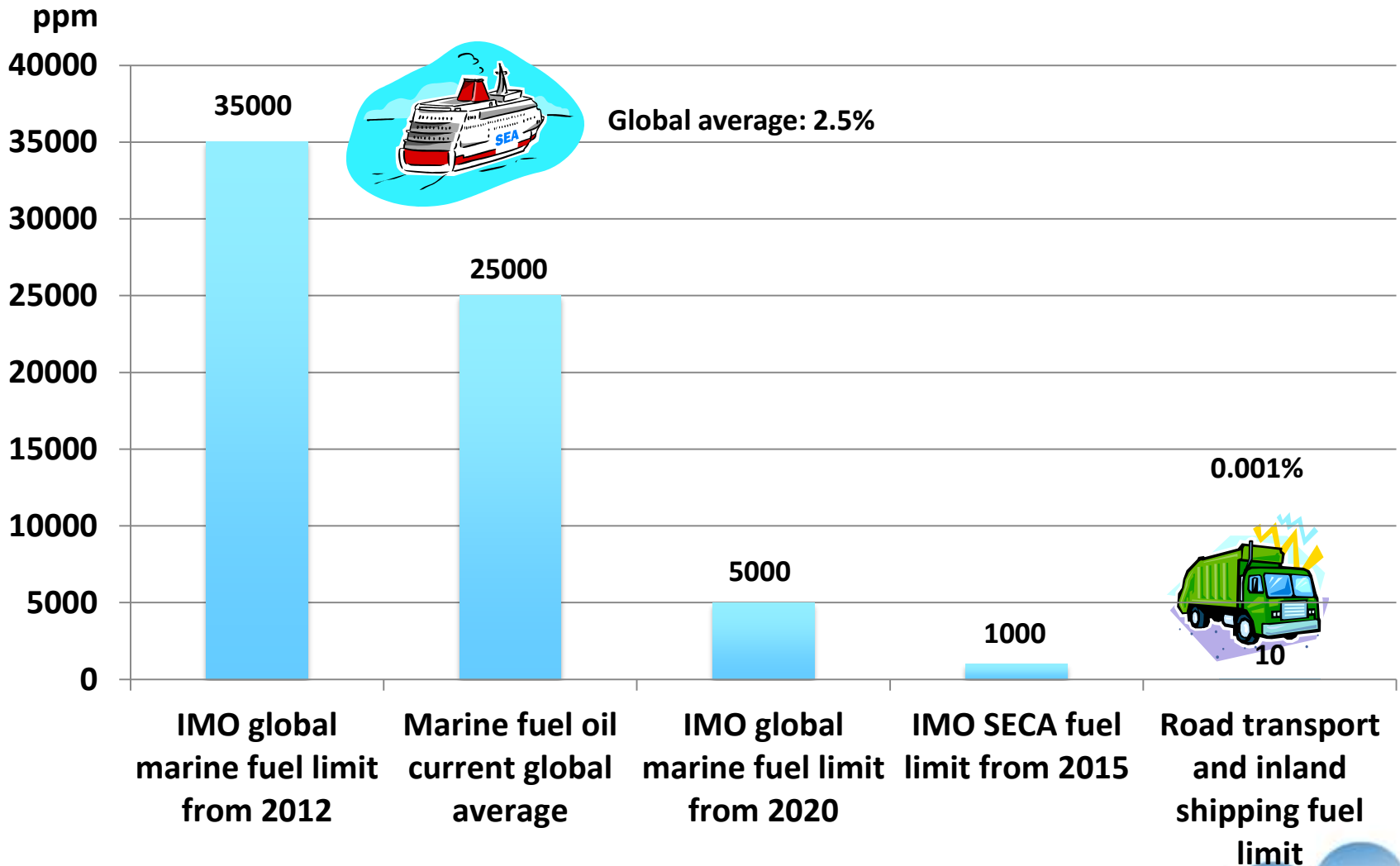
SO₂



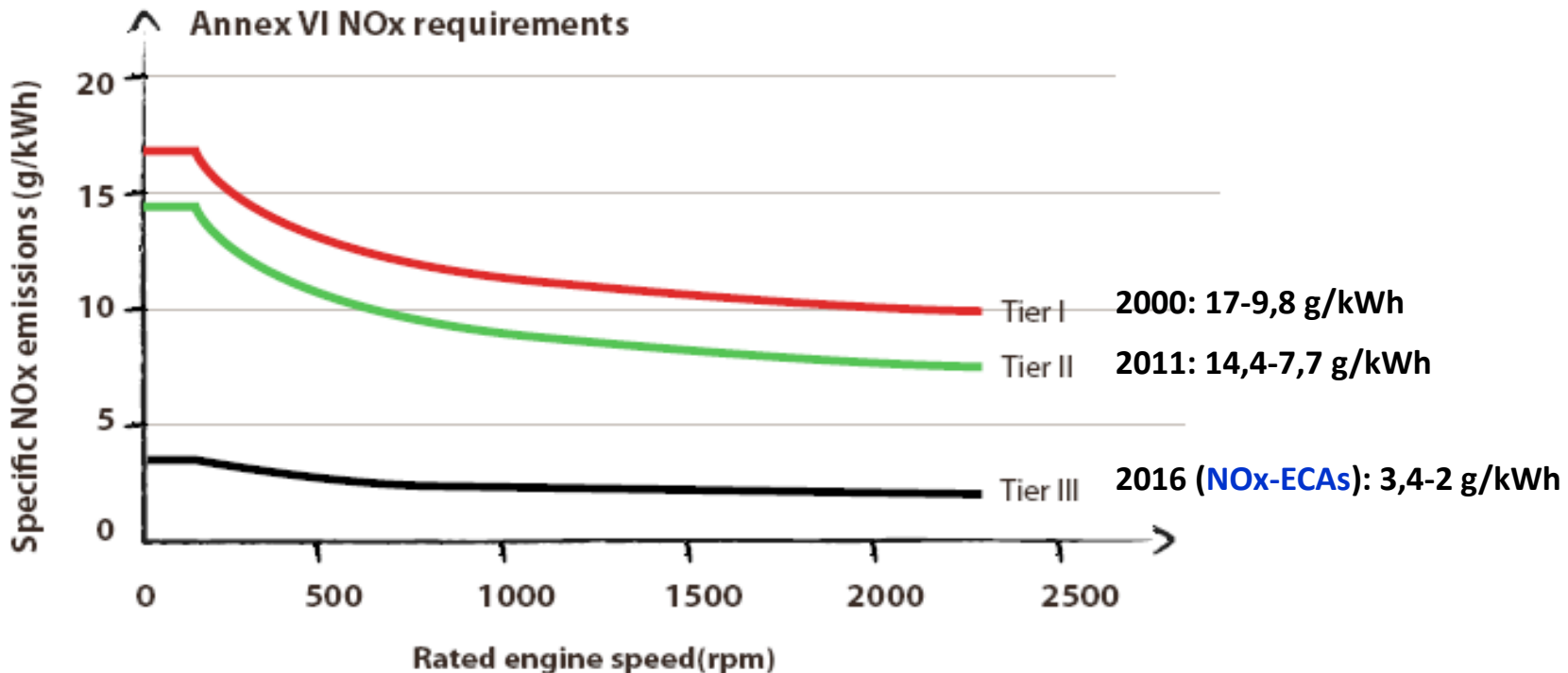
NOx



Sulphur content of transport fuels



IMO NOx-standards for new ship engines

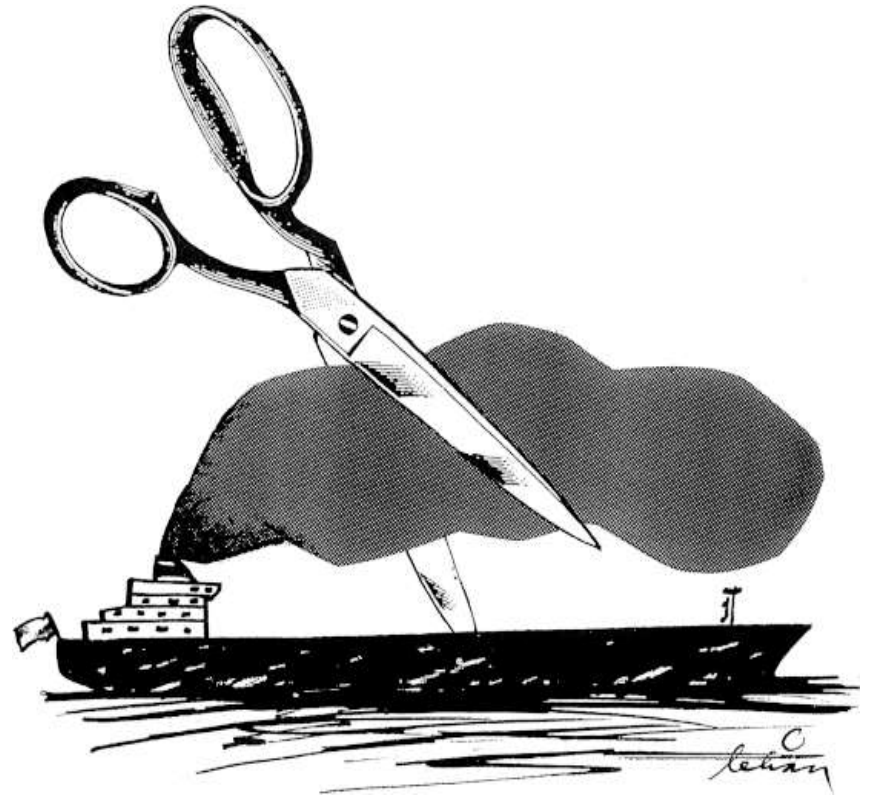


For comparison: EU-standards (Euro VI) for new heavy duty diesel engines in trucks and buses are set at **0.4 g/kWh** as from 2013 – down from 8 g/kWh from 1992 (Euro I).

NOx-abatement measures

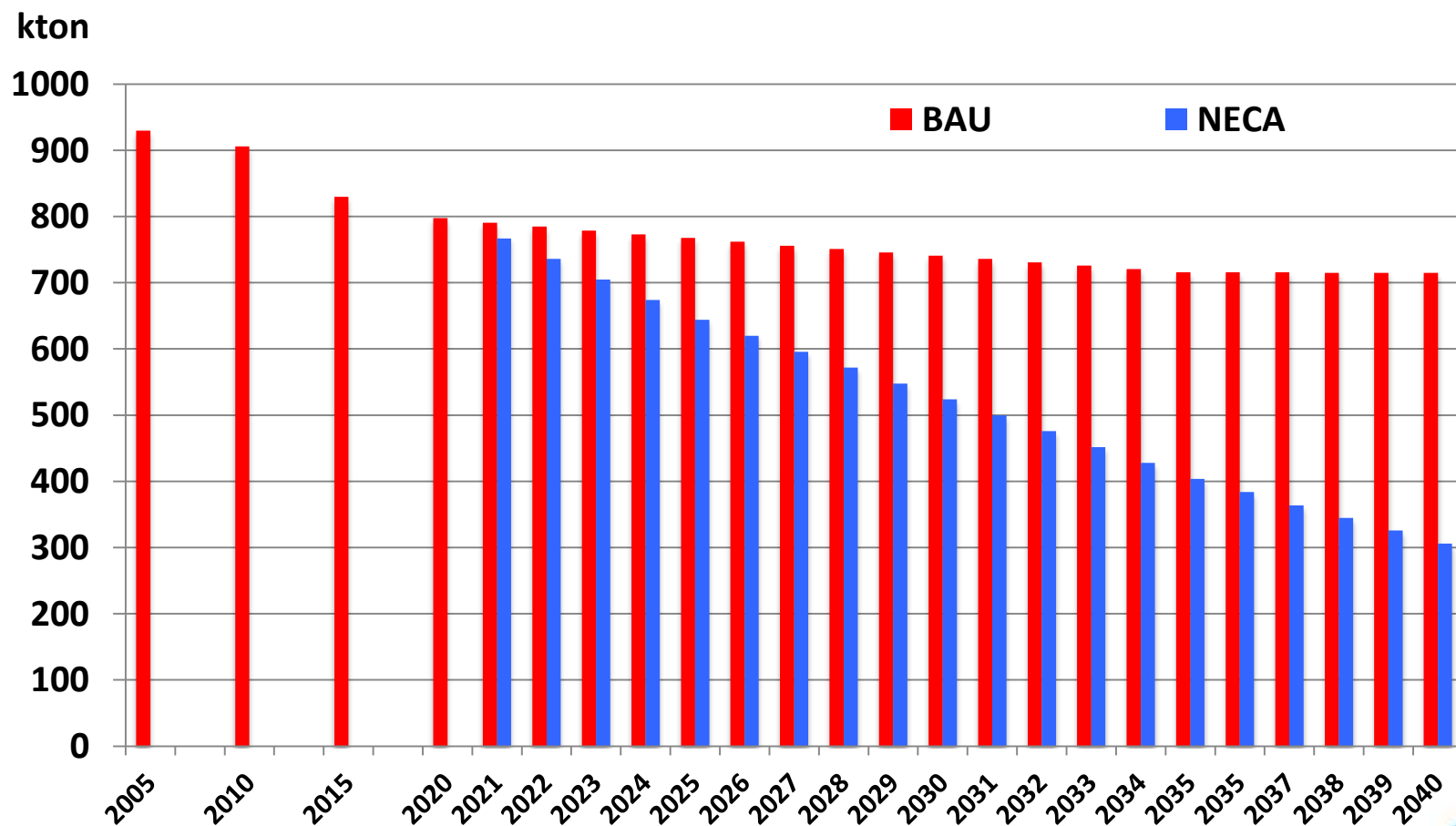
Some of the main NOx-abatement options for ships:

- **Exhaust gas after-treatment** (e.g. SCR)
- **Combustion modifications** (e.g. EGR)
- **Fuel switch** (e.g. to LNG or methanol)
- **Reduced fuel consumption** (e.g. lower speed)



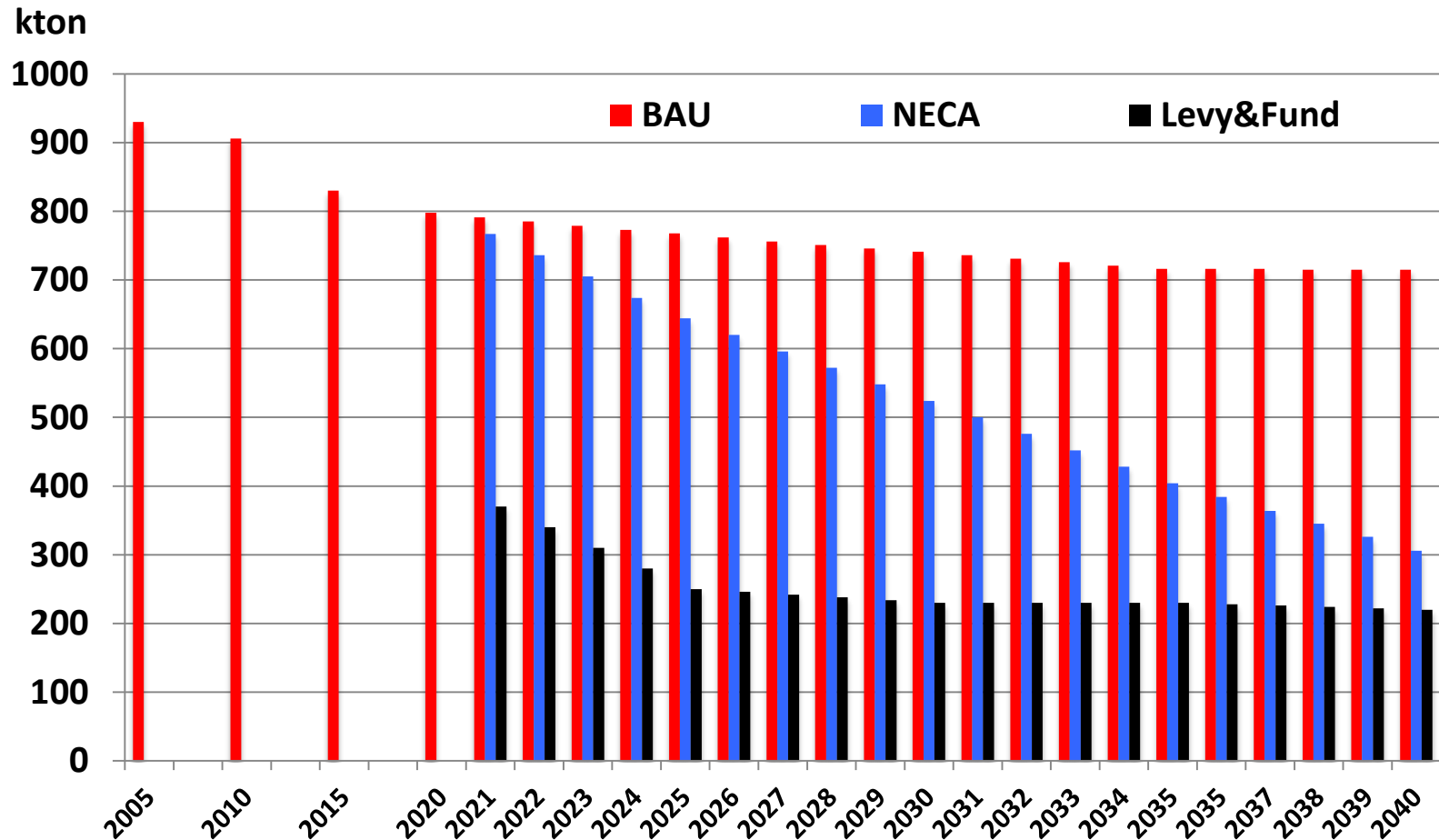
Reducing NOx by NECA

NOx emissions in the Baltic Sea and North Sea with/without NECA from 2021



Source: IVL/CE Delft (2016)

Reducing NOx by NECA + Levy & Fund



Source: IVL/CE Delft (2016)

Cost-benefit analysis

Study by IVL Swedish Environmental Research Institute 2016-2017

Costs

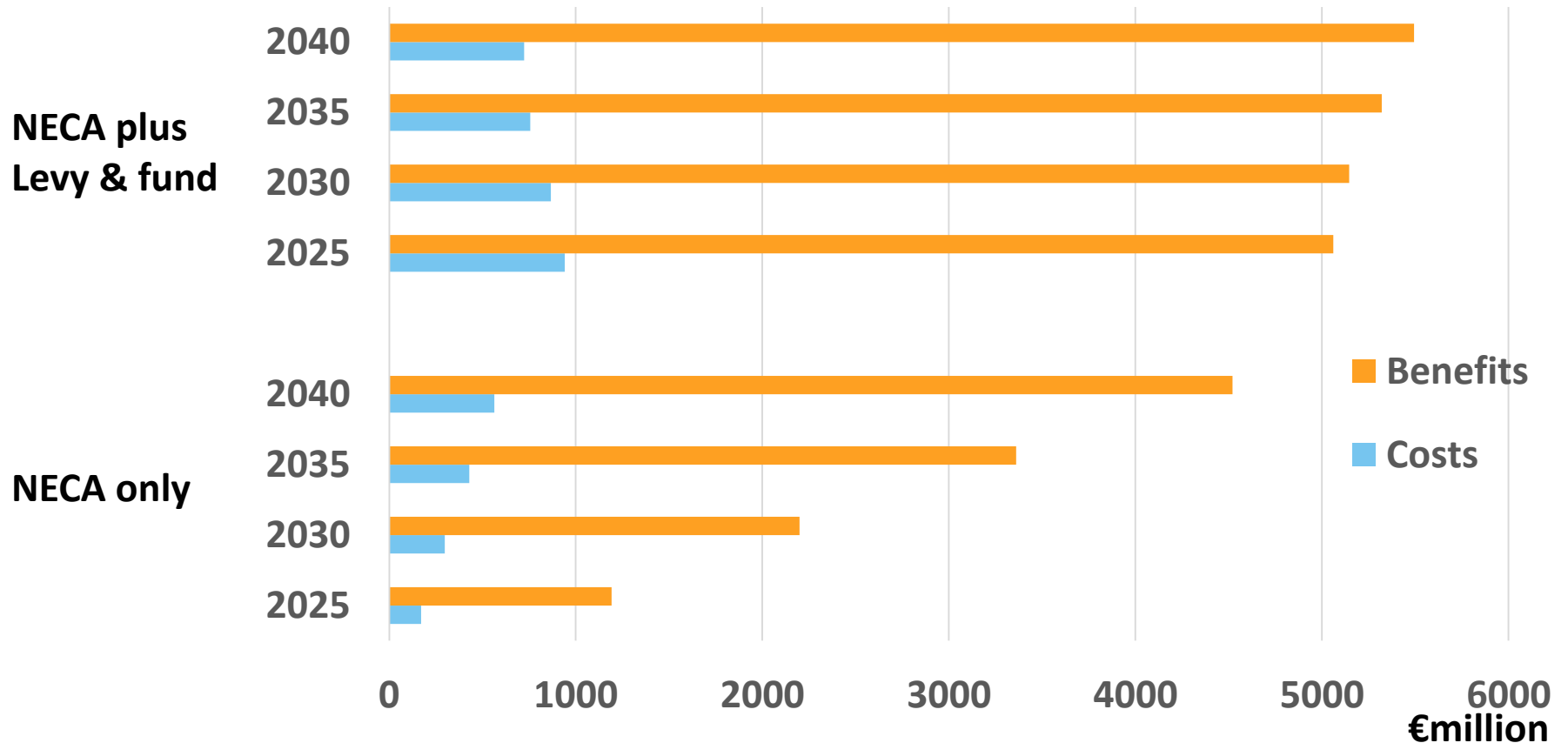
- Social cost perspective (4% interest rate)
- Based on costs for SCR (installation plus operation & maintenance)
- Differ between new installations and retrofits
- Tier 0 ships not retrofitted
- 75% of Tier I and Tier II ships retrofitted
- Assume SCR is used only in NECA (=> higher costs/ton NO_x abated)

Benefits

- Limited to health impacts of PM_{2.5} (O₃ and NO₂ impacts not included)
- Impacts on ecosystems, crops or materials not included
- Same valuation methodology as European Commission and Air Convention (LRTAP):
 - VOLY: Value of Life Year lost
 - VSL: Value of Statistical life
- Monetised health benefits shown also for individual countries



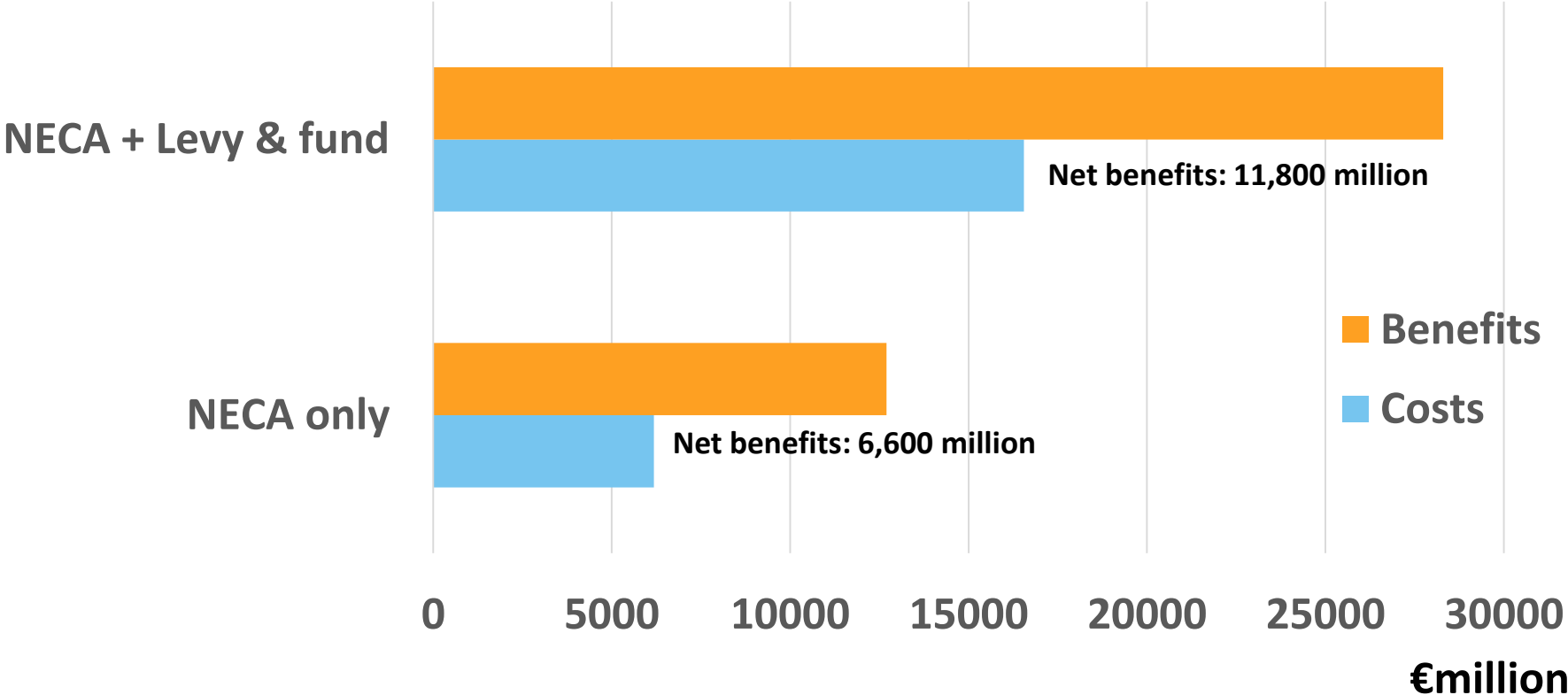
Annual costs and health benefits (VSL)



The benefits-to-costs ratio vary between 5 and 8

Source: IVL (2017)

Accumulated costs and health benefits (VOLY) (2021-2040)



Source: IVL (2017)



Some conclusions from the studies

- Baseline (BAU) projection up to 2040 indicates a slight NOx reduction (-14% 2015->2040) (maybe due “optimistic” assumptions on improved efficiency?)
- A NECA would significantly cut NOx in the longer term (-63% 2015->2040), but not so much in the near term (-37% 2015->2030)
- Significant short-term reductions are possible through the use of economic instruments, e.g. Levy & Fund (-72% 2015->2030)
- A Levy & Fund can cut NOx by around 400-500 thousand tonnes/year throughout the 2020s, i.e. more than the current total annual land-based emissions from SE, DK and FI combined.

Measures needed to cut ship emissions



- Designate all European seas as full Emission Control Areas
- Introduce emission charges to cut NOx (and PM?) from existing ships
- Enforce global 0.5% sulphur standard from 2020

- Improve emissions monitoring and compliance control
- Mandate lowered speeds
- Set emission standards for PM
- Develop and adopt an EU marine fuels quality directive



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