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Analysis of policy measures to reduce ship emissions in the context of the NECD

Based on a study for the European Commission, DG ENV

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Main characteristics of the study



- Revised emission inventories for 2000
 - 5 sea regions
 - 12-mile zone and international waters
 - Ferries, cargo ships
 - EU-flags and others
- SO₂, NO_x, PM2.5, VOC, CO₂
- Compilation of emission control measures and costs
- Updated emission projections for 2020
- New gridding of emissions and new source-receptor relations
- Cost-effectiveness of four packages of measures to achieve the TSAP targets in 2020

Emission control measures considered in the analysis



Measure	% emissions reduction (-) / increase (+) per vessel			
	SO ₂	NO _x	PM	VOC
Basic internal engine modifications (IEM) for 2-stroke slow speed only	0%	-20%	0%	0%
Advanced internal engine modifications	0%	-30%	0%	0%
Direct water injection	0%	-50%	0%	0%
Humid air motors	0%	-70%	0%	0%
Exhaust gas recirculation ¹	-93%	-35%	>-63% ²	± ³
Selective catalytic reduction (2.7% residual oil)	0%	-90%	0%	0%
Sea water scrubbing	-75%	0%	25% ⁴	±
Fuel switching 2.7->1.5% S residual oil fuel	-44%	±	-18%	±
Fuel switching 2.7->0.5% S residual oil fuel	-81%	±	--20% ⁵	±
Low S marine diesel 0.5->0.1 % S	-80%	±	±	±

Packages of measures for ships (1)



Baseline

SO₂ Sulphur content as in the EU Marine Fuel Directive (OJ L 191/59, 2005): 1.5% S in residual oil for all ships in SECA (North Sea and Baltic Sea); 1.5% S fuel all passenger ships in other sea regions surrounding the European Union; 0.1% S fuel at berth in ports

NO_x MARPOL NO_x standards for ships built since 2000

Ambition level 1 - all ships

SO₂ As in the baseline

NO_x Slide valve retrofit on all slow-speed engines pre-2000
Internal engine modifications for all new engines post-2010

Ambition level 2 - all ships

SO₂ 0.5% S in residual oil or scrubbing equivalent (2g SO₂/kWh) in SECA, and for passenger vessels everywhere.
Cargo vessels as in the baseline

NO_x Slide valve retrofit on all slow-speed engines pre-2000
Humid air motors for all new engines post-2010

Packages of measures for ships (2)



Ambition level 3 - all ships

SO ₂	Passenger and cargo ships: SECA - 1.0% S in residual oil from 2010, 0.5% or scrubbing from 2015. Other sea regions - as in the baseline but 0.5% or scrubbing from 2020.
NO _x	Pre-2010 vessels: 15% reduction above baseline level through available retrofit measures. Post-2010 vessels: 50% reduction above baseline level.

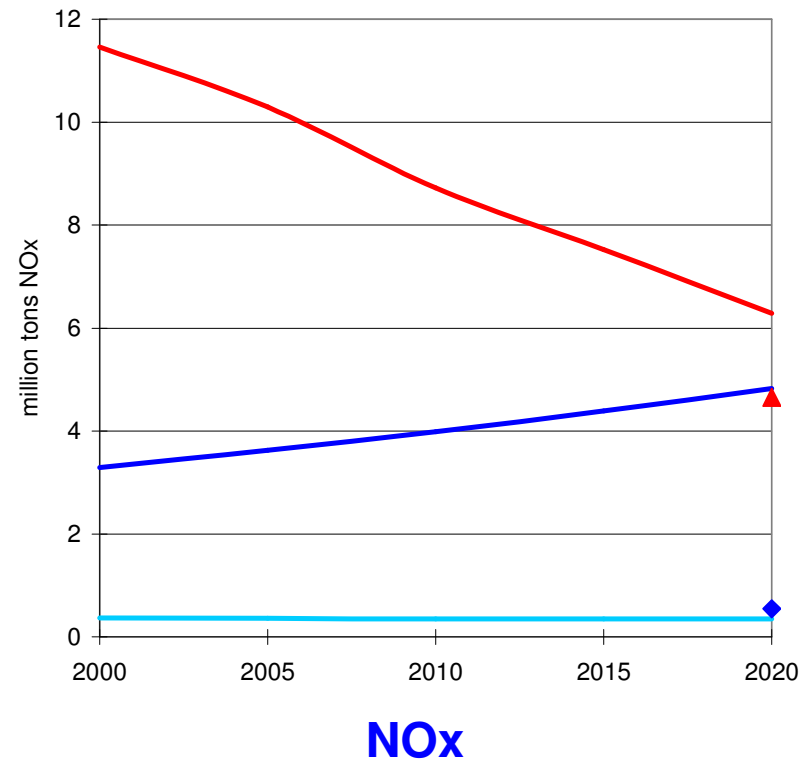
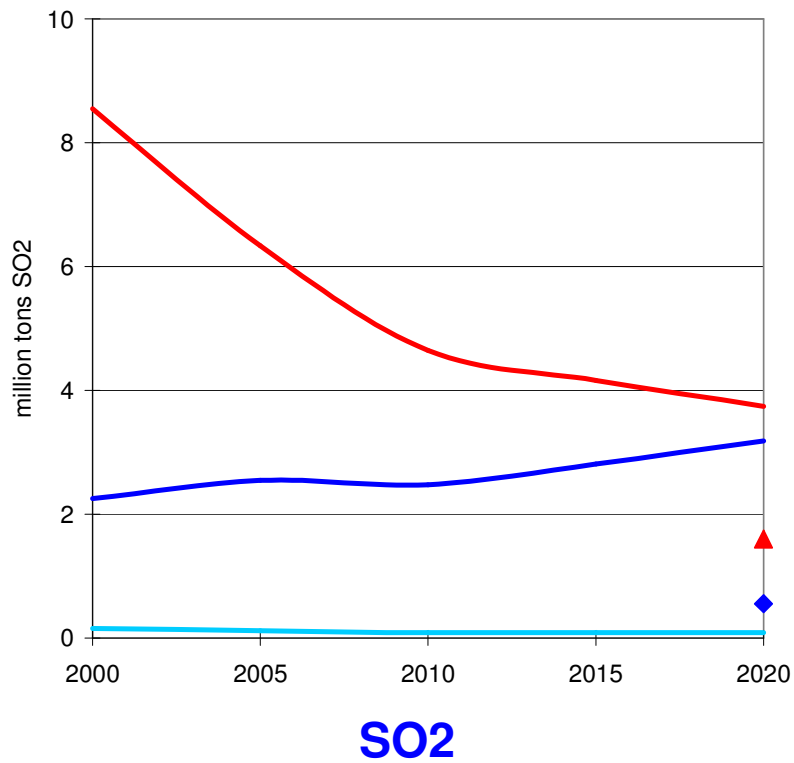
Ambition level 4 - all ships

SO ₂	As ambition level 3.
NO _x	Pre-2010 vessels: 15% reduction above baseline level through available retrofit measures. Post-2010 vessels: Selective catalytic reduction (SCR) technology.

Max. Reductions - all ships

SO ₂	Measures with highest reduction efficiency.
NO _x	Measures with highest reduction efficiency.

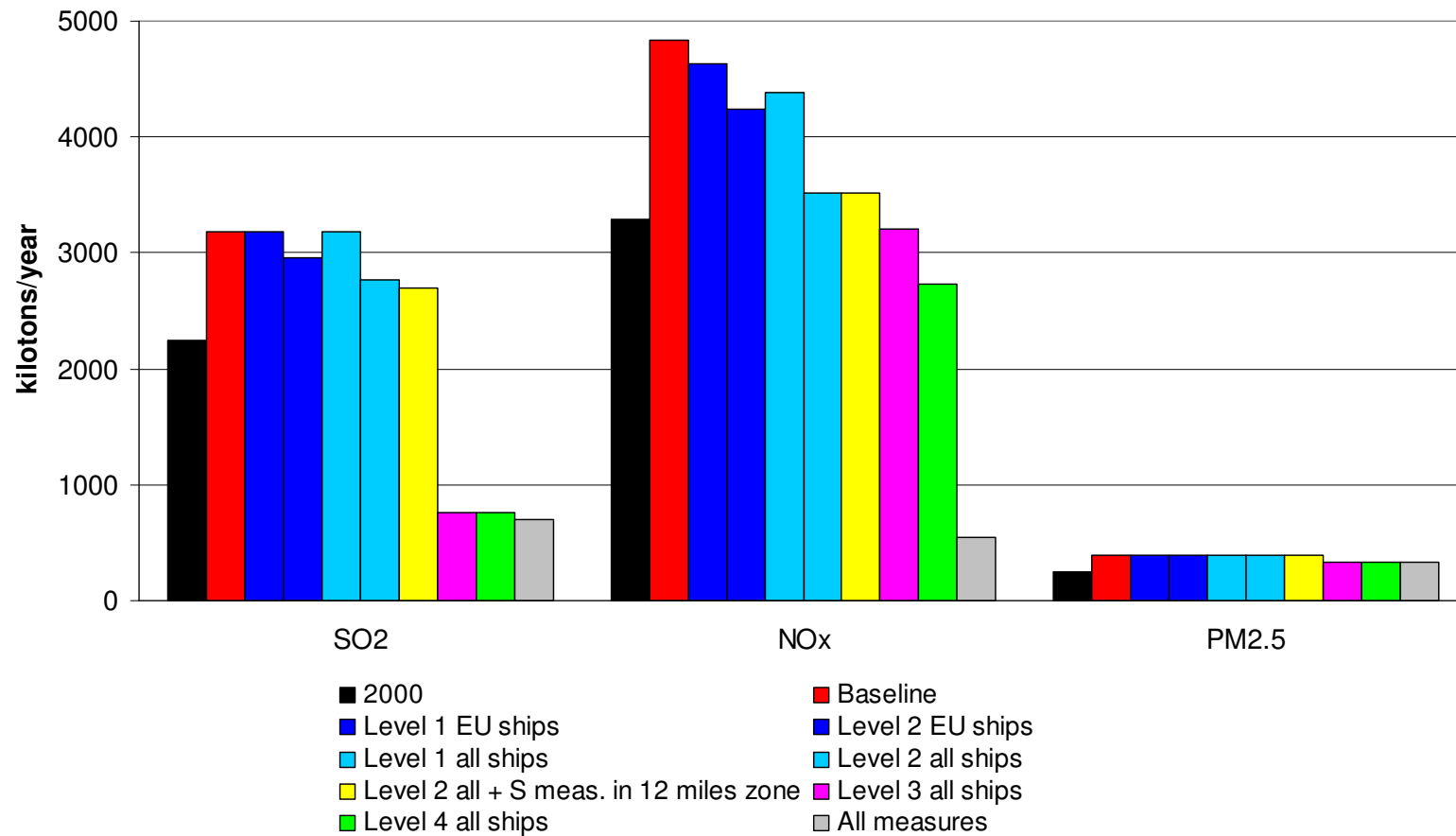
Baseline shipping emissions 2020 vs. EU-25 land - based



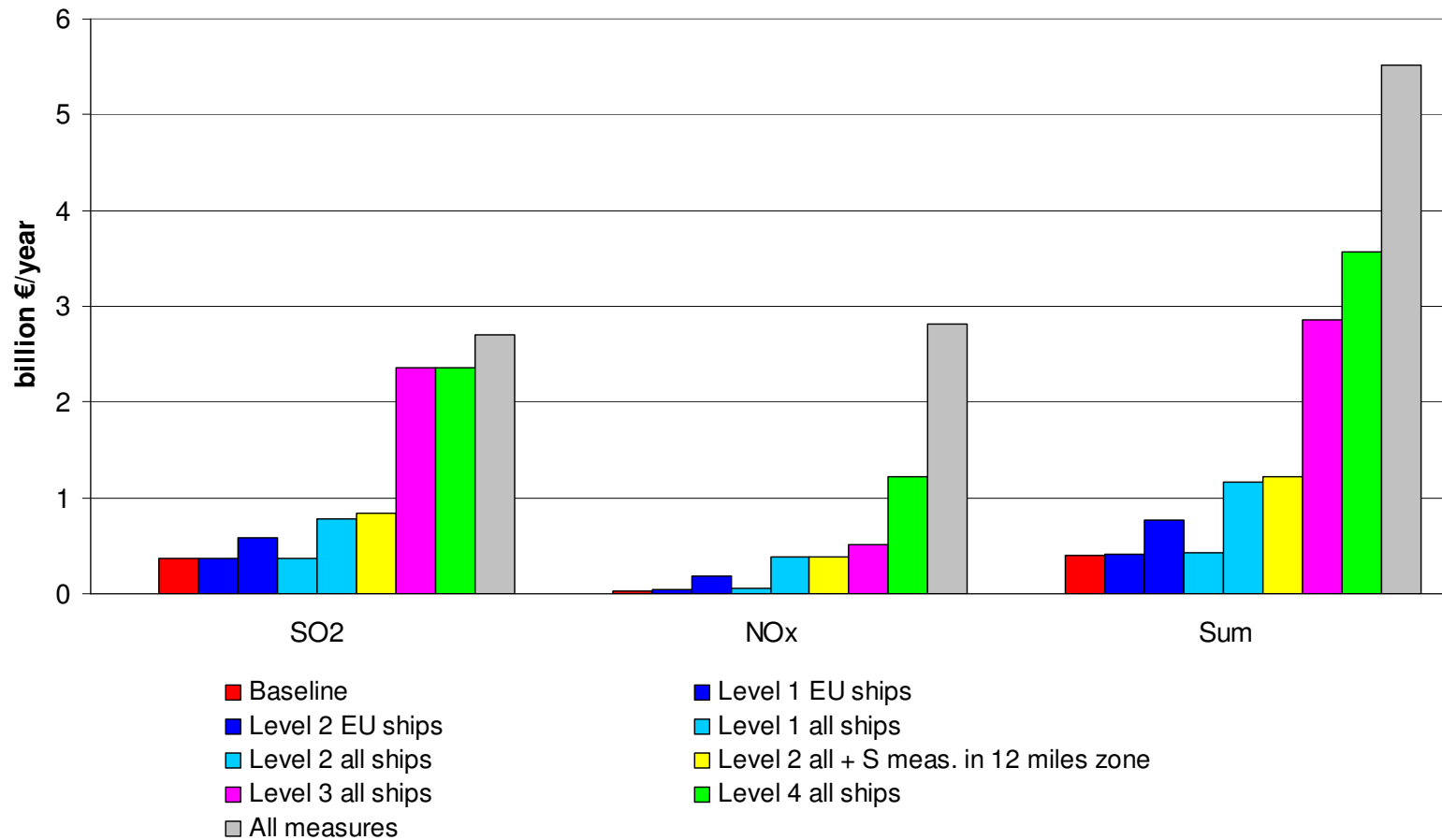
- Land-based sources
- International shipping - baseline
- National shipping - baseline

- ▲ Target of Thematic Strategy
- ◆ International shipping - Max. Feas. Red. (MTFR)

Emission scenarios for ships for 2020



Emission control costs of the scenarios

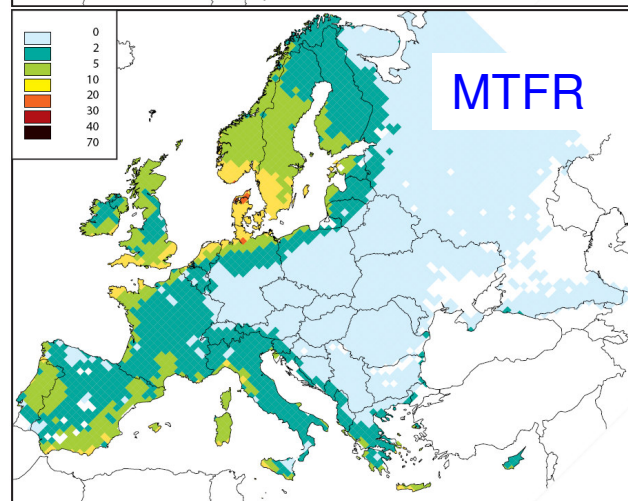
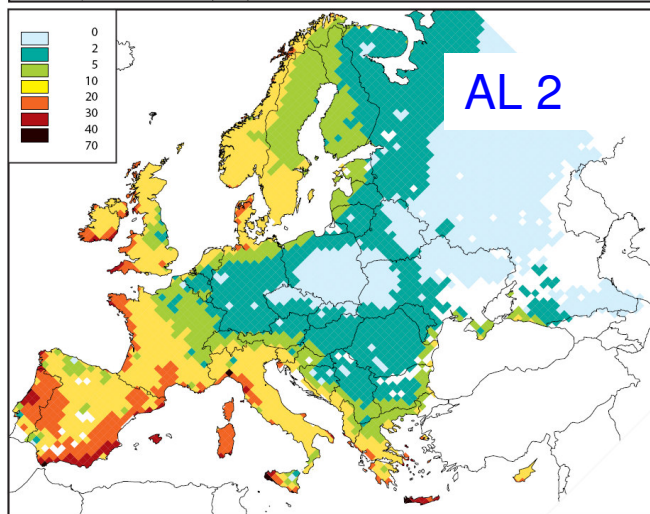
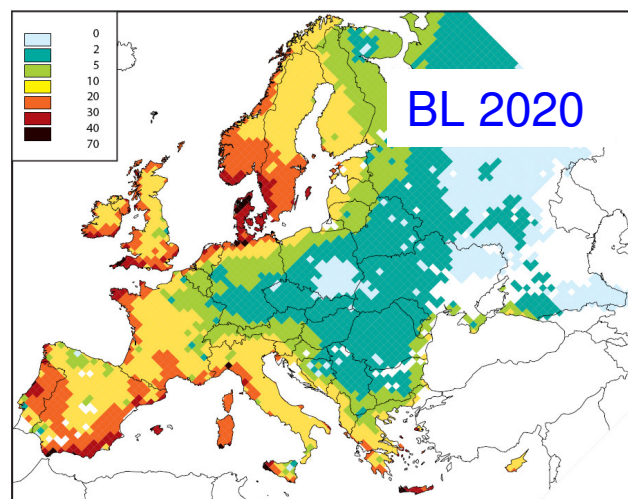
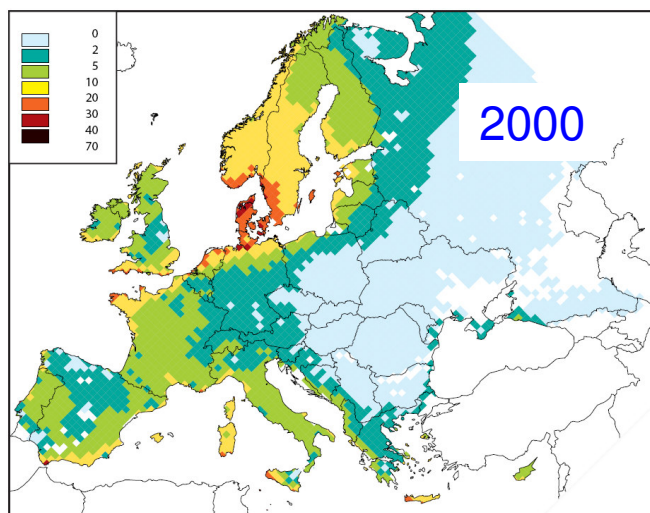


Impact indicators

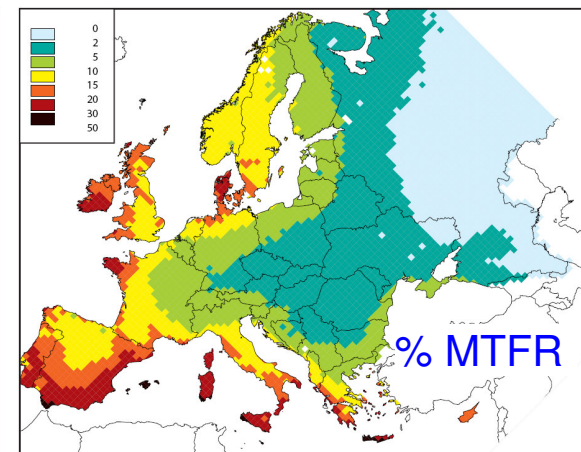
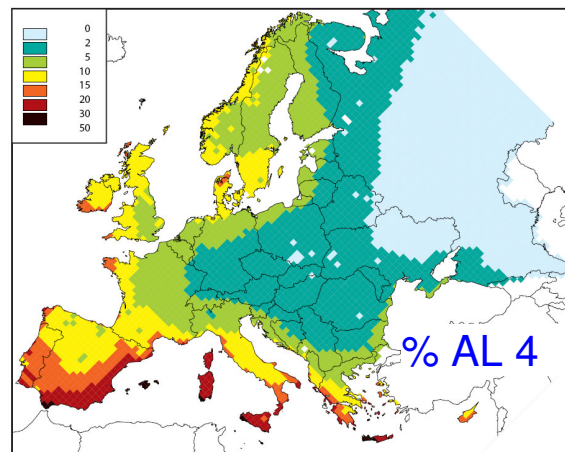
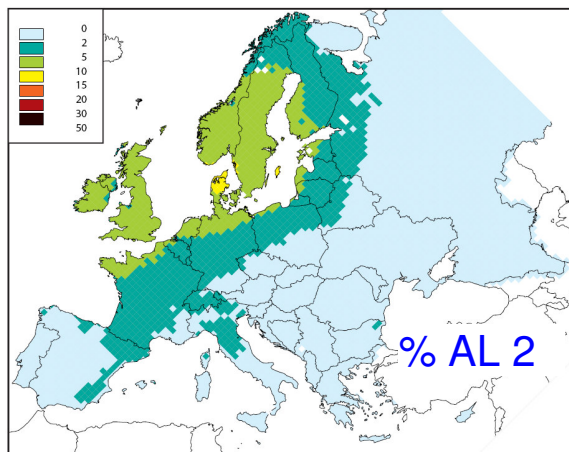
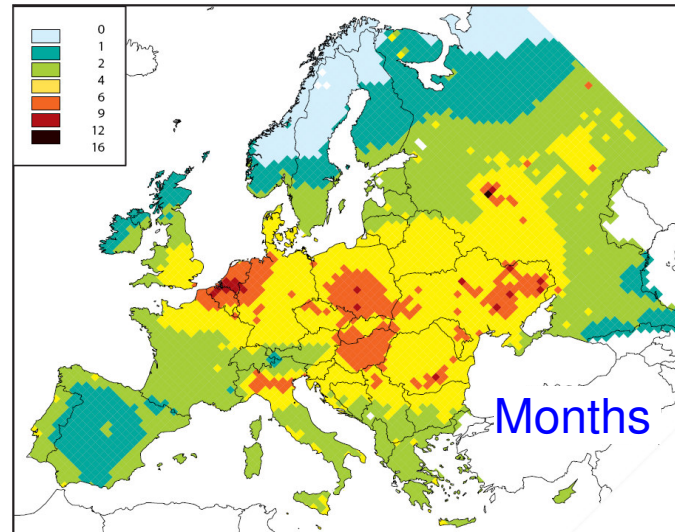


Indicator	2020						
	2000	BL	AL 1	AL 2	AL 3	AL 4	MTFR
Loss of life expectancy, months	8.0	5.2	-0.5%	-3.1%	-6.5%	-6.9%	-9.0%
Deaths - ozone 10 ³ cases/year	20.3	19.0	-0.7%	-1.9%	-2.3%	-2.8%	-5.0%
Acidification 10 ³ km ²	259.1	117.2	-3.4%	-14.1%	-18.5%	-19.8%	-27.7%
Eutrophication 10 ³ km ²	1020.0	876.9	-1.2%	-4.0%	-5.0%	-6.0%	-11.9%

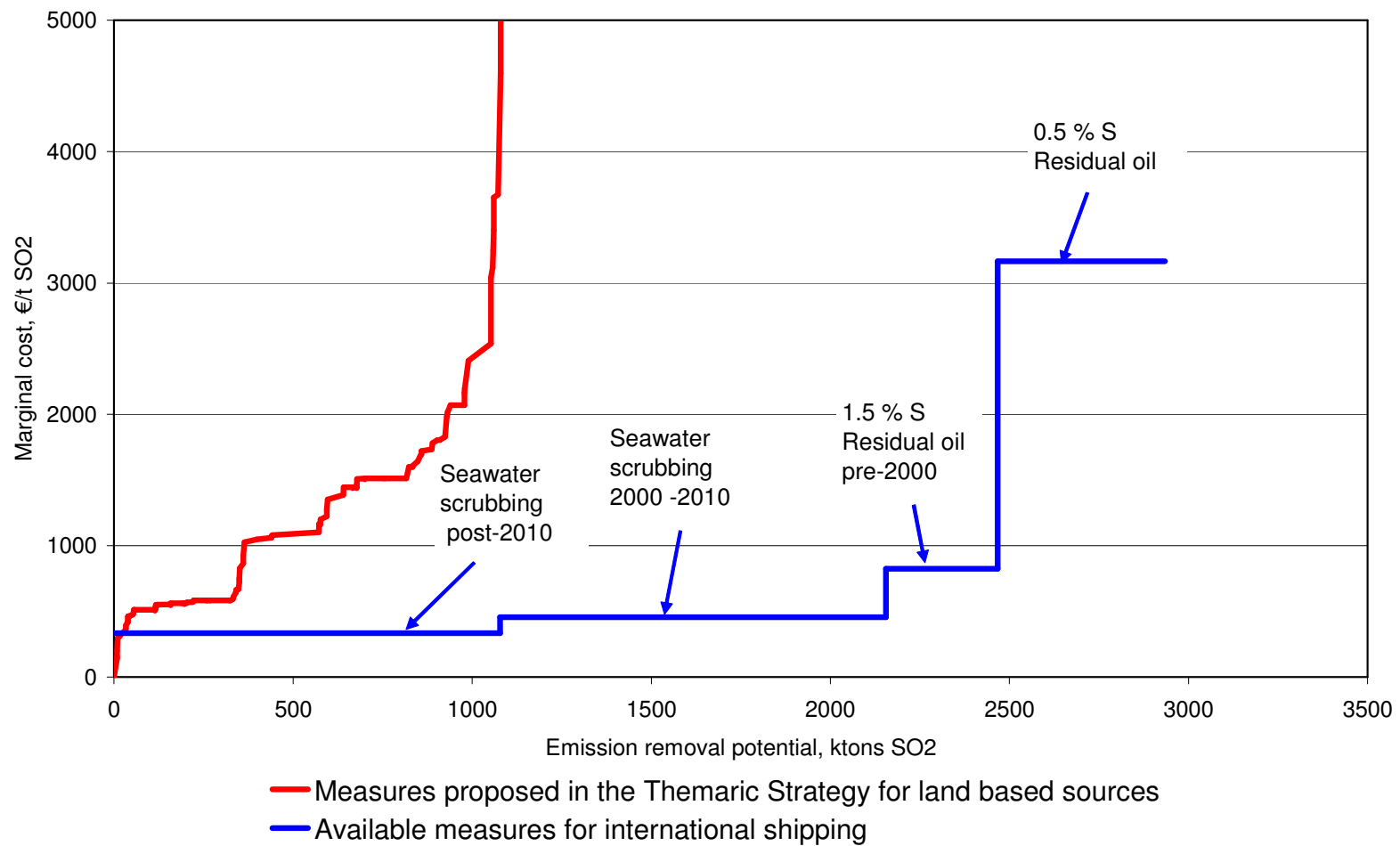
Contribution made by international shipping to sulphur deposition, %



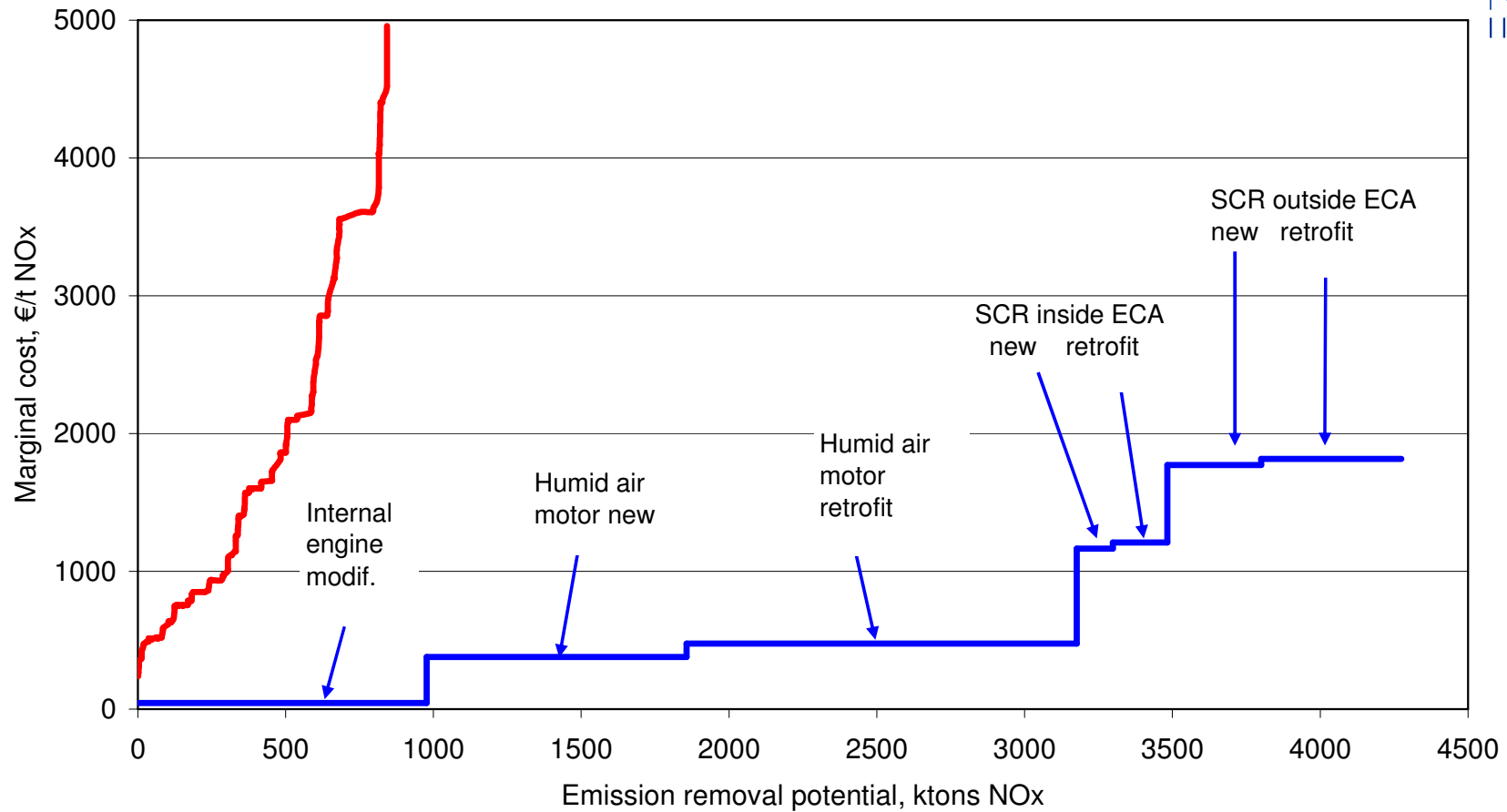
Loss in life expectancy due to PM2.5 in 2020 and % improvement from ship measures



SO₂ cost curves for ships and land-based sources 2020

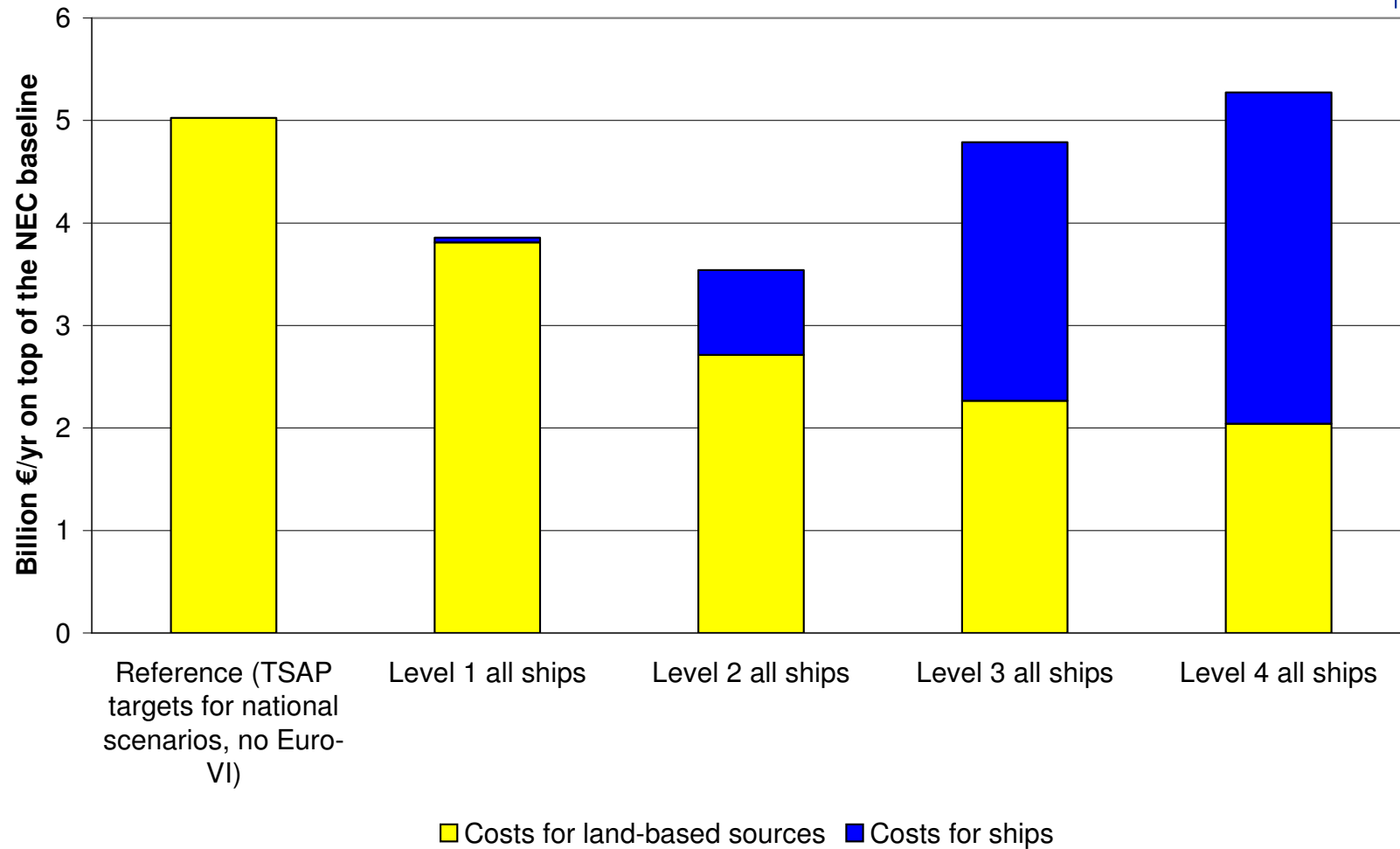


NO_x cost curves for ships and land-based sources 2020



- Measures proposed in the Thematic Strategy for land-based sources
- Available measures for international shipping

Costs for achieving the TSAP targets (National activity projections)



Conclusions (1)



- Increase in transport volumes will compensate effects of recent agreements on ship emission control
 - By 2020, emissions between CLE and TSAP of land-based sources
 - Increasing share of sulphur deposition originating from ships: in coastal regions, increase from 10 - 20% today to 30 - 50% in 2020
- 80 percent of emissions emitted outside of 12-mile zones
- Identified technologies can reduce ship emissions by 80 to 90% at costs € 5.5 billion/year

Conclusions (2)



- Cost of shipping measures low but cost-effectiveness depends on locations
- Scenarios considered bring important health and environmental benefits at moderate costs
- Trade-offs between additional land-based measures and measures for shipping to achieve TSAP targets analyzed with GAINS model
- Reduction of emissions from shipping lowers the net costs of TSAP by up to 1.5 billion €

Report available from Commission's
WEB page
and from IIASA:

http://www.iiasa.ac.at/rains/reports/IR06-107_Ships.pdf