Options to decrease pollution from international shipping on European seas

Study for the European Commission, DG ENV
Consortium: IIASA, MET.NO and EMRC
Scope of the Study

- Gridded emission inventory for 2015 from FMI by vessel type (Johansson et al., 2017)
  - Cargo
  - Passenger ships
  - Tankers
  - Other
  - Container
  - RoPax
  - Vehicle carrier

- Emission factors and costs based on recent literature – mainly 3rd IMO GHG Study, 2015, IVL (Astrom et al., 2017), EMSA, 2017

- Two scenarios of fuel demand: Low and High; consistent with a study (COWI, CENIT and VITO -EC, 2015) up to 2030 and then extrapolated to 2050 based on scenarios 1 and 3 from the 3rd GHG Study
European seas: regions and 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
Emission control scenarios

1. Current legislation: IMO global S limit 0.5% from 2020, Tier II new vessels from 2010), 0.1% S and Tier III new vessels from 2021 for ECAs
2. SECA and NECA all seas and zones from 2025
3. As scenario 2 but with retrofits of existing vessels with SCR
4. SECA and NECA all regions from 2021
5. As scenario 4 but with retrofits of existing vessels with SCR

Special focus on the Mediterranean Sea: five variants with different configurations of ECAs in EU and non-EU waters (EU waters – 2/3 of fuel consumption in 2015)
Shipping emissions vs. land-based sources
thousand tons

2015

2030 High fuel demand

SO2
NOx
PM2.5

Land sources
Maritime shipping
Gridded emissions 2015: SO2 (left) and NOx (right)
thousand tons per grid
Fuel consumption by vessel type, PJ
Fuel consumption by sea region, PJ
Emissions of SO2, thousand tons

CLE Low case

High case

MTFR Low case

High case

- Arctic Sea
- Atlantic Ocean
- Baltic Sea
- Bay of Biscay
- Black Sea
- Celtic Sea
- Mediterranean Sea
- North Sea
Emissions of NOx, thousand tons
Emissions of PM 2.5, thousand tons
Change in PM2.5 concentrations in 2050
ECA all seas, high fuel demand rel. to CLE
Change in PM2.5 concentrations in 2050
NECA Mediterranean Sea, high fuel demand rel. to CLE
Change in PM2.5 concentrations in 2050
ECA Mediterranean Sea, high fuel demand rel. to CLE
## Emission control costs, bln €/a

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Low case</th>
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<th>High case</th>
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<tbody>
<tr>
<td></td>
<td>2030</td>
<td>2050</td>
<td>2030</td>
<td>2050</td>
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<tr>
<td><strong>Current legislation</strong></td>
<td></td>
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<tr>
<td>SO2</td>
<td>2.4</td>
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<tr>
<td>NOx</td>
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<td>0.3</td>
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<tr>
<td>Total</td>
<td>2.5</td>
<td>1.7</td>
<td>3.3</td>
<td>3.7</td>
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<tr>
<td><strong>Costs on top of CLE</strong></td>
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<tr>
<td>ECA all regions Tier III new + retro existing ships from 2025</td>
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</tr>
<tr>
<td>SO2</td>
<td>0.7</td>
<td>0.3</td>
<td>1.0</td>
<td>0.8</td>
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<tr>
<td>NOx</td>
<td>0.4</td>
<td>0.4</td>
<td>0.7</td>
<td>1.1</td>
</tr>
<tr>
<td>Total</td>
<td>1.1</td>
<td>0.7</td>
<td>1.7</td>
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<tr>
<td>% of CLE</td>
<td>45%</td>
<td>42%</td>
<td>52%</td>
<td>50%</td>
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Cost of ceilings from NEC Directive – 1.3 bln €/a in 2030
Reduction of premature deaths due to PM2.5 in 2050, low fuel demand (cases /year)

Reduction in EU-28, thousand cases/year:
ECA all -2.1
MEDS NECA – 0.6
MEDS SECA and NECA 1.3

Red. due to NEC ceilings in 2030 -18.6
People dying in traffic accidents – 22.5
Reduction of premature deaths due to PM2.5 in 2050, high fuel demand (cases/year)

Reduction in EU-28, thousand cases/year:
- ECA all -5.3
- MEDS NECA – 1.4
- MEDS SECA and NECA 3.2

Red. due to NEC ceilings in 2030 -18.6
Findings (1)

- Sea shipping importantly contributes to air pollution in Europe.

- IMO global legislation and ECAs in the Baltic and North Seas decrease the emissions of SO2 by 50 – 80% in 2050 but emissions of NOx might even increase by 60%.

- For our scenarios of activity growth it is possible to reduce emissions of SO2 by more than 90%, NOx by 50 – 80% and PM2.5 by 20 – 70%.

- Reduction of emissions from the Mediterranean Sea should have a priority.
Findings (2)

- Measures on shipping reduce premature deaths caused by fine particles by 2 – 5 thousand cases/year. This is equivalent to 11 – 29% of benefits caused by implementation of the NEC Directive.

- Costs of measures on shipping (0.7 – 1.8 bln €) are comparable with the costs of the NEC Directive (1.3 bln €/a).

- Cost-effectiveness of shipping measures will be determined by the costs-benefits analysis (work in progress).