Increasing environmental regulation

- **SO\textsubscript{x}**
  - Acid rains
  - 3.5% (2012)
  - ECA 0.1% (2015)
  - Global 0.5% (2020)

- **NO\textsubscript{x}**
  - Acid rains
  - Ozone formation
  - Tier II (2011)
  - Tier III in ECA (2016)

- **PM**
  - Impact on air quality
  - Along with SO\textsubscript{x} reduction

- **GHG**
  - Global warming
  - Under evaluation by IMO

- **BALLAST WATER**
  - Damage to local ecosystems
  - Global ballast convention
Exhaust gas cleaning - a big opportunity
Strict regulations have been set

Emission Control Areas (ECA)

- Sulphur emissions is a recognised problem
- Shipping is a main contributor to SOx emissions, especially in the most sensitive areas
- Business as usual will aggravate the situation
Switch fuels or clean the exhaust

• Low Sulphur Residual Fuel (LSFO):
  - Limited availability

• Low-Sulphur Destillates (MGO):
  - Similar to automotive fuel
  - Supply shortage in 2015
  - Current price premium: 50%

• Gas (LNG/CNG):
  - Natural gas prices expected to remain low
  - Infrastructure for bunkering developing
  - Lowest overall emissions
  - Mostly for newbuilds

• High Sulphur Residual Fuel (HFO) with scrubbing:
  - Business as usual
  - Low overall CO2 footprint
Scrubbing is the most cost-effective solution

Return on investment

Payback time

Annual Fuel Consumption in ECA

Fuel price differential
- $250,000
- $350,000
- $500,000
- $750,000
- $1,000,000

10 MW Main Engine, 3x0.5MW Aux. Engines,
Total investment cost USD 3,000,000
• Market is in its infancy but set to develop as 2015 approaches
• Biggest market is retrofit
• Approximately 8,000 vessels affected by current ECA regulations
• Next phase in 2020 will effect an estimated 40,000 vessels
• Retrofit value between €1m to €5m per vessel
• Wärtsilä has strong references with 8 systems installed and several on order
Fresh water scrubber (FWS) – closed loop system
- Not dependent on seawater alkalinity
- Zero effluent discharge an option
- Low power demand
- Needs caustic soda as a reagent

**Applications:** seas with low alkalinity and for operators looking for zero discharge

Sea water scrubber (SWS) – open loop system
- Uses seawater i.e. no freshwater needs
- Slightly higher power demand than FWS
- Does not need caustic soda

**Applications:** main alternative for ocean-going ships

Hybrid scrubbers – both open loop and closed loop operations
- Flexible system
- More complex system

**Applications:** ships requiring full flexibility of operations (e.g. sailing both in low alkalinity areas as well in open oceans)
Key Features

- Open-loop system
- Same process as for IGS
- No additives
- Low running costs
- Simple and reliable
- Module based
- Flexible
- Standardised designs
- Tried and tested
<table>
<thead>
<tr>
<th>Vessel</th>
<th>Newbuilding or retrofit</th>
<th>SWS</th>
<th>FWS</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suula</td>
<td>retrofit</td>
<td></td>
<td>x</td>
<td>Test installation, test report available</td>
</tr>
<tr>
<td>Containerships VII</td>
<td>retrofit</td>
<td></td>
<td>x</td>
<td>Full commercial project with main stream scrubber. Modification to water treatment system ongoing.</td>
</tr>
<tr>
<td>Algoma (6+2 vessels)</td>
<td>newbuilding</td>
<td></td>
<td>x</td>
<td>Integrated scrubbers for main engines, auxiliary engines and boilers</td>
</tr>
<tr>
<td>Pride of Kent</td>
<td>retrofit</td>
<td></td>
<td>x</td>
<td>More than 30,000 hrs of operation</td>
</tr>
<tr>
<td>Zaandam</td>
<td>retrofit</td>
<td></td>
<td>x</td>
<td>More than 4,000 hrs of operation</td>
</tr>
<tr>
<td>APL England</td>
<td>retrofit</td>
<td></td>
<td>x</td>
<td>Integrated scrubber for 3 engines, 2.94 MW each</td>
</tr>
<tr>
<td>RoRo</td>
<td>retrofit</td>
<td></td>
<td>x</td>
<td>1 x 25 MW and 1 x 6 MW scrubbers</td>
</tr>
<tr>
<td>Ignazio Messina (4 vessels)</td>
<td>newbuilding</td>
<td></td>
<td>x</td>
<td>Separate scrubbers for auxiliary engines and boilers, up to 4.5% S-content</td>
</tr>
<tr>
<td>Solvang</td>
<td>newbuilding</td>
<td></td>
<td>x</td>
<td>Main engine scrubber and integrated auxiliary engine scrubber</td>
</tr>
</tbody>
</table>
Far ahead of the competition

- Legislation is in place
- Abatement is an economical solution
- Large market growth, both near and long-term
- Wärtsilä Hamworthy is the clear market leader: excellent products and "turnkey" projects capability
- Wärtsilä is well positioned to win