Best Practices to reducing air emissions from shipping and ports

2012 U.S.-Taiwan Sustainability Symposium: Creating Sustainable Cities and Promoting Sustainable Ports in the Asia Pacific Region

Freda Fung
Kaohsiung, Taiwan
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Countries present: China, Brazil, Canada, Europe, Germany, Russia, India, Mexico, Korea, United States.
Outline

- **Background**
  - Contribution of shipping to urban air pollution
  - Health impacts of shipping
  - Complex business and operational structure of shipping and ports

- **Examples of green port practices**
  - North America
  - Europe
  - Asia

- **Incentive analysis tool for ports**
Air pollution from shipping

- Marine shipping has become one of the major contributors to urban air pollution in some coastal regions
- Its contribution to air quality, however, is not widely recognized
  - Note: 48%, 32% and 36% of Hong Kong SO$_2$, NO$_x$ and respirable suspended particulates (RSP) are from marine navigation:

Shipping is directly linked to human health

Intertwined operational structure of shipping makes it difficult to control emissions.
North America

- Multi-ports approach
  - San Pedro Bay ports
  - Puget Sound ports
  - Gulf of Mexico ports
  - Port authority of New York and New Jersey

- A variety of emission mitigation measures
  - Voluntary vs. mandatory
  - Technology vs. operational

- Collaboration with other agencies
  - Federal: Environmental Protection Agency
  - State: California Air Resource Board
  - Local/Regional: Air Quality Districts

- Implementation of Emission Control Area (ECA)
  - Promote use of low sulfur fuel: 1% now, 0.1% in 2015
  - Tier III standard for engine
Example: San Pedro Bay

- Ports of Los Angeles and Long Beach
  - San Pedro Bay Port Clean Air Action Plan since 2006

- Ocean-going vessels and harbor crafts
  - Operational: vessel speed reduction
  - Technology: shore power
  - Fuel: fuel switching, hybrid assist tugs
  - Incentive: Environmental Shipping Index

- Heavy duty trucks, and other off-roads
  - Clean truck program
  - Electric drayage trucks
  - Locomotive upgrade
Europe

- **A variety of mitigation measures**
  - Liquefied natural gas (e.g., alliance of Ports of Rotterdam and Gothenburg)
  - Environmental shipping index

- **Collaboration with other agencies and among different country state governments**
  - Multiple trans-boundary rivers
  - Rhine-Danube network
  - Azov-Black-Caspian seas basin

- **More efforts on inland shipping**
  - Bigger share of inland shipping in Europe than in the U.S.
  - First to enforce ultra low sulfur fuel (10 ppm) regulation for inland waterway vessels

Implementation of SOx ECA (Baltic Sea and North Sea)
- Promote use of low sulfur fuel: 1% now and 0.1% in 2015
Example: Rijnmond Ports

- **Port of Rotterdam**
  - Regional Air Quality Action Program since 2004

- **Ocean-going vessels and harbor craft**
  - Shore power
  - Ultra low sulfur diesel for inland shipping
  - Environmental shipping index
  - Liquefied natural gas in collaboration with Port of Gothenburg

- **Heavy duty trucks and other off-roads**
  - Fleet management and modernization
  - Electrification of cargo handling equipment
Asia: Significant growth in shipping activities

Sustainable Port Development in the ASEAN Region

- **Air emissions inventory**
  - First step to understand major sources of emissions
  - Cover vessels, cargo handling equipment, vehicles and others
  - OGVs the dominant source of NOx, PM and SOx

- **Recommended measures**
  - Use alternative energy or better energy efficiency equipment
  - Reduce congestion
  - Improve port management

http://www.sustainableport.org/
Incentive Analysis Tool for Ports

- **Environmental Shipping Index (ESI)**
  - Index for ship environmental performance relative to IMO Rules
  - Serve as ranking tool for governments/ports to reward clean ships
  - Covers NOx, SOx, and CO2 (emphasis on NOx, shore power bonus)

- **Cost estimation**
  - Based on a ESI incentive structure, estimate costs, NOx, SOx, CO2 reductions, benefits, incentives

- **Air quality toolbox**
  - Identifies mitigation options at ports’ disposal
  - Aids in design of clean air program for ports

- **Goal:**
  - Allow regulators and ports to analyze costs and benefits, make improved decisions
Air quality toolbox

- Groups of technologies and operational strategies to reduce air emissions from ports
  - Developed by the International Association of Ports and Harbors
  - ICCT commissioned Starcrest to update the toolbox in 2012
- Goal: Help regulators and port authorities identify available measures to reduce air emissions
  - Address major air pollutants
  - Cover most transportation modes in and around the port
### Common Emissions Control Technologies

- Many proven, cost-effective technologies for port/ship equipment

<table>
<thead>
<tr>
<th>Technology Type</th>
<th>General Emissions Control Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
<td>Diesel Oxidative Catalysts (DOC)</td>
</tr>
<tr>
<td></td>
<td>Diesel Particulate Filters (DPF)</td>
</tr>
<tr>
<td></td>
<td>Selective Catalytic Reduction (SCR)</td>
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<tr>
<td></td>
<td>Exhaust Gas Scrubbers</td>
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<td></td>
<td>Shore power</td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td>Trucks CHE (&gt;750hp)</td>
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<tr>
<td></td>
<td>Marine &amp; CHE (&lt;750hp)</td>
</tr>
<tr>
<td></td>
<td>Locomotives</td>
</tr>
<tr>
<td><strong>Targeted Air Pollutant</strong></td>
<td>PM 20-30%</td>
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<tr>
<td></td>
<td>HC 50-90%</td>
</tr>
<tr>
<td></td>
<td>CO 70-90%</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>$1,000-4,000</td>
</tr>
<tr>
<td></td>
<td>$6-18K (Truck) up to $40K (Marine)</td>
</tr>
<tr>
<td></td>
<td>$36K (Truck &amp; CHE) $60K-120K (Marine)</td>
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<tr>
<td></td>
<td>$5M (Marine) $1-15M</td>
</tr>
</tbody>
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Table based on data from Starcrest (2012) “Developing Port Clean Air Programs” prepared for the ICCT

CHE – Cargo handling equipment
# Common Technologies and Operational Improvements

- **Many proven, cost-effective strategies for port/ship equipment**

<table>
<thead>
<tr>
<th>Technology Type</th>
<th>On-Engine Modification</th>
<th>Diesel Fuel Alternatives</th>
<th>Operational Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
<td>Exhaust Gas Recirculation (EGR)</td>
<td>Engine Replacement, Repower, Rebuild</td>
<td>Slide Valves</td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td>Truck Marine Locomotive</td>
<td>Truck CHE Marine Locomotive</td>
<td>Truck CHE Marine Locomotive</td>
</tr>
<tr>
<td><strong>Targeted Air Pollutant</strong></td>
<td>NOx 40-50% PM 70% (with DPF)</td>
<td>NOx up to 90% PM up to 90%</td>
<td>PM 10-50% NOx 10-25%</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>$12K (Truck) $10M (Marine)</td>
<td>$0.5-1.5M</td>
<td>$1.5-16K (Marine)</td>
</tr>
</tbody>
</table>

Table based on data from Starcrest (2012) “Developing Port Clean Air Programs” prepared for the ICCT

CHE – Cargo handling equipment
Conclusions

- Shipping can have profound adverse impacts on urban air quality and human health, especially in coastal areas.
- Shipping pollutant emissions are challenging to control due to complex business and operational structure.
- Ports in North America and Europe have made significant progress in addressing air emissions from shipping and ports.
- Ports in Asia are catching up.
- A wide variety of technologies and operational measures have proven successful and cost-effective to reduce port-related emissions.
- Inventory development offers a powerful way to prioritize actions.
- Tools are available to guide regulators and ports to analyze costs and benefits, make informed decisions.
Thank You

www.theicct.org/marine