WEBINAR: Air quality challenges and strategies for ports

Wednesday 20 February, 1.00pm-2.30pm

Guy Hitchcock and Tim Scarbrough (Ricardo)
Tanya Ferry (Port of London Authority)
What this webinar will cover

What you will learn

- Key drivers requiring action on emissions and air quality in and around ports;
- How develop an evidence base on emissions for your port;
- What are the likely key sources of emissions;
- Implications for developing an Air Quality Strategy.

The webinar will also be useful for:

- Local authorities with ports within their jurisdictions to understand the possible contributions of ports to local air quality.
- Port authorities and users such as vessel operators whose operations impact on port air quality.

The Agenda

- Introduction to Ricardo
- Clean Air Strategy introduction
- Guest speaker – experience at the Port of London Authority
- Ricardo - experience in developing an evidence base at Southampton
- Concluding remarks
- Questions and discussion
Tim has over 10 years of experience in quantifying maritime transport emissions and on evaluating emission mitigation options.

He has overseen the development for the UK Government of a national spatially resolved bottom-up ship emission inventory using minute-by-minute AIS data.

At a local level, Tim has worked with Southampton port to develop a port emission inventory, using extracts from the national ship emission inventory and supplementing with port level information.

Guy has over 20 years experience on the environmental impacts of transport. He has worked with many UK cities on Low Emission Strategies and Clean Air Zones.

Guy leads Ricardo’s work on the feasibility study for the Southampton Clean Air Zone and the related assessment work with Southampton Port.
Housekeeping

- You can submit your question or comment in writing at any time during the webinar, using the control panel on your screen.
- (The control panel is usually located in the top right or top left of your screen.)
- Any questions about the process?

If your panel is minimised, click the orange button to expand it.

Type your question here
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- Providing analysis and solutions for major environmental challenges
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  - emissions and air quality
  - resource productivity
  - waste management
  - sustainable transport
  - chemical risk
  - Water

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The Clean Air Strategy and other drivers for action on emissions and air quality at ports
The drivers for action

- **Local air quality management regime**
  - Duty on local authorities to assess and manage air quality in their areas
  - Focus has been on limit values and relevant exposure for NO₂ and PM
  - Where ports have been a contributor they will have been engaged by the Local Authority on potential mitigation measures

- **The national roadside NO₂ compliance plan and Clean Air Zones**
  - Key activity on achieving NO₂ compliance in relation to the European Air Quality Directive
  - Ports may have been a contributing source and so again were engaged with these studies
  - Key contributions
    - Traffic to ports
    - Shipping and port side emissions

- **The Clean Air Strategy**
  - Recently released
  - Covers maritime and port activities
What underpins the Clean Air Strategy?

➢ “ambitious, legally binding international targets to reduce emissions of five of the most damaging air pollutants”
  ▪ This means the National Emissions Ceiling Directive (NECD)
  ▪ Requires a National Air Pollution Control Programme (NAPCP)
  ▪ So is focused on emissions NOT concentrations
  ▪ But reducing overall emissions burden will help reduce exposure, and related health and habitat issues

➢ “tough new goals to cut public exposure to particulate matter pollution, as recommended by the World Health Organization”
  ▪ Particular focus on PM as this is a key health related pollutant and not tackled by the Roadside NO₂ plan
  ▪ This does relate directly to exposure
The strategy builds on a number of existing plans and policies:

- **25 year Environment Plan** - setting out the UK’s environmental ambitions and targets going forward
- ‘Clean Growth Strategy’ – looking at low carbon growth so links strategy to carbon emissions
- ‘Roadside NO₂ plan’ – significant work around Clean Air Zones, and another driver
- ‘Road to Zero’ – setting out how Government will achieve zero emission vehicles by 2040
Key pollutants of the Clean Air Strategy

- Particulate matter, PM$_{2.5}$
- Nitrogen dioxide, NOx
- Sulphur dioxide, SOx
- Ammonia, NH$_3$
- Volatile organic compounds, NMVOCs
### Pollutant reduction targets and main sources

<table>
<thead>
<tr>
<th></th>
<th>PM$_{2.5}$</th>
<th>NOx</th>
<th>SOx</th>
<th>NH$_3$</th>
<th>NMVOCs</th>
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<tbody>
<tr>
<td><strong>Reduction target (against 2005 levels)</strong></td>
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<tr>
<td>30% by 2020</td>
<td>30% by 2020</td>
<td>55% by 2020</td>
<td>59% by 2020</td>
<td>8% by 2020</td>
<td>32% by 2020</td>
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<tr>
<td>46% by 2030</td>
<td>73% by 2030</td>
<td>88% by 2030</td>
<td>16% by 2030</td>
<td>39% by 2030</td>
<td></td>
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<tr>
<td><strong>Key sources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic burning</td>
<td>38%</td>
<td>Road transport</td>
<td>34%</td>
<td>Energy generation</td>
<td>Agriculture</td>
</tr>
<tr>
<td>Industry</td>
<td>16%</td>
<td>Energy generation</td>
<td>19%</td>
<td>Industrial combustion</td>
<td>88%</td>
</tr>
<tr>
<td>Road transport</td>
<td>12%</td>
<td>Domestic and industrial combustion</td>
<td>19%</td>
<td>Domestic combustion</td>
<td>22%</td>
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</tbody>
</table>

Measured and tracked through the National Atmospheric Emission Inventory (NAEI) delivered by Ricardo
The contribution of maritime and port activity to emissions

- Only domestic shipping is covered under National Emissions Ceiling Directive targets 2016 contribution to UK totals:
  - NOx -> 10%
  - SO₂ -> 7%
  - PM$_{2.5}$ -> 2%

- However, this is only part of UK shipping emissions:

<table>
<thead>
<tr>
<th>NOx Emissions from Shipping 2016 (Kt/year)</th>
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<tbody>
<tr>
<td>Domestic</td>
</tr>
<tr>
<td>International</td>
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<tr>
<td>In Transit</td>
</tr>
</tbody>
</table>

- Also it does not include other sources
  - Shore side activities will be part of wider non-road mobile machinery
  - Port related traffic part of general road traffic
  - Industrial sources
The Clean Air Strategy includes efforts to cut public exposure to particulate matter pollution → PM$_{2.5}$ exposure target

➢ The current situation - We already meet the EU limit value of 25 μg/m$^3$ and are on track to meet a second stage limit of 20 μg/m$^3$ by 2020

➢ The target – reduce the number of people living in locations above 10 μg/m$^3$ by 50% by 2025, compared to a 2016 baseline.
Maritime measures in the strategy

- **Clean Maritime Plan** – route to zero emissions, due in spring 2019

- Consulting on environmental regulations for vessels operating domestically
  - Call for evidence in Spring 2019

- Potential extension of Emission Control Areas (ECAs) beyond North Sea and English Channel
  - Limits on vessel NOx and SOx emissions
  - Consultation in Spring 2019

- **Ports within scope should produce Air Quality Strategies**
  - In scope ports are “major ports” in England
  - Strategy should cover emissions from shore side activities and shipping
  - Advice to ports on how to develop effective and targeted strategies due in Spring 2019
  - Strategies due by end 2019
These drivers, and in particular the Clean Air Strategy, are providing a strong impetus for Ports to explore emissions from their activities and measures to reduce them.

Several ports have already made big strides in this area and have generated key learnings that will help others.

Two examples that we want to explore today are:
- The Port of London – our guest speaker Tanya Ferry
- Southampton – Ricardo’s work with the city and Port to manage NO₂ concentrations

The key outcomes of this experience covers:
- Challenges and benefits for a Port
- Developing a detailed emissions inventory
- Mitigation measures
Port of London’s AIR QUALITY STRATEGY

Its development and need

Tanya Ferry
Context

- Air pollution can significantly contribute to human health issues, in particular NO$_2$ & PM$_{2.5}$ contributing to 9,400 Londoners deaths in 2010
- River currently contributes a small percentage of total London emissions (approx. 1%)
  - Road engines are improving and as use of the river increases the river will contribute a bigger proportion of the total
### Percentage of NOx in London

#### 2013
- Equivalent to 2.09% of Road Emissions
- 1.05% of London’s total

#### 2025 projection
- Equivalent to 8.27% of Road Emissions
- 2.33% of London’s total

#### Total NOx Emissions by Source Type - GLA

<table>
<thead>
<tr>
<th>Year</th>
<th>Road Transport</th>
<th>Aviation</th>
<th>River</th>
<th>Rail</th>
<th>Industry</th>
<th>NRMM</th>
<th>D&amp;C Gas</th>
<th>D&amp;C Other Fuels</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>31,774</td>
<td>4,210</td>
<td>825</td>
<td>1,281</td>
<td>3,604</td>
<td>7,625</td>
<td>12,178</td>
<td>1,863</td>
<td>599</td>
<td>63,957</td>
</tr>
<tr>
<td>2010</td>
<td>28,049</td>
<td>3,864</td>
<td>775</td>
<td>1,236</td>
<td>3,604</td>
<td>5,638</td>
<td>10,712</td>
<td>1,553</td>
<td>580</td>
<td>56,011</td>
</tr>
<tr>
<td>2013</td>
<td>23,853</td>
<td>3,759</td>
<td>500</td>
<td>1,205</td>
<td>3,353</td>
<td>3,571</td>
<td>9,397</td>
<td>1,363</td>
<td>661</td>
<td>47,661</td>
</tr>
<tr>
<td>2020</td>
<td>11,995</td>
<td>3,557</td>
<td>573</td>
<td>861</td>
<td>3,353</td>
<td>2,117</td>
<td>8,171</td>
<td>550</td>
<td>661</td>
<td>31,852</td>
</tr>
<tr>
<td>2025</td>
<td>7,535</td>
<td>3,212</td>
<td>623</td>
<td>861</td>
<td>3,353</td>
<td>2,057</td>
<td>7,994</td>
<td>594</td>
<td>679</td>
<td>26,708</td>
</tr>
<tr>
<td>2030</td>
<td>5,018</td>
<td>2,867</td>
<td>659</td>
<td>861</td>
<td>3,353</td>
<td>2,057</td>
<td>8,690</td>
<td>343</td>
<td>704</td>
<td>24,553</td>
</tr>
</tbody>
</table>

**Notes:**
- The emissions are combined into reasonably self-explanatory “Source Types”.
- Other: the total emissions from a number of small sources including agriculture, outdoor fires, garden emissions, forests, waste and waste transfer sites, combined.

#### NOx - GLA % Change in Emissions

<table>
<thead>
<tr>
<th>Year</th>
<th>Road Transport</th>
<th>Aviation</th>
<th>River</th>
<th>Rail</th>
<th>Industry</th>
<th>NRMM</th>
<th>D&amp;C Gas</th>
<th>D&amp;C Other Fuels</th>
<th>Other</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>12%</td>
<td>-6%</td>
<td>4%</td>
<td>-3%</td>
<td>-1%</td>
<td>-12%</td>
<td>-17%</td>
<td>17%</td>
<td>-1%</td>
<td>-1%</td>
</tr>
<tr>
<td>2010</td>
<td>-6%</td>
<td>-11%</td>
<td>-4%</td>
<td>-5%</td>
<td>1%</td>
<td>-12%</td>
<td>-27%</td>
<td>27%</td>
<td>-3%</td>
<td>-23%</td>
</tr>
<tr>
<td>2013</td>
<td>-8%</td>
<td>-10%</td>
<td>-3%</td>
<td>-2%</td>
<td>-12%</td>
<td>-17%</td>
<td>-37%</td>
<td>37%</td>
<td>-5%</td>
<td>-56%</td>
</tr>
<tr>
<td>2020</td>
<td>-6%</td>
<td>-10%</td>
<td>-2%</td>
<td>-1%</td>
<td>-12%</td>
<td>-17%</td>
<td>-47%</td>
<td>47%</td>
<td>-7%</td>
<td>-77%</td>
</tr>
<tr>
<td>2025</td>
<td>-4%</td>
<td>-10%</td>
<td>-1%</td>
<td>-2%</td>
<td>-12%</td>
<td>-17%</td>
<td>-57%</td>
<td>57%</td>
<td>-9%</td>
<td>-98%</td>
</tr>
<tr>
<td>2030</td>
<td>-2%</td>
<td>-10%</td>
<td>-1%</td>
<td>-2%</td>
<td>-12%</td>
<td>-17%</td>
<td>-67%</td>
<td>67%</td>
<td>-11%</td>
<td>-118%</td>
</tr>
</tbody>
</table>
Percentage of $PM_{10}$ in London

- 2013
  - Equivalent to 1.3% of Road Emissions
  - 0.6% of London’s total

- 2025 projection
  - Equivalent to 1.8% of Road Emissions
  - 0.9% of London’s total
## Much lower legal standards for marine engines

<table>
<thead>
<tr>
<th></th>
<th>CO₂ (g/kWh)</th>
<th>NOₓ (g/kWh)</th>
<th>SOₓ</th>
<th>PM (g/kWh)</th>
<th>Regulatory source</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro VI Truck</td>
<td>4</td>
<td>0.46</td>
<td>0.01</td>
<td>0.01</td>
<td>EU Diesel Road</td>
<td>2013</td>
</tr>
<tr>
<td>Stage III</td>
<td>5</td>
<td>11.2 (HC inclusive)</td>
<td>0.5</td>
<td></td>
<td>EU Inland Waterways</td>
<td>2009</td>
</tr>
<tr>
<td>Stage V</td>
<td>5 - 3.5</td>
<td>4.7 - 1.8</td>
<td>0.015</td>
<td></td>
<td>EU Inland Waterways</td>
<td>2019</td>
</tr>
<tr>
<td>Tier II</td>
<td>7.7 - 14.4</td>
<td></td>
<td></td>
<td></td>
<td>IMO Annex VI</td>
<td>2011</td>
</tr>
<tr>
<td>Tier III</td>
<td>2 - 3.4</td>
<td></td>
<td></td>
<td></td>
<td>IMO Annex VI</td>
<td>2021</td>
</tr>
</tbody>
</table>
Setting the Baseline

• Research undertaken;
  • Shore-side electricity cost benefit & feasibility;
• Vessel versus lorry exhaust emissions;
• Literary review:- NOx abatement, NOx Exposure & Tug & barge configuration;
• Port Wide Inventory of marine source emissions.
Port wide Inventory projections – Do nothing scenario

Emission Trends 2010-2030
(PM and SO₂ on secondary axis)
Framing the Strategy

• Any action needs to be effective, based on evidence
• Consideration of legal mechanisms available to relevant organisations
• How can changes take place? Technical; Mechanical; Behavioural; Infrastructure
• Initial findings and strategy shared with stakeholders
• Final document published in January along side 2016 inventory
• Reviewed regularly, published as relevant.
## What should we do?

<table>
<thead>
<tr>
<th>Regulatory</th>
<th>Financial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byelaw</td>
<td>Incentives for different areas of the port</td>
</tr>
<tr>
<td>Ambient Levels with MCA support</td>
<td>Increase scope and scale of green tariff to encourage change in international shipping</td>
</tr>
<tr>
<td>Speed limit review for emission impact</td>
<td></td>
</tr>
<tr>
<td>River Works/Mooring Licence</td>
<td></td>
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<tr>
<td>Requirement to implement green technology</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Research</th>
<th>Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispersion model</td>
<td>Trial of shore power installation</td>
</tr>
<tr>
<td>Feasibility of LNG and required infrastructure</td>
<td>Low emission technology to encourage manufacturers</td>
</tr>
<tr>
<td>Convene an EXPO with operators and manufacturers</td>
<td>Exemplify use alternatives improve own fleet</td>
</tr>
<tr>
<td>Monitor benefits of alternative propulsion for vessels in the Thames</td>
<td>Monitoring of ambient levels at relevant sites</td>
</tr>
<tr>
<td>Effectiveness of add-ins into marine fuel</td>
<td>Trial alternative propulsion for own vessels</td>
</tr>
</tbody>
</table>
What reduction targets should we set?

- Measuring against the 2016 inventory (at source)

<table>
<thead>
<tr>
<th>2026</th>
<th>2031</th>
<th>2041</th>
<th>Overarching</th>
</tr>
</thead>
<tbody>
<tr>
<td>• PM - 20% reduction.</td>
<td>• PM- 40% reduction.</td>
<td>• PM- 50% reduction.</td>
<td>Reduction in CO₂</td>
</tr>
<tr>
<td>• NOx- 20% reduction.</td>
<td>• NOx- 40% reduction.</td>
<td>• NOx- 50% reduction.</td>
<td>Reduction in all other emissions produced on the Thames.</td>
</tr>
</tbody>
</table>
How far have we come

- Monitoring
- Guidance
- Trials or retrofitting
- Modelling
- LNG review for the Thames
Developing a port emission inventory – considerations and learnings from carrying out a port emission inventory for Southampton
Southampton as a case study for developing a port emission inventory and associated tools/techniques

- Ricardo carried out work for Southampton City Council during 2018 on the air quality modelling for the appraisal of options to reduce NO₂ concentrations in the city, including a possible clean air zone.

- Driver: compliance with annual mean NO₂ concentrations limit set by the Air Quality Directive
  - i.e. this was a different driver compared to the focus on emissions under the Clean Air Strategy which is under the remit of the National Emissions Ceiling Directive.

- Steps undertaken in Southampton assessment for the port:
  - **Port emission inventory baseline 2016**
    - Ships
    - Landside operations
    - Rail
    - Traffic
    - Industrial
  - **Port emission inventory projection 2020**
    - Growth factors
    - Efficiency gains
    - Policy impacts
    - Existing commitments
  - **Dispersion modelling 2020**
    - Meteorology
    - Emission release heights
    - Representation as line or area sources
  - **Estimating impact of additional policies**
    - Anticipated effects
Port air quality strategies need to be evidence-based. The focus for ports within the Clean Air Strategy is on emissions mitigation.

Evidence base

Emission inventories
- Compile emission **inventories** using data and assumptions from the port estate
- Make projections of how this may change
- To understand the sources of pollution and target and assess the impact of improvement measures.

Concentration measurements
- Design, install, operate, manage and quality-assure air quality **measurements**
- Understand trends and relate these to port-actions
- Support occupational and public exposure studies.

Dispersion modelling
- Detailed dispersion **modelling** to assess current and future air quality and the impact of improvement strategies.
- Can also include odour and dust assessment
- Use e.g. Ricardo proprietary tool RapidAir®
- Source apportionment

Mitigation (aka Air Quality Strategy)
- Project future impacts using inventory and modelling tools
- Establish mitigation options based on the highest priority emission/contributing sources.
- Use cost-benefit analysis to compare alternatives (reductions in emissions can be valued as health and environmental benefits)
Emissions are not the same as concentrations

**Emissions**

Which is the largest emission (tonnes/year) source?

- Driver for assessment: National Emissions Ceiling Directive
- Pollutant mass, i.e. tonnes or kilograms per year
- Location does not need to be specified
- The quantity emitted directly by a source or sources
- Largest emission source for ports may be ships

**Concentrations**

Which source is contributing the most to pollutant concentrations at the point of interest?

- Driver for assessment: Air Quality Directive
- Pollutant concentrations, i.e. µg/m³ or ppm as annual average
- Location needs to be specified (point of exposure)
- The resulting ambient concentration at a specific location following dispersion
- Largest contributing source to concentrations at key receptors not necessarily ships
Key steps in developing the evidence base baseline to underpin a strategy

- Understand the driver (e.g. focus on emissions?)
- Select pollutants
- Select emissions sources, including major emissions sources near port
- Select geographical and operational extent of the inventory
- Choose inventory temporal period and frequency
- Identify data sources
Which sources and pollutants are key for ports and their air quality strategies?

<table>
<thead>
<tr>
<th>Source</th>
<th>Pollutants</th>
<th>Dust, PM$<em>{10}$, PM$</em>{2.5}$</th>
<th>NOx</th>
<th>SO$_2$</th>
<th>NH$_3$</th>
<th>NMVOC</th>
<th>GHG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ships</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Port machinery</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Rail</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
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<td></td>
<td>X</td>
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<tr>
<td>Road traffic</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
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<td>X</td>
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<td>Raw materials storage</td>
<td>X</td>
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<tr>
<td>Industrial processes</td>
<td>X</td>
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<td>X</td>
<td>X</td>
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<tr>
<td>Power generation, industrial combustion</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
</tr>
</tbody>
</table>
A projection of future emissions under “business as usual” is needed. From this projection, the impacts of mitigation measures will be estimated.

- The projection of future emissions is estimated from a baseline year.
- The baseline year represents current activity levels, and is most likely to be the year of the latest available data for each emission source.
- The focus for ports on emissions in the Clean Air Strategy is driven by the National Emissions Ceiling Directive → the years of most interest to the Government are 2020, 2025 and 2030.
- Note this is different to the years of interest in the Southampton case study, which focused on 2020 only.

Baseline e.g. 2018

- Port growth rates, split by commodity/vessel type
- Policies affecting ship emissions (e.g. SO₂/NOx ECA)
- Fleet turnover (ships, port machinery, vehicles)
- Existing traffic calming projects
- Existing efforts to improve rail

Projection 2020, 2025, 2030
Emission source: ships
Ships are an important emission source at ports

Graphic: ship position density map 2014 (Ricardo, 2017)

- Ships are a key source of emissions in port emission inventories (emissions quantity)
- Ricardo has developed a national inventory of estimated shipping emissions
- This now forms part of the National Atmospheric Emissions Inventory (NAEI)
- Available at 1km$^2$ grid resolution

- **Data source**: national Automatic Identification System (AIS) data from the Maritime and Coastguard Agency
- **Scope**:  
  - All vessels that use AIS (15 vessel types, excl. recreational, navy)  
  - All trips: domestic and international  
  - At berth (hotelling) and underway  
  - Main engines, auxiliary engines and boilers
- **Spatial resolution publicly available**: 1km grid squares.
- **Temporal resolution**: downsampled to tracking vessels every 5 minutes.
- **Year**: AIS for year 2014; spatial distribution assumed to remain constant for future years.
- **Fuel and emission factors**: drawn mainly from IMO 3rd Greenhouse Gas study
Southampton case study: Ricardo refined the resolution from 1km to 100m to better understand the spatial distribution of ship emissions

- Such refinement suitable for detailed analysis for air quality impacts, but unlikely to be necessary for Air Quality Strategy scope limited to quantity of emissions only.
NAEI ship emissions estimates available at 1km resolution for around the UK, latest year available is 2016 at http://naei.beis.gov.uk/emissionsapp/
The data underpinning the NAEI ship emissions inventory is split by vessel type. It includes all sea-going and domestic in-port vessels that used AIS. Understanding the split by vessel type is important for mitigation strategies.

<table>
<thead>
<tr>
<th>Bulk carrier</th>
<th>Chemical tanker</th>
<th>Container</th>
<th>General cargo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquefied gas tanker</td>
<td>Oil tanker</td>
<td>Ferry (passenger)</td>
<td>Cruise</td>
</tr>
<tr>
<td>Refrigerated bulk</td>
<td>Ro-Ro</td>
<td>Service – tugs</td>
<td>Fishing</td>
</tr>
<tr>
<td>Offshore</td>
<td>Service – other</td>
<td>Miscellaneous other</td>
<td></td>
</tr>
</tbody>
</table>
Emission sources: port machinery and landside operations, and port-related traffic
All port landside operations should be inventoried. Estimates of their emissions to be developed.

- Non-road machinery
  - Straddle carriers
  - Forklifts
  - Excavators
  - Reach stackers
  - Cranes

- Rail
  - Container
  - Vehicle transport
  - Bulk transport

- On-site power generation
  - Temporary generators

- Industrial installations
  - Combustion
  - Processes
  - Storage

- Road vehicles
  - Exclusively in-port vehicles
  - Import/export
  - Stevedoring movements
  - Regular (public) traffic
Methods and data sources for estimating emissions

For **non-road machinery, rail and on-site power generation**, methods based on fuel consumption and emission factors

- **Fuel consumption**
  - Records from port operators
  - Estimate from equipment operating hours and fuel consumption factors (e.g. from inventory guidance such as EEA)
- **Emission factors**
  - Real world testing is ideal
  - Else from inventory guidance (e.g. EEA)

For **industrial installations**

- Emissions may be reported to local authorities
- Fuel consumption records
- Emission factors from own monitoring
- E-PRTR

For **road vehicles**

- Traffic count data
- Estimates of distances driven
- Inventory guidance emission factors
Example: Ricardo used real world emission factors for the straddle carrier fleet at Southampton, as tested by Ricardo engineers using PEMS.

PEMS Testing of Straddle Carriers

Objective to assess the current level of emission from the DP World straddle carrier and potential retrofit technologies to reduce these:

- Data collection on the characteristics and activity of the straddle carrier fleet
- Benchmark fleet emissions using existing emissions assessment factors
- PEMS testing to establish 'real world' emission factors and update fleet emissions
- Desk top assessment of retrofit options to reduce emission from the fleet
Port related traffic

- Port related traffic can be a significant contributor to air quality around a port and on major routes to ports.
- However, it is difficult to set boundaries around what emissions should be attributed to the port.
- An indication of the level of traffic accessing the port could be a useful metric for include in a Port Air Quality Strategy.
- Potential sources:
  - Traffic counts / Automatic Number Plate Recognition (ANPR) / booking systems at dock gates.
  - Local/regional traffic models that can separate out traffic destined for the Port.
- Understanding proportion of wider city traffic attributed to the port is important to fully account for the ports impact on wider air pollutant concentrations.
Southampton emissions inventory model example

NOx emissions from fuel consumption data

NOx emissions from operational data

NOx emissions from transported NRMM moving through port
Key questions for projections

- **Year of data?**
- **How representative are the data?**
- **Any temporal variation?**
- **Which port traffic commodity projection will these vary with?**
- **What business as usual plans are there to change (upgrade? enlarge?) the fleet of machinery?**
- **For the traffic projections, how will the traffic fleet renew?**
- **Are the locomotives using stop-start technology or idling whilst loading/unloading?**
- **Do the port growth factors represent true/likely growth?**
Air Quality Monitoring and Modelling
– in support of, and extending, emission inventories
The role for monitoring and modelling

- Concentrations are relevant for
  - Local Air Quality Management (LAQM)
    - in particular \( \text{NO}_2 \) exceedance
  - \( \text{PM}_{2.5} \) exposure target - but as part of a wider assessment
  - Work place exposure
  - Public information and awareness

- Monitoring
  - Within site for work place exposure
  - Around boundary – ideally working with the Local Authority

- Modelling
  - Essentially part of wider LAQM assessment
  - LAQM exposure criteria will be around port
  - PM exposure criteria requires population level modelling
What monitoring may be done?

Ideally an air quality strategy would present information on pollutant concentrations considering:

- Work related exposure areas;
- Public receptors in relation to Local Air Quality Management (LAQM)
- Long term trends give best information
- Particulates and dust can be particularly important for ports and their neighbours

Key sources of data:

- Readily available Local Authority air quality monitoring data
- Local monitoring either continuous, passive and/or ad-hoc
- Caution: cheap sensors can be indicative rather than accurate
- Quality assurance of monitoring is important

Ricardo implements baseline monitoring for London Gateway Port and Logistics Park

- Ricardo has assisted DP World London Gateway in implementing an air quality monitoring programme, with the aim of assessing pollutant concentrations around the port and logistic park.
- Ricardo staff undertake monthly visits, deploying a network of passive nitrogen dioxide (NO₂) diffusion tubes at nine locations in and around the port and logistic park.
- Following the screening assessment concentrations will be assessed to decide if and where further continuous traceable measurements are required
- The network is set up to assess air quality at DP World London Gateway and to identify if there are any trends in the air quality data as the development grows.
Putting it all together for NO$_2$ modelling

- Combine NOx concentrations
- Adjusted background NOx
- Adjusted Road NOx
- Monitoring Data
- NO$_2$ concentrations
- NOx to NO$_2$ Converter
Air quality modelling of emissions using Ricardo’s tool RapidAir®

- State-of-the-art air quality diagnostics and decision support tool
- Fast and efficient city-scale air quality modelling and mitigation scenario testing – run times in minutes
- Comprehensive range of emission sources and pollutants
- Spatial resolution: one metre
- RapidAir equips decision makers with the ability to test and optimise complex air pollution abatement strategies with unrivalled power and speed
Implications for developing Air Quality Strategies at ports
Objectives and targets

- Key pollutants (i.e. NOx, PM$_{10}$ and PM$_{2.5}$, SOx)

- Sources
  - Shipping
  - Shore side activities (potentially covering all businesses/tenants on site)
  - Port related traffic

- Target years
  - 2020 quick wins, contribution to Clean Air Zones work
  - 2025 contribution to PM exposure target
  - 2030 longer emissions reduction to support National Emissions Ceilings Directive (NECD)

- Quantify impacts on pollutant emissions

- Evaluate impacts – cost effectiveness (£/tonne), cost/benefit ratios, wider impacts on businesses at port
**Possible mitigation options**

**Driver: emissions reduction (Clean Air Strategy)**
- Needs to target the port pollution source with the largest emissions, focussed on priority pollutants
- Vessels likely to be the largest contribution, but can be the most difficult for a port operator to change
- Trade off against ease to act / cost to implement

**Driver: concentration exposure reduction (Air Quality Directive)**
- Needs to target the port pollution sources having the largest impacts on pollutant concentrations
- Traffic is commonly a significant source contributing to the high concentrations at sensitive receptor locations
- Trade off against ease to act / cost to implement

<table>
<thead>
<tr>
<th>Ships</th>
<th>Rail</th>
<th>Port machinery</th>
<th>Road vehicles</th>
<th>Stationary</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cleaner / newer vessels</td>
<td>• stop/start functionality</td>
<td>• Electric/hybrid machinery</td>
<td>• Traffic smoothing</td>
<td>• Switch electricity to on-site</td>
</tr>
<tr>
<td>• Alternative fuels</td>
<td>• Longer trains</td>
<td>• Removal of machinery with</td>
<td>• Reduce queueing</td>
<td>renewables</td>
</tr>
<tr>
<td>• Shore power</td>
<td>• Shift road to rail</td>
<td>worst real world emissions</td>
<td>• Electric vehicles</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Encourage faster uptake of Euro 6/VI</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Sustainable travel solutions (e.g. cycle provision)</td>
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</tbody>
</table>
Mitigation option example: Shore Power
Ships at berth plug in to draw electricity from the port in place of running their diesel auxiliary engines – this reduces emissions within the port.

- Technical considerations
  - Network capacity / reinforcement issues
  - Power source (renewable?)
  - Flexibility
  - Which vessels have the potential to plug in?

- How to incentivise ships to plug-in once kit is in place?

- Cost benefit analysis
  - Seek several capital cost quotes
  - Comparison of capital costs with energy savings (only) likely to show costs outweigh benefits
  - Important to also account for GHG and air pollutant (monetised) savings \(\Rightarrow\) costs and benefits may be more balanced and within margin for uncertainty of e.g. the choice of appraisal period
  - Reduction of noise could also be a benefit
  - Pay particular attention if sensitive receptors are downwind of dock

The value of the health and environmental impacts that could be avoided by eliminating all NO\(_X\), SO\(_2\) and PM\(_{10}\) emissions from ships’ auxiliary engines at berth around the whole UK in 2016 could be up to £100-£400million/year

Source: Ricardo 2018 study for Schneider Electric “Ship emissions whilst at berth in the UK”
This guidance sets out an overall approach to Port emissions inventory work and is fully consistent with the approach that Ricardo has developed and applied for Southampton.

The guidance mentions indirect GHG emissions associated with the consumption of electricity by port operators (‘Scope 2’).

- Such consumption does not affect local air quality (unless the electricity is generated on site).
- This may not be needed for port’s air quality strategies, but is still a useful metric to seek to reduce.

Contains a lot of detail about estimating ship emissions. Note that the Ricardo resource on ship emissions is already completed and available.

The International Maritime Organization has published guidance on developing port emission inventories in autumn 2018.
Concluding remarks: what might this mean for you?

- Work out the drivers for the work: is it focussed strictly on reductions of emissions or concentrations?
- Get ahead by thinking about pollution sources and which pollutants may be important for your port.
- Establish data sources already collected on the port: engage with port operators/tenants
- Consider what information is available to try to establish a business as usual projection
- Talk to others about their experiences and measures that may work for your port
- Consider what technical support you may need to develop your strategy – we’ll be happy to help!
Discussion: any questions?
For any specific questions relating to this webinar, or to discuss your business needs and requirements, please do not hesitate to use the following contact information:

Dr Guy Hitchcock  
Technical Director – Energy & Environment

Ricardo UK Ltd – Gemini Building, Fermi Avenue, Harwell, Oxon, OX11 0QR, UK

Direct Dial: +44 (0)1235 753 327  
Reception: +44 (0)1235 753 000  
Guy.Hitchcock@ricardo.com

www.ricardo.com

Tim Scarbrough  
Associate Director – Energy & Environment


Direct Dial: +44 (0)1235 753 159  
Reception: +44 (0)1235 753 000  
Tim.Scarbrough@ricardo.com

www.ricardo.com