PORT DECARBONISATION AND ENVIRONMENTAL SUSTAINABILITY

10:15 – 11:45

Port Eco Systems, Current Status and Future Directions

Environmental Sustainability

Alan Wells

Founder,
Redshift Associates

Belfast Harbour

UK SPACE AGENCY

In association with **Redshift Associates**

Port Environmental Sustainability

Professor Alan Wells
Redshift Associates Ltd.

IMO Strategy for NetZero CO_2 Emissions:
Impact for Ports

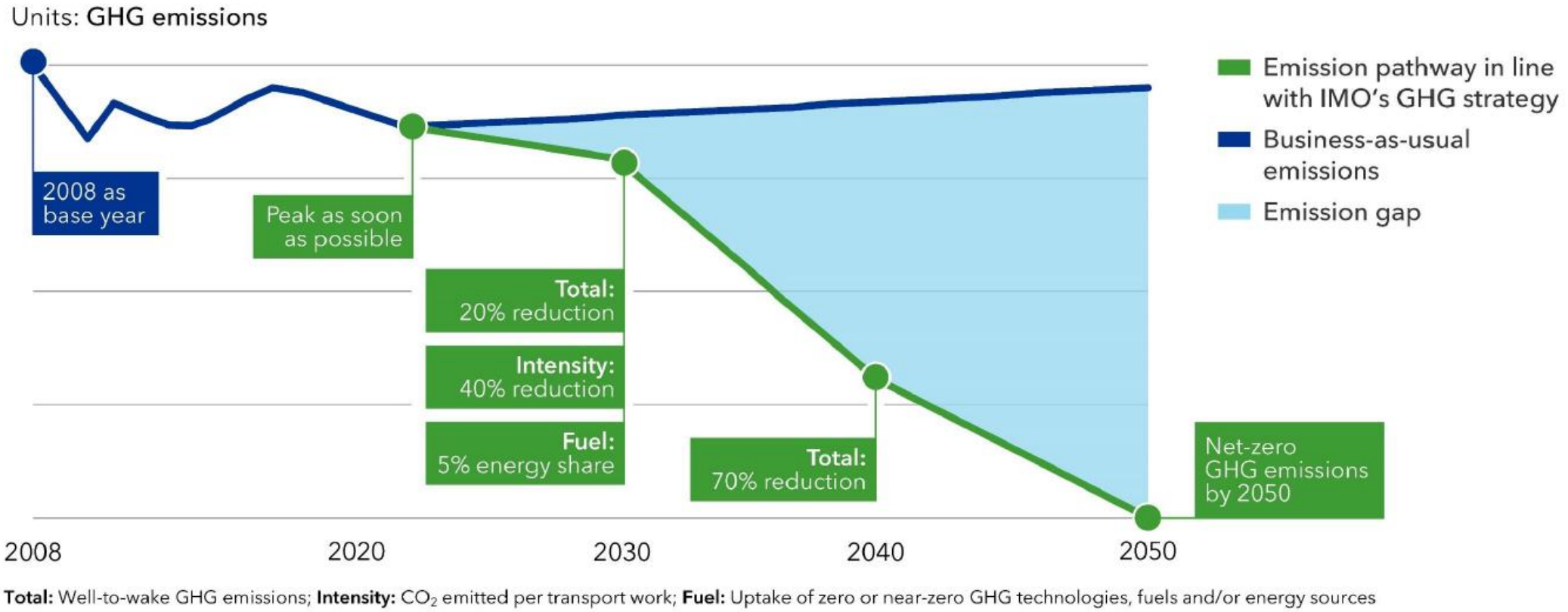
Port Air Quality

Emission Monitoring and Validation

Emission Location and Dispersion

New Space-enabled Services

IMO Strategy for GHG Reductions.

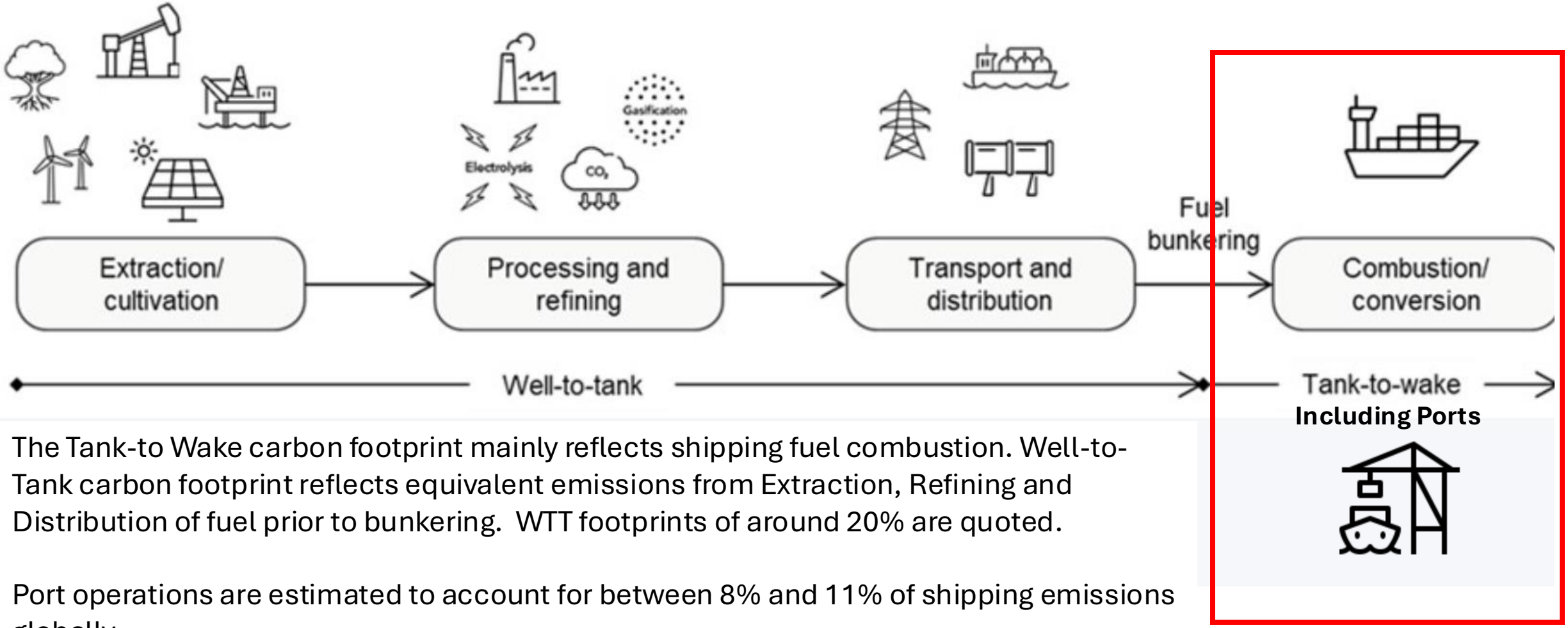


Current Maritime CO_2 Emissions

IMO estimates that 1.1 Gtonnes of CO_2 originated from international shipping in 2023 i.e. about 2.7% of global CO_2 annual emissions

- Year-on-year differences occur due to fluctuations in global economic activity.
  - COVID, Ukraine, maritime piracy
- Year-on year differences result from implementation of carbon reduction measures and regulations
  - Alternative fuels, slow steaming, electrification
- Independent, unbiassed monitoring and validation is essential.
- Acquiring reliable data for carbon inventories from accountable sources is challenging.
- Ports and Harbour emissions are additional CO_2 contributors
  - Local vessels, port equipment, port logistics.

Carbon Footprints: Generic Well-to-Wake Supply Chain



The Tank-to Wake carbon footprint mainly reflects shipping fuel combustion. Well-to-Tank carbon footprint reflects equivalent emissions from Extraction, Refining and Distribution of fuel prior to bunkering. WTT footprints of around 20% are quoted.

Port operations are estimated to account for between 8% and 11% of shipping emissions globally.
Local and coastal shipping and port equipment add to a port's carbon footprint.

Environmental Impact of Emissions

CO_2 emissions from port operations clearly contribute to global warming.

Pathways to Net Zero inevitably require reductions in CO_2 emission.

Port emissions also affect local air quality from fossil fuel combustion products.

So, for **every tonne of CO_2** emitted from ships powered with engines using MDO **about 10kg on NO_x** is added to the local atmosphere.

Re: Fuel Emission Factors for Marine Gas Oil: **CO_2 : 3.2kg/kg**. **NOx 0.03 kg/gm**

Emission factors vary for different fuels and other pollutants like PM and SO_2.

Monitoring and Reporting Frameworks for Port Emissions

CO2.

Ports are increasingly required to report their CO_2 emissions as part of efforts to reduce their GHG emissions.

Ports in the EU comply with Monitoring, Reporting and Verification (MRV) regulations regarding CO_2 emissions from ships over 5000 tonnes.

UK ports routinely report Scope 1 and Scope 2 emissions annually under the UK's Streamlined Energy and Carbon Reporting (SECR) framework which applies mainly to large ports.

IMO has implemented a Data Collection System for ship fuel oil consumption.

Air Pollution.

City councils and local authorities already report air pollution emissions annually and are required to undertake emission reduction measures in designated Air Quality Management Areas where emission levels are known to exceed regulatory limits.

Many ports have voluntarily established their own air quality strategies that follow Government 2019 guidelines. Ports expect that regulations similar to those applying to local authorities will come into force in due course.

Urban Emission Monitoring

Urban Air Pollution.

Monitoring of air pollution in cities and towns is well established in the UK

Local sensors coupled with modelling of air mass movement are used to map dispersion of air pollutants emitted from local sources including road traffic, domestic, commercial and industrial emissions

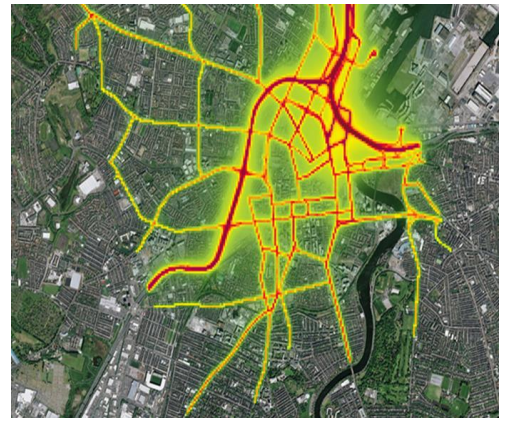
Pollution dispersion is largely dominated by the prevailing wind and its interaction with building and street infrastructure.

Urban air quality models deliver geospatial mapping of air pollution emissions at high resolution on hourly and annual timescales.

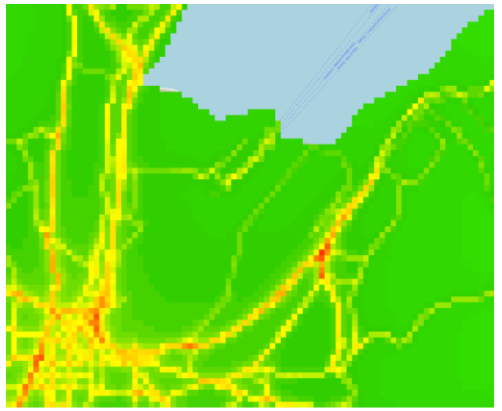
CO_2 emissions fall outside local authority remits so are not included in local authority emission monitoring plans.

To include port emissions in urban air quality monitoring requires port emissions to be added to core urban air quality models and for accounting of CO_2 emissions to be undertaken for both port and urban zones.

This is the approach adopted for ESA's Clean Air and Clean Harbour Energy (CACHE) project.



NOx Concentrations: Greater Belfast



NOx Concentrations: Belfast Harbour

CACHE Net Zero: Urban air quality modelling applied to the port environment.

Monitoring and managing air pollution and carbon emissions.

Advanced analytics using AIS data to determine shipping pollution and CO_2 emissions.

Automated data analytics to determine port and shipping carbon footprints.

Single vessel, fleets,

Emission source apportionment between shipping, industry, road traffic and other external sources.

Data sub-sets for vessels as berth, manoeuvring or underway identified by vessel class (containers, tankers, general cargo, ferry and cruise).

Hourly monitoring and modelling of port and urban air quality with high spatial granularity (10-20 metre).

ESA's Clean Air Clean Harbour Energy (CACHE) programme is led by Geospatial Insight, along with Redshift Associates, Cambridge Environmental Research Consultants, and Babel Smart Cities in Stuttgart.

Maritime Shipping Automatic Identification Systems (AIS)

AIS, which is a space enabled service, provides a data rich, low-cost source of information for tracking vessels through all stages of their voyage.

AIS tracks identified vessels and records their location-to 100m or better- speed, heading and state (hotelling, anchored, manoeuvring, steaming) at hourly to minute level resolution.

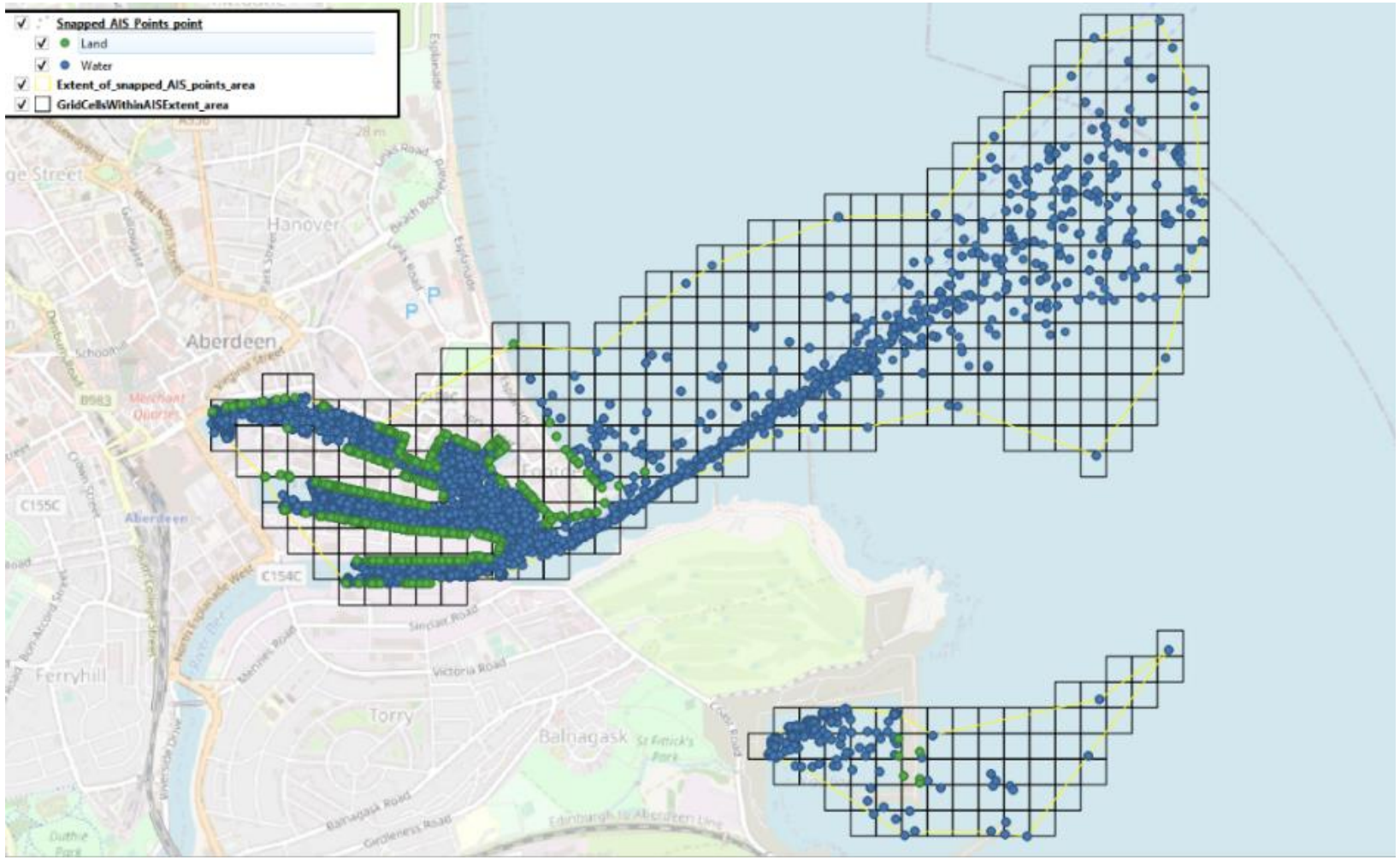
AIS data on vessel movements are combined with known vessel power ratings to determine time dependent emission rates of CO_2 and air pollutants for vessels while they manoeuvring, berthed or anchored in port waters, or for whole voyages.

Carbon footprints and air pollution apportionments are aggregated from emissions from individual vessel.

Emissions from individual vessels are aggregated into an hourly time-stamped mesh of 100m x 100m cells overlaid on the port area according to the location and time stamp provided by the vessel's AIS signature.

Files of emissions aggregated in the 100m x 100m mesh are transmitted hourly to the dispersion model to be incorporated into an hourly combined port and urban area model. Model can be run in near Real Time (< 1 Hour Latenc) as well as a 24-hour forecast mode.

Shipping emissions source network

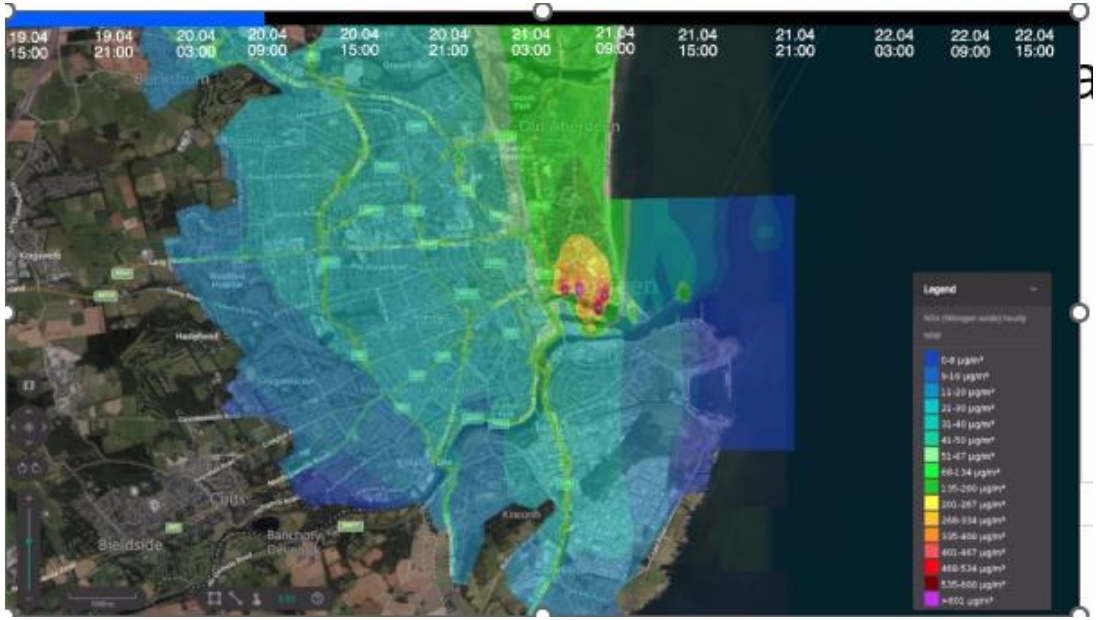


- Cells populated with hourly shipping emission events (from AIS data)
- 100 m x 100 m volume sources around port area, where emissions are concentrated

CACHE Net Zero Validation and Use Cases

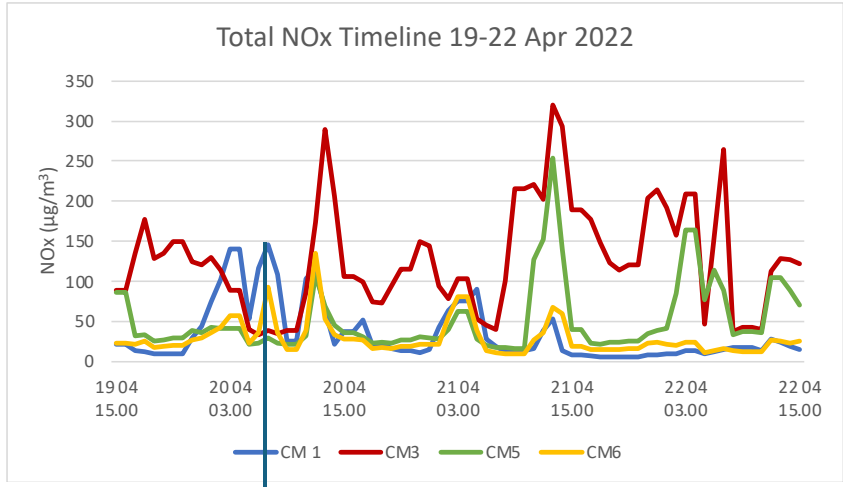
- Dispersion modelling
- Calibration and Source Apportionment
- Port Carbon and Air Pollution Inventories
- Green Maritime Corridors.
- CACHE Net Zero Delivery Platform

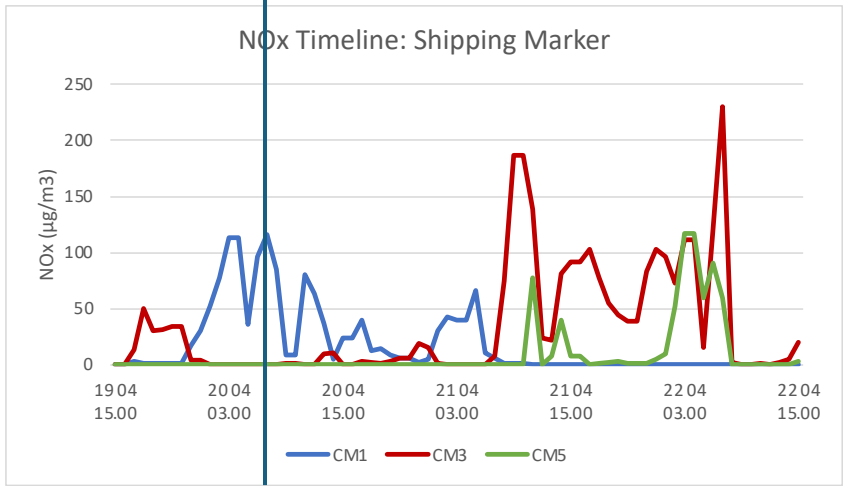
Dispersion Modelling of Port Emissions. Monitored NOX concentrations at on-land sensor locations



Incident 1. 20.04. 09.00. High harbour activity. Strong wind from the South.

Harbour plume avoids the sensor on the port boundary
Intercepts two sensors 1.8km and 3.4km to the North of the port





Incident 1.

Belfast to Liverpool: Tracking Carbon Intensity