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Energy & Environment



UK shipping inventory

TFEIP meeting
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- **Background and previous shipping inventory**
- New methodology summary
- Results: key changes in emissions compared to 2017 UK's National Atmospheric Emissions Inventory

Split of **domestic shipping emissions** and **international shipping emissions**

The new shipping model estimates replaced the existing UK NAEI estimates for:

- National Navigation (source category **1A3dii**), the main category of domestic voyages for coastwise shipping.
- Fishing vessels (source category **1A4ciii**), within and outside of UK waters.

Existing estimates from the NAEI are proposed to continue to be used for:

- Inland waterways (source category **1A3dii**) includes sailing boats with auxiliary engines, motorboats / workboats, personal watercraft and inland-goods carrying vessels used on rivers, canals and for recreational use off the UK coast.
- Naval vessels (source category **1A5b**).
- Shipping between UK and Gibraltar.

- Key pollutants are SO₂, NO_x, PM, VOC from in-engine fuel combustion
- Two marine fuels within NAEI are heavy fuel oil (HFO) and marine diesel oil (MDO)
- Future projections illustrate that liquefied natural gas (LNG) has increasing use as a marine fuel

Existing NAEI domestic shipping emissions estimates are based on a detailed shipping model in Entec (2010)

- a bottom-up Tier 3 inventory based on a database of vessel movements for the year 2007 that indicated vessel departure port and arrival ports and also covered vessels transiting through UK waters
- Fuel consumption and emissions for years 1990 - 2006 and 2008 to the latest year DfT port statistics are used as proxies to backcast and forecast 2007 estimates

Existing NAEI approach: international shipping fuel consumption derived as
[DUKES total marine fuel sales] - [modelled estimates of UK domestic shipping]

→ i.e. overall a fuel sales approach

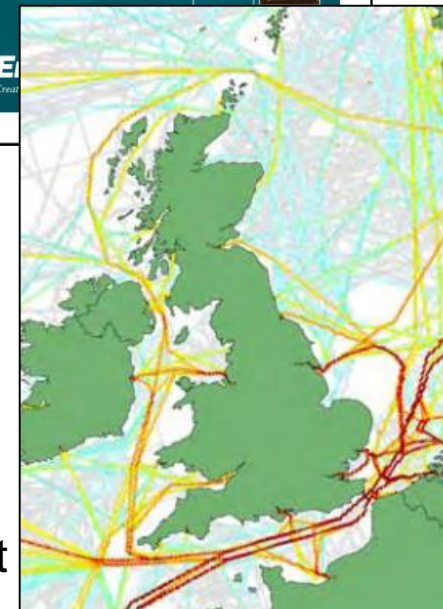
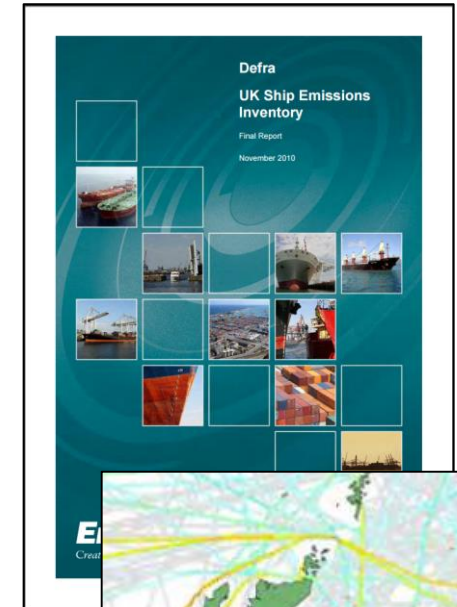
Previous shipping inventory in NAEI good but has limitations

- Good

- Bottom-up tier 3 method based on Lloyd's (LMIU) data
- Domestic/international split by port origin/arrival
- Detailed consideration of vessel types, engines, fuels
- Spatially distributed (5x5km) based on *estimated* routes
- 2007 base year of activity data

- Limitations

- **Incomplete:** poor capture of vessels not engaged in international trade (smaller vessels, fishing vessels, offshore, service)
- **Accuracy could be improved:** Blanket assumptions on vessel speeds (→ engine loads)
- **Spatial accuracy could be improved:** No capture of *actual* vessel routes limits spatial granularity
 - E.g. poor understanding of vessels starting/finishing at same port

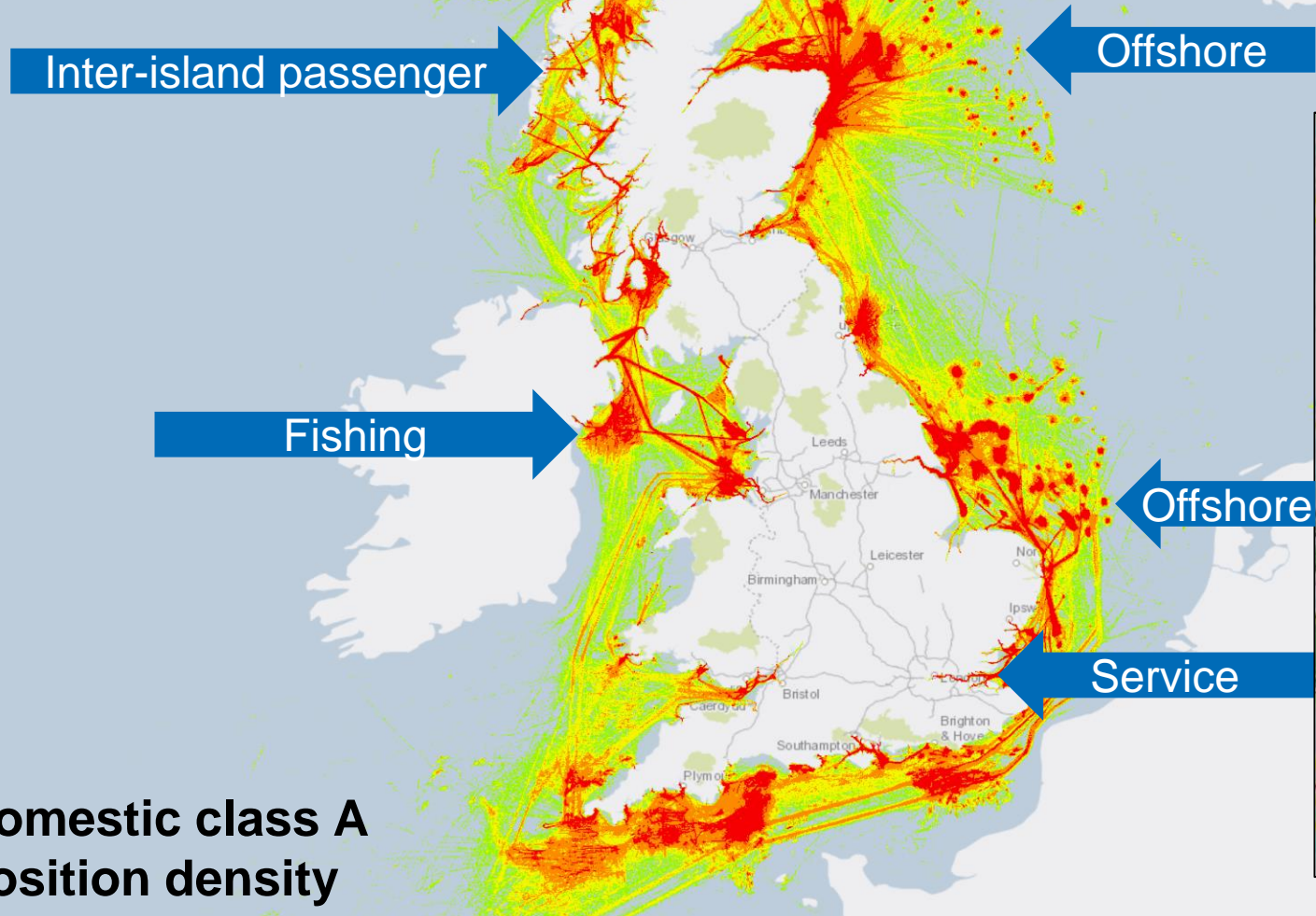


- Shipping sector background and existing shipping inventory
- **New methodology summary**
- Results: key changes in emissions compared to existing NAEI

New methodology summary (1)

- New bottom-up methodology using terrestrial Automatic Identification System (AIS) activity data from the Maritime and Coastguard Agency (+more recent 2014 base year)
- Emission factors updated for most pollutants to match International Maritime Organization global inventory
- Minor changes to approach to estimate time series back to 1990 from base year – still using trends in DfT statistics as proxies for activity trends.
- NAEI estimates for inland waterways updated to account for new model
- No change to existing NAEI estimates for naval, to/from Gib./OTs
- Forecasts now account for four major ports' specific growth forecasts

More complete activity dataset: improved domestic vessel coverage and actual routes travelled



**Domestic class A
position density**

New methodology summary (2)

- **Highly granular raw activity data**
 - Vessels uniquely identified
 - Vessel positions up to every 3 seconds when in range of terrestrial AIS network
 - Unknown route (+destination) of vessels after leaving range of terrestrial AIS
- **Emissions estimated for every vessel position**, accounting for:
 - Vessel type, engine power (main, auxiliary, boilers) of each vessel
 - Engine load, accounting for speed and draught at each position
 - Time (duration) until next position
 - Speed dependent emission factors
 - Location (at berth, at sea in a sulphur control area or not)
- **Consecutive vessel positions linked as passages, allocated UK domestic / crown dependencies / UK international / transit**

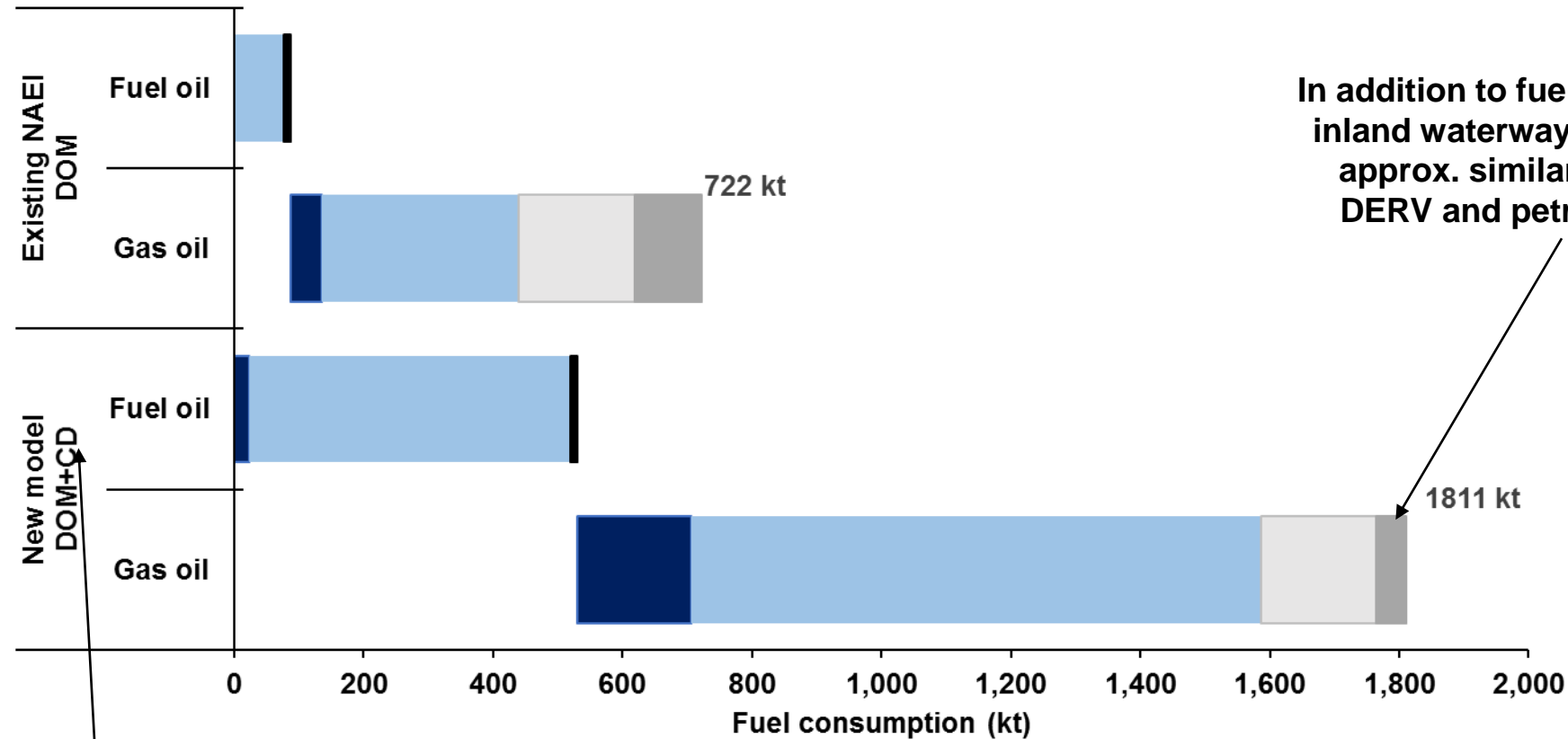
- Shipping sector background and existing shipping inventory
- New methodology summary
- **Results: key changes in emissions compared to existing NAEI**

- More complete activity dataset for vessels on domestic voyages, including vessel categories not previously covered
- Improved engine emission calculation, and accounts for source not previously covered
- Increased domestic emissions compared to existing NAEI
- Model estimates compare well to leading academics' European shipping inventories
- Low uncertainty emission calculation for most large vessels (85% of total emissions)
- More robust spatial allocation of inventory
- Results are sensitive to the approach taken to define domestic/international
 - High uncertainty in dom./int. allocation when vessels go out of AIS range

Increased (2.5x) 2014 fuel consumption compared to existing NAEI

Results sensitive to approach taken to define domestic/international

DOM Domestic
CD Crown Dependencies



In addition to fuel oil and gas oil, inland waterways also includes approx. similar quantities of DERV and petrol as gas oil.

CD adds ~1.5% fuel consumption

Scope of new model

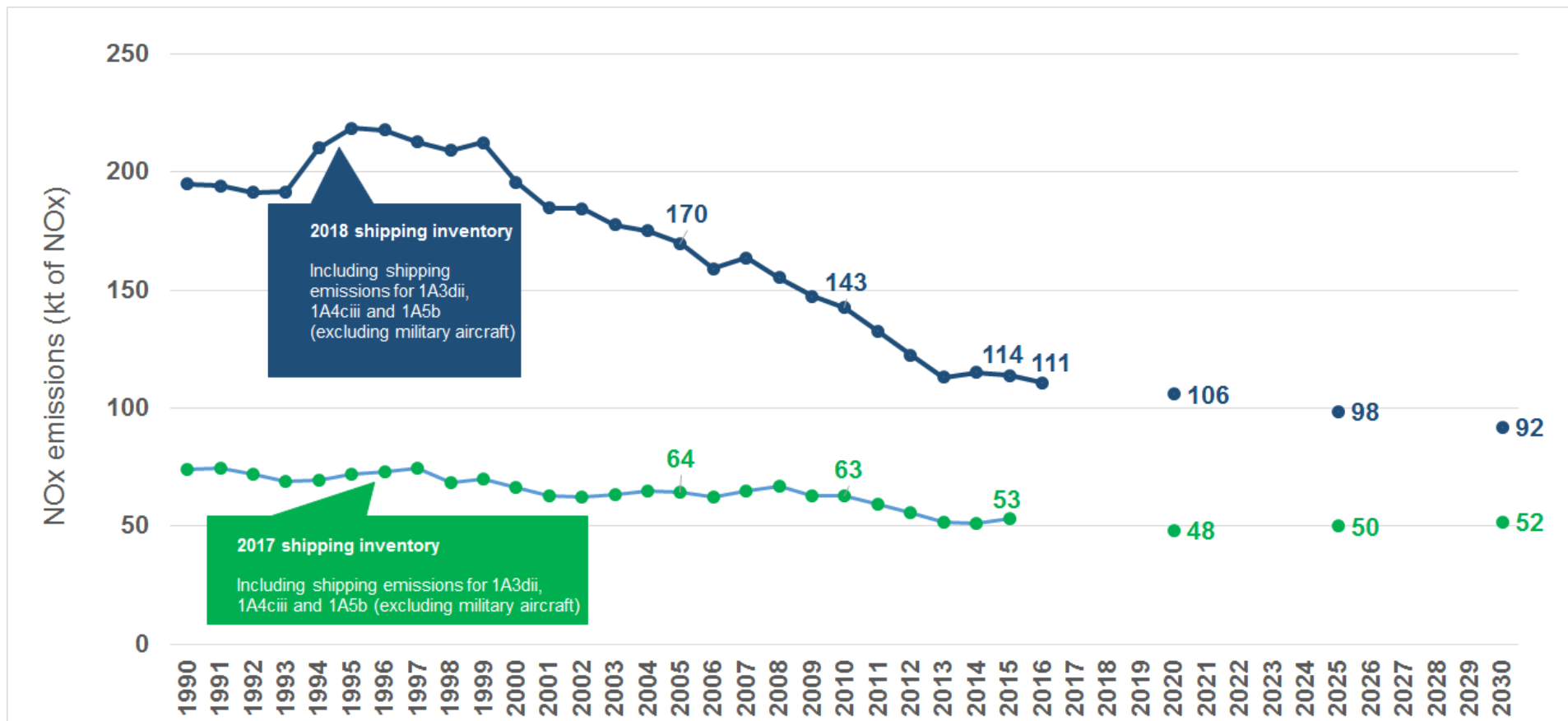
- 1A4ciii Fishing
- 1A3dii Domestic Water-borne navigation (non-fishing)
- Between UK and Overseas Territories
- Naval
- Inland waterways

Domestic NOx emissions (NECD scope match)

Included: National navigation (inc. inland waterways) + fishing + naval + Gib.

Excluded: Crown Dependencies, OTs other than Gib.

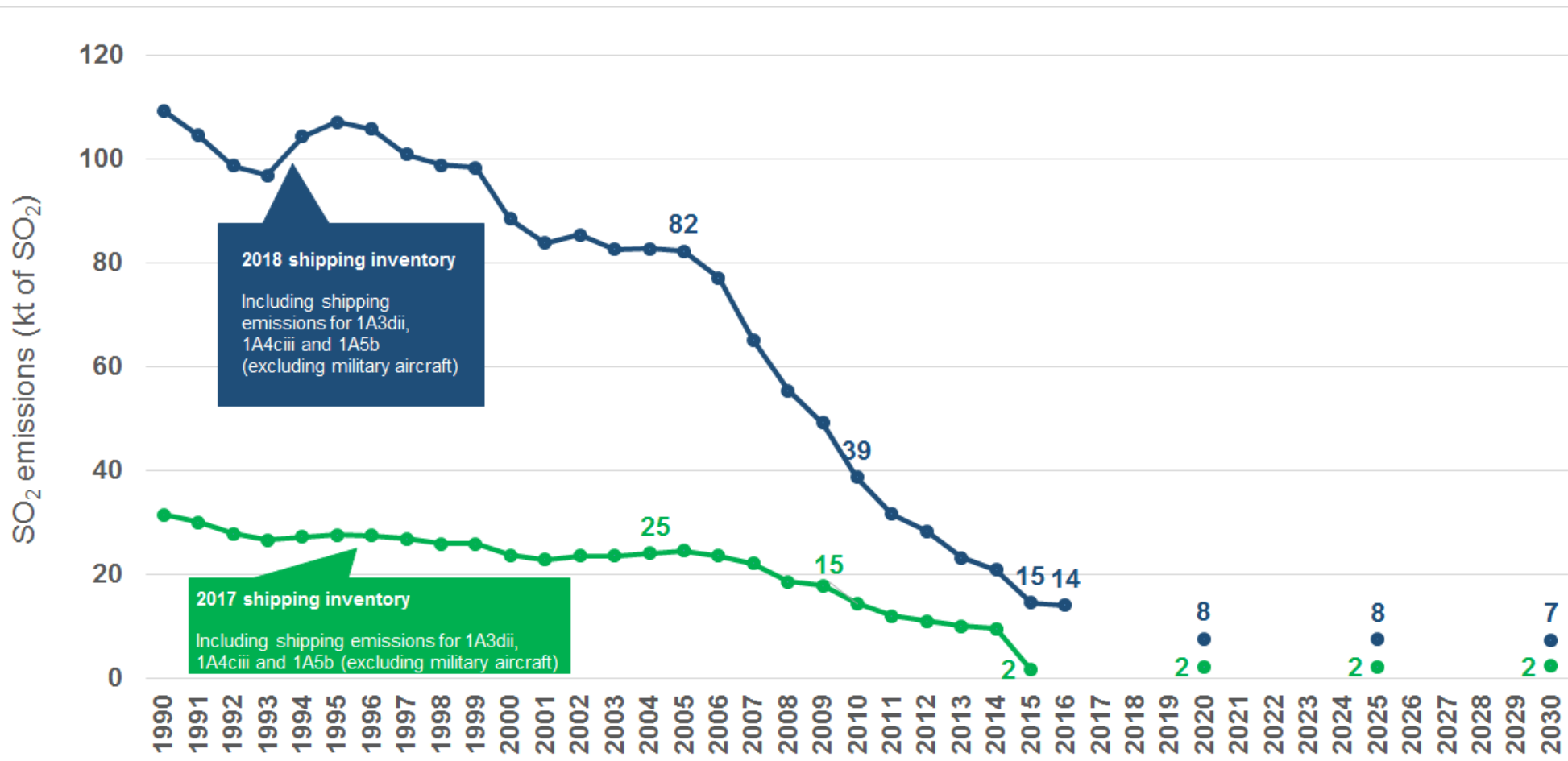
- NECA taken into account



Domestic SO₂ emissions (NECD scope match)

Included: National navigation (inc. inland waterways) + fishing + naval + Gib.

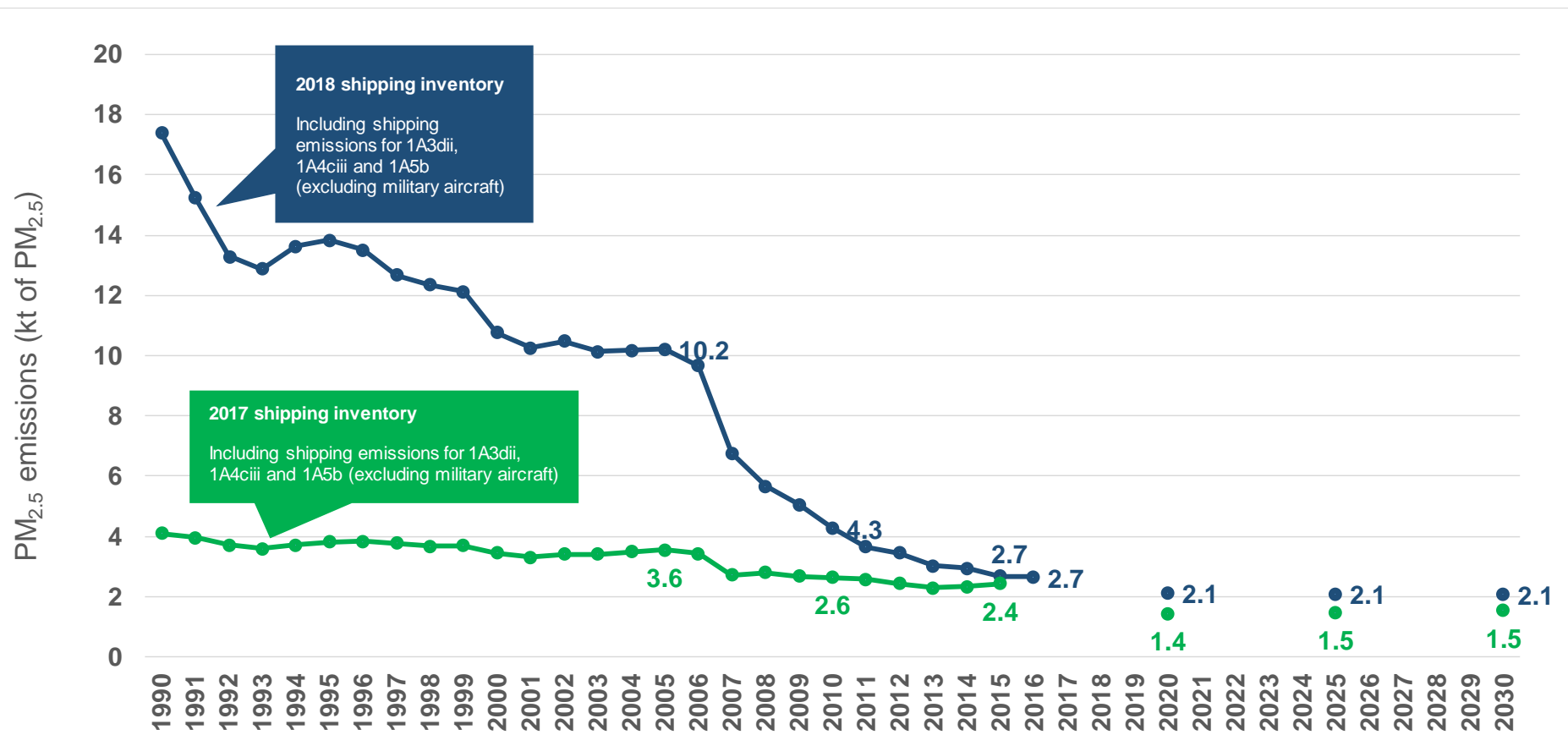
Excluded: Crown Dependencies, OTs other than Gib.



Domestic PM_{2.5} emissions (NECD scope match)

Included: National navigation (inc. inland waterways) + fishing + naval + Gib.

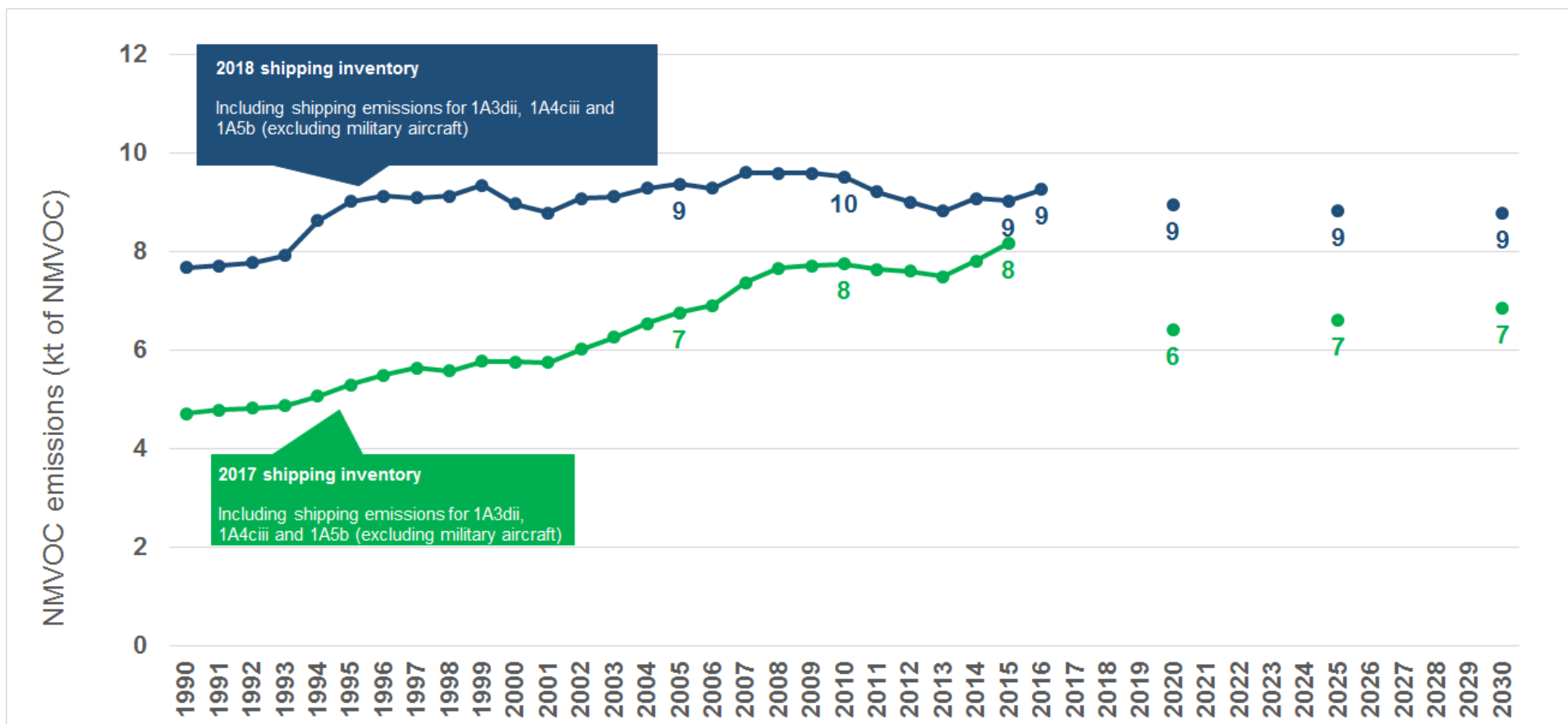
Excluded: Crown Dependencies, OTs other than Gib.



Domestic NMVOC emissions (NECD scope match)

Included: National navigation (inc. inland waterways) + fishing + naval + Gib.

Excluded: Crown Dependencies, OTs other than Gib.



Shipping inventory – reporting

- **Previous approach:**

- Domestic: NAEI inventory for domestic (fuel used estimate)
- International (memo item): [DUKES total] minus [Domestic]
- Total domestic+international matches DUKES total marine fuel sold

- **New approach:**

- Domestic: New shipping model (fuel used estimate)
- International (memo item): DUKES international (fuel sold estimate)
- Total domestic+international will not match DUKES total marine fuel sold

https://uk-air.defra.gov.uk/library/reports?report_id=950

http://cdr.eionet.europa.eu/gb/eu/nec_revised/iir/envwqfzqa/GB_IIR_2018_v1.2.pdf

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