

Air Quality Support for Review of ANPS

Review of Airside Emissions

Department for Transport

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Quality information

Prepared by	Checked by	Verified by	Approved by
Olivia Wilkin Air Quality Consultant	Matthew Hill Principal Air Quality Consultant	Gareth Hodgkiss Associate Director	Anna Savage Technical Director

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Prepared for:

Prepared by:

Olivia Wilkin
Air Quality Consultant
E: olivia.wilkin@aecom.com

AECOM Limited
69 Park Lane
Croydon CRO 1JD
United Kingdom

T: +44 (0)20 8639 3500
aecom.com

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1. Introduction

In 2018, the Department for Transport (DfT) published the Airports National Policy Statement (ANPS), hereafter referred to as “the 2018 ANPS”. The ANPS outlines a policy framework for decision making on applications for the expansion of some UK airports, including consideration of a new Northwest runway (NWR) at Heathrow Airport. The 2018 ANPS was informed by information available at that time and included the Airports Commission’s detailed modelling of Heathrow Airport, published in 2015.

The 2018 ANPS, concluded that the operation of a new NWR at Heathrow Airport would have an adverse impact on local air quality but that impact would not cause an exceedance of the UK’s annual mean air quality objectives. The 2018 ANPS also stated that the NWR would not impact on modelled compliance with the EU Directive limit values. However, it acknowledged that, given the inherent uncertainties associated with air quality modelling, there remained a risk that the NWR could impact on compliance, and that the risk increased the earlier the assumed opening year. The risk was considered medium by 2030, when projected concentrations with the scheme was estimated to fall below 90% of the limit value in the core forecast scenarios and below 95% of the limit value in the baseline scenarios.

Since then, conditions at airports have changed which will have influenced the emissions to air associated with them, irrespective of any changes in the number of Air Traffic Movements (ATM). This includes the evolution of the aircraft fleet and the ground support equipment (GSE) fleets, and changing policies implemented at the airport. Such policies are those that often minimise combustion emissions with the primary aim of decarbonisation but have a secondary benefit of reducing other emissions including NOX, PM10 and PM2.5.

Airside activity can be a major source of emissions to air including NOX, PM10 and PM2.5. Activity with the greatest potential for emissions include:

- Aircraft movements during the Landing-Take-Off (LTO) cycle;
- GSE and Auxiliary Power Unit (APU) use; and
- Energy generation plant within the Airports Energy Centre.

The report includes a review of the baseline and future airside emissions data used in the Airports Commission’s Modelling Assessment, with a particular focus on projected ATMs using current trends and changes due to construction of the third runway at Heathrow. The report includes a review of:

- Current and projected air traffic movements and passenger numbers. This considers information from the Heathrow Airport emissions inventory, Airports Commission’s modelling assessment, and the most recent projections provided by DfT;
- Current and projected aircraft fleet, and how this may change in the future. This considers information from the Heathrow Airport emissions inventory, Airports Commission’s modelling assessment;
- NOX, PM10, and PM2.5 emissions from aircraft. This considers information from the Heathrow Airport emissions inventory (published by Ricardo), Airports Commission’s modelling assessment and the International Civil Aviation Organisation’s (ICAO) Aircraft Engine Emissions Databank;
- NOX, PM10, and PM2.5 emissions from GSEs. This considers information from the Heathrow Airport emissions inventory (published by Ricardo), Airports Commission’s modelling assessment; and
- NOX, PM10, and PM2.5 emissions from APUs. This considers information from the Heathrow Airport emissions inventory (published by Ricardo), Airports Commission’s modelling assessment;

Analysis of ATMs from the Airports Commission’s modelling assessment and DfT projections considers projections for a do-minimum (DM) and do-something (DS) scenarios. The DM scenario considers the number of ATMs if the NWR was not constructed, but all other committed development takes place. The DS scenario considers the construction of the NWR as well as all other committed development.

The review aims to assess whether the conclusions of the Airports Commission’s Modelling Assessment would be the same if that assessment was completed using current data published since.

It should be noted that modelling reported in 2015 assumed an opening year of 2030 and therefore provided fleet projections for 2030. The current northwest runway plans would see an opening year in the mid-2030’s, which

differs to that modelled. As such, this report compares the 2030 emissions projections described in the 2015 report with current estimates of fleet projections for 2030, to allow for a more like-for-like comparison.

It should also be noted that impacts on PM_{2.5} were not assessed within the Airports Commission's modelling assessment. These impacts have been considered in a separate deliverable submitted for this commissions, titled *Review of PM_{2.5} Concentrations and Exposure report*. The impact of increased passenger transport to/from the airport as a result of increased capacity has not been considered within this report either. Road transport emissions have been considered in separate deliverables, titled *Review of Emissions Source Data* and *Ammonia Emissions Trends*, also submitted for this commission.

2. Methodology

A desktop review of airside emissions has been undertaken using data which informed the Airports Commission's modelling assessment and, subsequently, the ANPS. Baseline and future airside emissions data used to inform those publications has been reviewed to understand how they represent current and future baseline emissions, with reference to current emissions data sources. Heathrow Airport's policies and strategies that are relevant to airside emissions have also been reviewed.

The review has been undertaken with reference to the International Civil Aviation Organisation's (ICAO) Airport Air Quality Manual (International Civil Aviation Organization, 2020).

Data from the following sources have been used to inform this review:

- Heathrow Airport 2024 Emissions Inventory (Ricardo, 2025);
- ICAO Aircraft Engine Emissions Databank (International Civil Aviation Organization, 2025); and

Unlike the Department of Environment Food and Rural Affairs (Defra's) Emissions Factors Toolkit (EFT) (Department for Environment, Food, and Rural Affairs, 2025), which provides in-built assumptions on the road traffic fleet, no such tool is available for aircraft or other airside emission sources. In the absence of such a tool, the items listed above have been used to inform a best estimate of how conditions have changed since 2015.

Emission Calculations

To inform this review, NOX, PM10, and PM2.5 emissions have been calculated using the most recent version of the ICAO Aircraft Engine Emissions Databank (International Civil Aviation Organization, 2025). The databank provides data for a number of aircraft engines, including emissions indices (mass of pollutant per unit mass of fuel burned, provided as g/kg) for NOX and non-volatile PMx. The information within the database is provided by the engine manufacturers.

In order to calculate emissions, it was necessary to ensure that the engines modelled in the Airports Commission's modelling assessment were included within the ICAO databank. There is no requirement for engine manufacturers to submit data for inclusion in the ICAO databank, and therefore data are not available for all engines in operation. Where data were not available for an engine modelled in the Airports Commission's modelling assessment, data for a similar engine from the same manufacturer was used (e.g. from the same engine family). In some cases, multiple engine options were available. For these, a weighted average of the calculated emission rates for each engine option was used to create a composite emission rate. This approach was favoured ahead of selecting a "worst-case" engine in terms of emissions from the engine options available, because no one engine can be considered worst-case. For example, an engine that has the highest NOX emissions typically will not have the highest PM10 or PM2.5 emissions, and *vice versa*.

Calculation of pollutant emissions was informed by the methodology outlined in the Airports Commission's modelling assessment and guidance published by the ICAO (International Civil Aviation Organization, 2020). For NOX, emissions indices are directly provided by the engine manufacturer and included within the ICAO databank for each stage of the LTO cycle (idle, take-off, climb-out, and approach) as grams per kilogram of fuel burnt (g/Kg). For PM emissions, a volatile and non-volatile component is required. The ICAO databank provides emission indices for the non-volatile PM component for each engine. The volatile component of PM is formed from a volatile sulphate and volatile organic aerosol component. The emission indices for these components were calculated using the methodology outlined in Section 3 of the ICAO manual. The emissions index for PM is formed by summing the non-volatile and volatile components.

A fuel flow and fuel type for each engine is provided in the databank for each stage of the LTO cycle. It should be noted that the databank does not account for the use of Sustainable Aviation Fuel (SAF) and it is acknowledged that SAF is becoming increasingly used both at Heathrow Airport and globally. However, there is limited information on which aircraft and airlines utilise SAF, and there is limited literature on what effect SAF has on non-CO₂ engine emissions (what literature is currently available suggest little effect on emissions of NOX and some reduction in emissions of PM ((International Air Transport Association, 2025) and (Song, Li, & Liu, 2024))). Therefore, it has not been possible to account for the increasing use of SAF in the calculations used to inform this assessment. The emissions are calculated based on the emission indices and the fuel flow provided by the ICAO databank for each stage of the LTO cycle.

The emission rate for NOX and PM was calculated using Equation 1.

Equation 1

$$\text{Emission Rate per LTO Stage} = \text{Fuel Flow} \times \text{Emissions Index}$$

where emission rate is given as grams per second, fuel flow is given as kilograms per second, emissions index is given as grams per kilogram, and thrust power is given as a percentage. The thrust power for each stage is accounted for in the values provided for the emissions indices.

The emission rate for NOX and PM was used to calculate total annual emissions based on the number of ATMs per year. Timings for each stage of the LTO cycle were not available within the Airports Commission's modelling assessment. The reference timings outlined in Table 3-A1-1 of the ICAO manual were assumed. The total annual emissions were calculated using Equation 2 and Equation 3.

Equation 2

$$\text{Emissions per LTO Cycle} = \sum \text{Emission Rate per LTO Stage} \times \text{Time in Mode}$$

where emissions per LTO cycle is given in grams, emission rate per LTO stage is given as grams per second, and time in mode is given in seconds.

Equation 3

$$\text{Annual Emissions} = \text{Emissions per LTO Cycle} \times \text{Annual ATMs}$$

where annual emissions is given in tonnes, emissions per LTO cycle is given in grams, and annual ATMs is the number of air traffic movements.

The annual emissions were calculated for each modelling category (MCAT), as outlined in the Airports Commission's Modelling Assessment, and summed to give total annual emissions from aircrafts during the LTO cycle.

Assumptions and Limitations

The following assumptions were used to inform the review:

- For engines where data were not available in the most recent version of the ICAO databank, a similar engine from the same manufacturer was assumed. For engines where multiple similar engines could be chosen, the weighted average of emissions from all possible matches was calculated for each MCAT, based on the aircraft and engine listed.

To calculate annual emissions from aircraft LTO cycles, it has been assumed that the time-in-mode for each stage of the LTO cycle was the same as the reference values outlined in Table 3-A1-1 of the ICAO manual.

The following limitations should be considered:

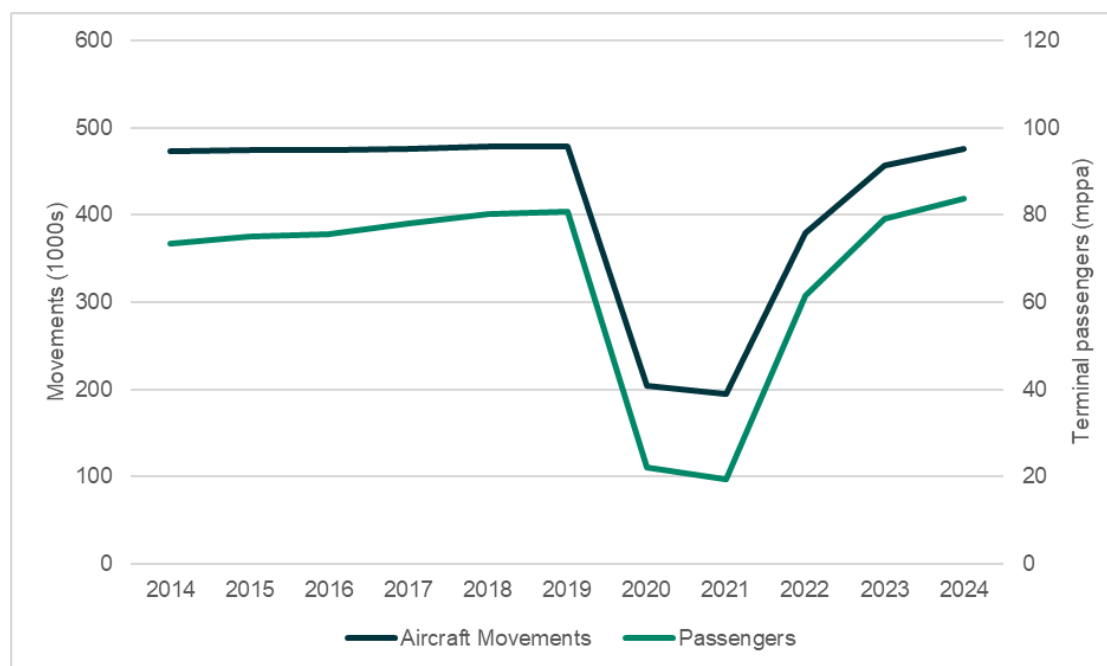
- The review has been undertaken based on information available from the Airports Commission's 2015 modelling report. In cases where data were not available, precautionary assumptions have been made which may not reflect Airports Commission's model.

3. Review of Airport Emissions

Passengers and Air Traffic Movements

As part of the Heathrow Airport Emissions Inventory, Ricardo publishes the total number of air traffic movements and terminal passengers each year at Heathrow Airport. Figure 1 shows the air traffic movements, terminal passengers for all years from 2014 to 2024. Figure 2 shows the average number of passengers per movement for all years from 2014 to 2024.

Figure 1 Heathrow Airport Passengers and ATMs



Note: mppa – Million passengers per annum

Figure 2 Heathrow Airport Passengers per Movement

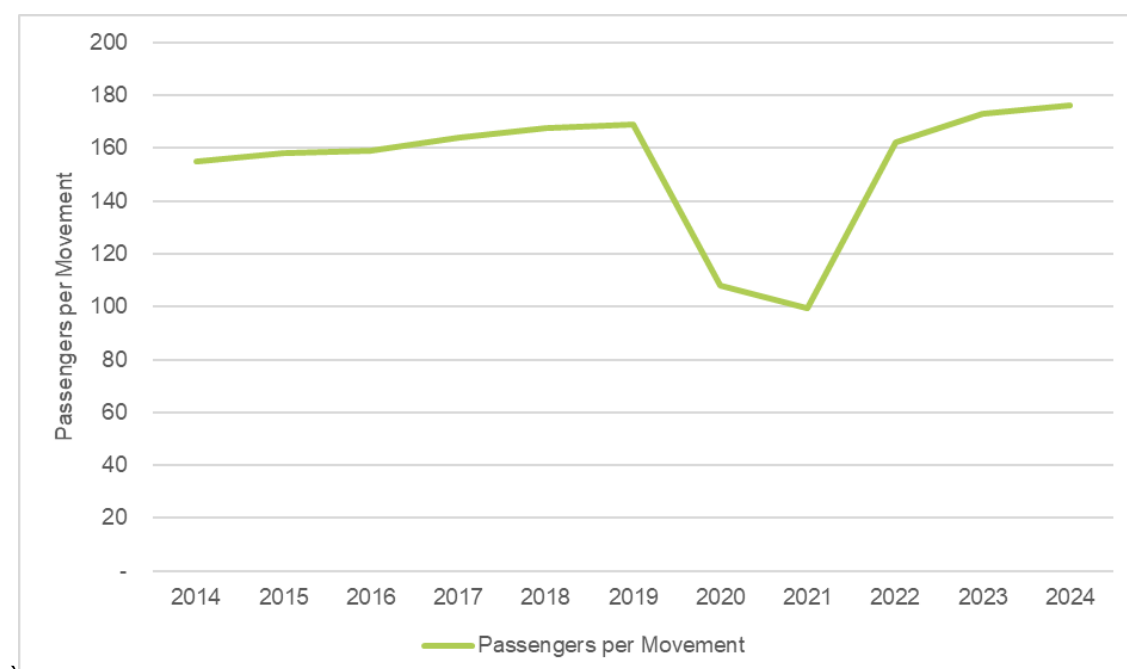


Figure 1 shows that, in the years before the COVID-19 pandemic, ATMs remained stable with values just below the cap of 480,000 ATMs per year. Passenger numbers increased slightly from 2014 to 2019. A large drop in both

ATMs and passenger numbers is shown during 2020 and 2021 due to the COVID-19 pandemic, with values beginning to recover in 2022 and 2023. Passenger numbers have peaked in 2024. In addition, the number of passengers per ATM have continued to increase year-on-year, as shown in Figure 2. This increase in passengers per ATM suggests that the fleet has shifted towards heavier aircraft which are able to carry more passengers, which is supported by information available on the fleet outlined in Table 2. This increase could also be caused by fuller flights, with a significant decline in passengers per ATM during 2019, 2020 and 2021 due to less people travelling as well as less flights operating.

DfT provided data showing its most recent predicted ATMs as a result of the Heathrow expansion. Table 1 shows the predicted number of ATMs in the do-minimum (DM) (i.e. without expansion) and do-something (DS) (i.e. with expansion) scenario in DfT data and the Airports Commission's modelling assessment. The data from the Airports Commission's modelling assessment assumes an opening year of 2030. Data from DfT was provided for all years from 2024 to 2055. Predicted ATMs in 2055 are shown in Table 1 as this year has the greatest increase in ATMs as a result of the Heathrow expansion.

Table 1 Projected Increase in the Air Traffic Movements

	DM	DS	Change
Airports National Policy Statement (2030)	484,208	722,534	+238,326 (+49.2%)
DfT (2055)	455,685	722,367	+266,682 (+58.5%)

Table 1 demonstrates a similar number of predicted ATMs, both with and without the Heathrow expansion, in both the DfT data and the Airports Commission's modelling assessment. The data from DfT, which is more recent than the Airports Commission's data, predicts a lower number of ATMs in both scenarios compared to the Airports Commission's modelling assessment. However, given the lower baseline in the DM scenario, the DfT data shows a greater increase in ATMs, which is ~9% more than the increase reported in the Airport's Commission's modelling assessment.

Aircraft

A review of possible changes in aircraft emissions which may impact the predicted concentrations reported in the Airport Commission's modelling, submitted in support of the ANPS, are outlined below.

Fleet Evolution

As discussed in the Passengers and Air Traffic Movements section, the aircraft fleet at Heathrow Airport has seen a slight shift towards a heavier fleet, with more passengers per ATM. Table 2 and Figure 3 show the fleet breakdown at Heathrow Airport based on information provided by the Heathrow Airport 2024 Emissions Inventory (Ricardo, 2025). The fleet breakdown outlined in the Airports Commission's modelling assessment for the 2030 do-minimum scenario was broken down into the same categories used to inform the Emissions Inventory

In order to allow for a comparison to the Heathrow emission inventory data, aircraft were combined into the following categories based on the MCATS designation of each aircraft:

- Small – MCATS 1
- Medium – MCATS 2, 3 & 4
- Heavy – MCATS 5, 6, 7, 8 & 9
- A380 – Airbus A380 only (MCATS 10)

Table 2 Aircraft Fleet Proportions

Aircraft Type	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Heathrow Emissions Inventory																
Small	0.8%	0.5%	0.9%	1.1%	2.0%	1.2%	1.0%	1.0%	0.8%	0.9%	-	-	-	-	-	-
Medium	62.2%	61.0%	59.9%	59.5%	59.4%	53.2%	48.7%	58.9%	58.6%	59.6%	-	-	-	-	-	-
Heavy	33.9%	34.6%	35.3%	35.9%	35.3%	43.4%	49.2%	37.0%	37.5%	36.4%	-	-	-	-	-	-
A380	3.1%	3.8%	3.9%	3.5%	3.3%	2.2%	1.2%	3.0%	3.2%	3.1%	-	-	-	-	-	-
Airports Commission's Modelling																
Small	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.8%
Medium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	49.2%
Heavy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40.2%
A380	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.8%

Figure 3 Aircraft Fleet Proportions

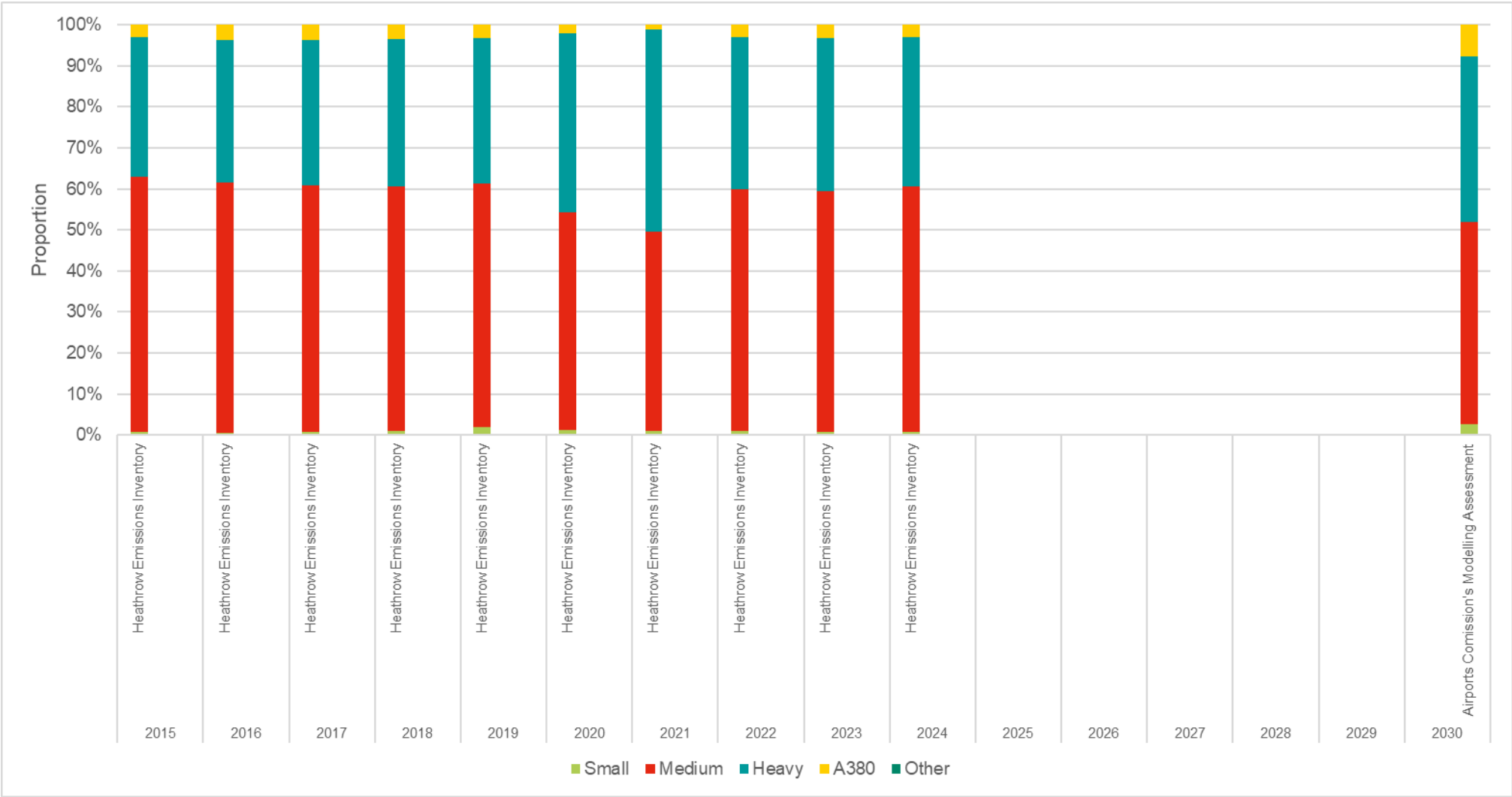


Table 2 highlights the slight increase in heavy aircraft at Heathrow Airport from 2014 to 2024, with a slight decrease in medium aircraft. In general, there is no change to the number of A380's at Heathrow Airport, which is the largest passenger plane currently in operation and operates using four engines. The majority of aircraft typically only have two engines.

The Airports Commission's modelling assessment assumed a smaller proportion of medium and heavy aircraft in 2030, and a proportion of A380's which is over double what is currently in operation at the airport. Based on the fleet split alone, the proportion of emissions from the A380 in the Airports Commission's modelling assessment is likely to be higher than that based on current conditions. Due to the size of the A380 aircraft, this change in fleet composition may lead to a significant reduction in emissions from that assumed in the Airports Commission's modelling assessment. The proportion of A380's at Heathrow Airport has been relatively stable since 2014, although the future projections are uncertain as airlines have shifted towards medium and heavy aircraft, and the A380 fleet is gradually retired over the next decade. It is therefore likely that the current proportion of A380's would present a precautionary estimate of the proportions expected in 2030.

The higher proportion of heavier aircraft (Heavy and A380 aircraft types) assumed in the Airports Commission's modelling assessment may also result in an overestimation of pollutant emissions, due to the relationship between forecast (modelled) and actual (observed) numbers of ATMs, the number of engines per ATM, and the efficiency of those engines. Emission rates will not be linear to the number of passengers nor ATMs and increases in more efficient aircraft engines means original projections are likely to be overestimated. However, the emissions inventories published by Heathrow show that the actual proportion of Heavy aircraft (excluding the A380) at Heathrow Airport has shown a slight increase since 2014, though ATMs are still dominated by Medium aircraft. In order to maintain the same number of passenger movements, there will need to be an increase in ATMs from Medium and Heavy aircraft types. Therefore, the overestimate of heavy aircraft emissions in the Airports Commission's modelling is offset, to some extent, by the higher number of ATMs from Medium aircraft demonstrated in the Airport's emissions inventories.

Engine Emissions

Annual emissions have been calculated based on the number of ATMs for each MCAT category in the Airports Commission's modelling assessment, and the most recent engine data from the ICAO databank. Table 3 shows the NOX emission rates for the lead engines within the Airports Commission's modelling assessment, and shows the difference between calculated ICAO values and those outlined in the Airports Commission's modelling assessment. The emission rates for PM have not been provided within the Airports Commission's modelling assessment. Table 3 highlights that engines have a higher emission rate when using the most recent ICAO databank.

Table 3 NOX Emission per Lead Aircraft

MCAT	Engine	Lead Aircraft	Aircraft Type	Total NOX per Engine – g/s (ACMA)	Total NOX per Engine – g/s (ICAO)	Change
1	PW1524G	Bombardier C Series	Small	21.6	38.4	+16.8
2	V2527-A5	Airbus A320-100/200	Medium	27.9	51.6	+23.7
3	PW1127G	Post 2016 G2 Airbus A320	Medium	12.8	28.9	+16.1
4	CFM-LEAP-1B	New Gen Post 2016 B737-800	Medium	17.6	74.2	+56.6
5	TRENT XWB-84	Airbus A350-900	Heavy	128.2	219.2	+91.0
6	Trent 1000-J2	Boeing 787 (Trent)	Heavy	154.6	262.5	+107.9
7	GE9x-1B70	Boeing 787 (GE9x)	Heavy	84.9	131.3	+46.4
8	GE90-115B	Boeing 777-300	Heavy	236.1	379.0	+142.9
9	GE9X	Boeing 777X	Heavy	37.6	124.0	+86.4
10	Trent 970-84	Airbus A380 pax	A380	96.7	175.4	+78.7

Table 4 outlines the total NOX and PM emissions from the do-minimum and do-something scenarios of the Airports Commission's modelling assessment and the current ICAO databank. These emissions are based on the aircraft LTO cycle only and do not include other aspects of airport operations.

Table 4 Annual Emissions from Aircraft LTO Cycle for 2030– Airports Commission's Modelling Assessment and ICAO Database (aircraft engines only)

Pollutant	Airports Commission's modelling assessment			ICAO Databank		
	DM ²	DS ³	Change	DM ²	DS ³	Change
NOX (tonnes per year)	5309.8	7606.7	+2296.9 (+43%)	12549.7	17133.2	+4583.5 (+37%)
PM ¹ (tonnes per year)	179.3	286.8	+107.5 (+60%)	258.1	383.6	+125.5 (+50%)

¹Representative of PM10 and PM2.5. Emissions from the ICAO calculations do not include emissions from brake and tyre wear.

²DM = Do-Minimum, meaning emissions that occur assuming the proposed runway is not in operation.

³DS = Do-Something, meaning emissions that occur assuming the proposed runway is in operation.

Table 4 shows that using the most recently available engine emissions data, calculated annual emissions of NOX and PM are higher than those outlined in the Airports Commission's modelling assessment. This would result in higher NOX, NO2 and PM concentrations at nearby receptors as a result of the LTO cycle. However, the percentage change in emissions as a result of the do-something scenario is expected to be slightly lower than that reported in the Airports Commission's modelling assessment due to differences in the assumptions used when calculating emissions.

The Airports Commission's modelling assessment has utilised time-in-mode values and thrust settings that were provided by the Promoters, whereas default values were used within this report to calculate updated annual emissions. Detailed calculations to derive the emissions were not provided within the Airport Commission's modelling assessment and therefore it is not possible to recreate the calculations using the time-in-mode and thrust setting values from the Promoters. Therefore, default values were assumed which result in larger emissions than the Airport Commission's modelling assessment.

Table 5 outlines the annual emissions from the LTO cycle from the Heathrow Airport 2024 Emissions Inventory (Ricardo, 2025), the do-minimum scenario in the Airports Commission's modelling assessment, and emissions calculated using the most recent version of the ICAO databank (International Civil Aviation Organization, 2025). Emissions from the Heathrow Emissions Inventory have been forecasted by AECOM to 2030 to estimate whether the emissions presented within the Airports Commission's modelling assessment will be reached by 2030. Figure 4, Figure 5, and Figure 6 show a comparison between the Heathrow Emissions Inventory data and the Airports Commission's modelling assessment data for NOX, PM10, and PM2.5.

Emissions from the Heathrow Airport 2024 Emissions Inventory were projected by AECOM to 2030 based on values from 2023 to 2024. The projection assumes the same linear relationship between 2023 and 2024 would continue into future years. The linear equation was calculated and this was applied to future years, up to 2030. Only a small dataset was used due to the impact of COVID-19 which led to a significant reduction in emissions from 2020 to 2022. The projections do not directly consider any changes in fleet, fuel mix, or activity at the airport aside from those changes embedded into the reported 2023 and 2024 emissions. The introduction of newer aircraft, along with increased usage of SAF may result in a non-linear relationship in the future. However, these changes are difficult to predict.

NOX emissions have increased at Heathrow Airport since 2015, while PM emissions have remained relatively stable. NOX emissions in the Airports Commission's modelling assessment are higher than the Heathrow Emissions Inventory in 2024, however with the increases in emissions since 2015 it is expected that emissions at Heathrow Airport will exceed those presented in the Airports Commission's modelling assessment by 2028. In the Heathrow Emissions Inventory, PM emissions are significantly lower in 2024 than in the Airports Commission's modelling assessment and, therefore, it's likely that PM emissions in 2030 will be much lower than those in the Airports Commission's modelling assessment.

Table 5 Annual Emissions from Aircraft LTO Cycle – Airports Commission’s Modelling Assessment, Heathrow Airport Airfield Emissions Inventory and ICAO Databank

Pollutant	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Heathrow Emissions Inventory^{1,2}																
NOX (tonnes per year)	4065.3	4170.4	4299.6	4617.7	4397.1	1880.1	1747.5	3184.8	4238.6	4473.5	4708.3	4943.2	5178.0	5412.8	5647.7	5882.5
PM10 (tonnes per year)	43.9	45.0	44.9	45.3	43.9	18.0	16.5	31.6	43.5	43.9	44.4	44.9	45.3	45.8	46.2	46.7
PM2.5 (tonnes per year)	36.3	37.2	37.0	37.4	36.0	14.4	13.0	25.4	35.9	36.1	36.3	36.5	36.8	37.0	37.2	37.4
Airports Commission’s Modelling Assessment¹																
NOX (tonnes per year)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,309.8
⁴ PM10/PM2.5 (tonnes per year)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	179.3
ICAO Databank³																
NOX (tonnes per year)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12,549.7
⁴ PM10/PM2.5 (tonnes per year)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	258.1

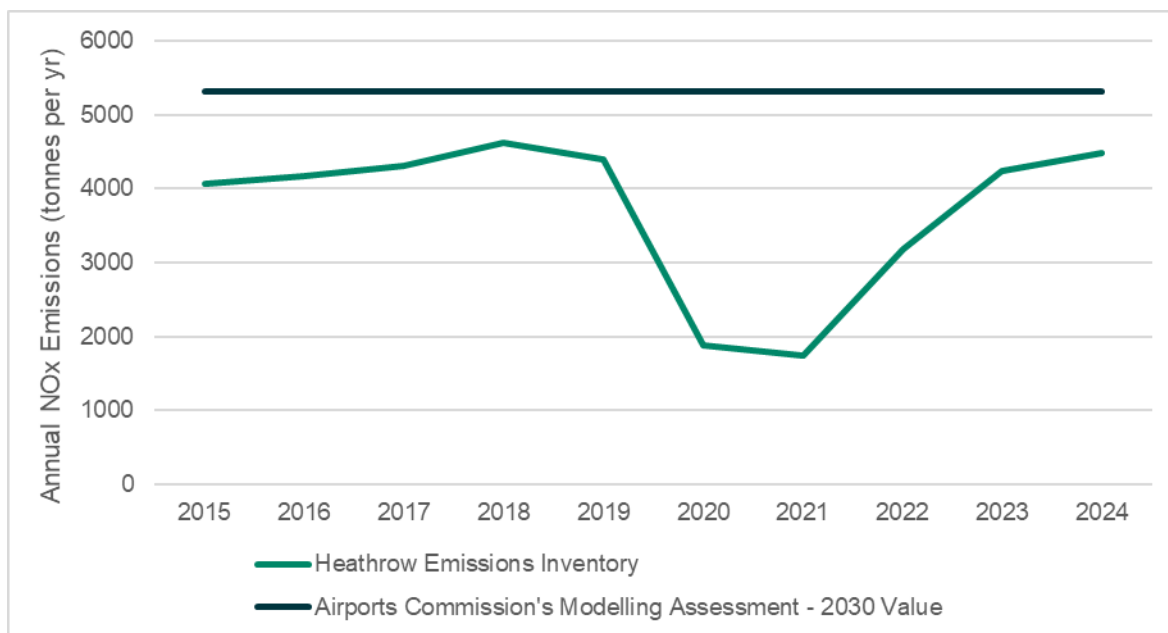
¹Emissions from Landing, Taxi, Hold, Take-off, Climb, and Approach. Includes brake and tyre wear.

²Emissions from 2025 to 2030 estimated based on trends from 2023 to 2024.

³Emissions from Landing, Taxi, Hold, Take-off, Climb, and Approach.

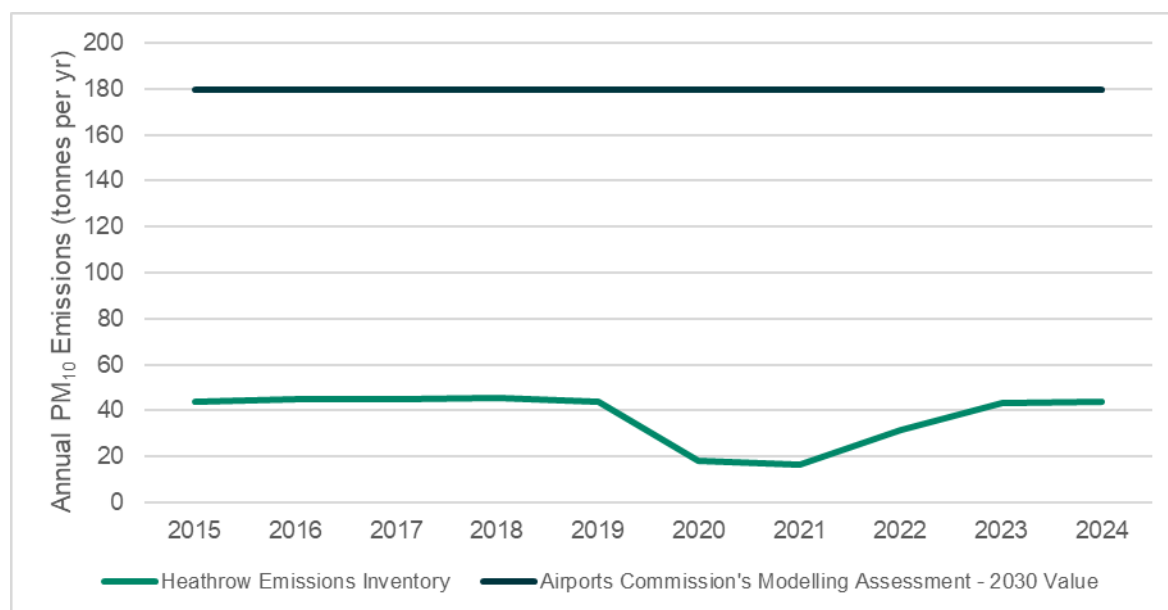
⁴Data for PM10 and PM2.5 not provided separately.

Figure 4 Annual NOx Emissions from Aircraft LTO Cycle – Airports Commission’s Modelling Assessment and Heathrow Airport Airfield Emissions Inventory



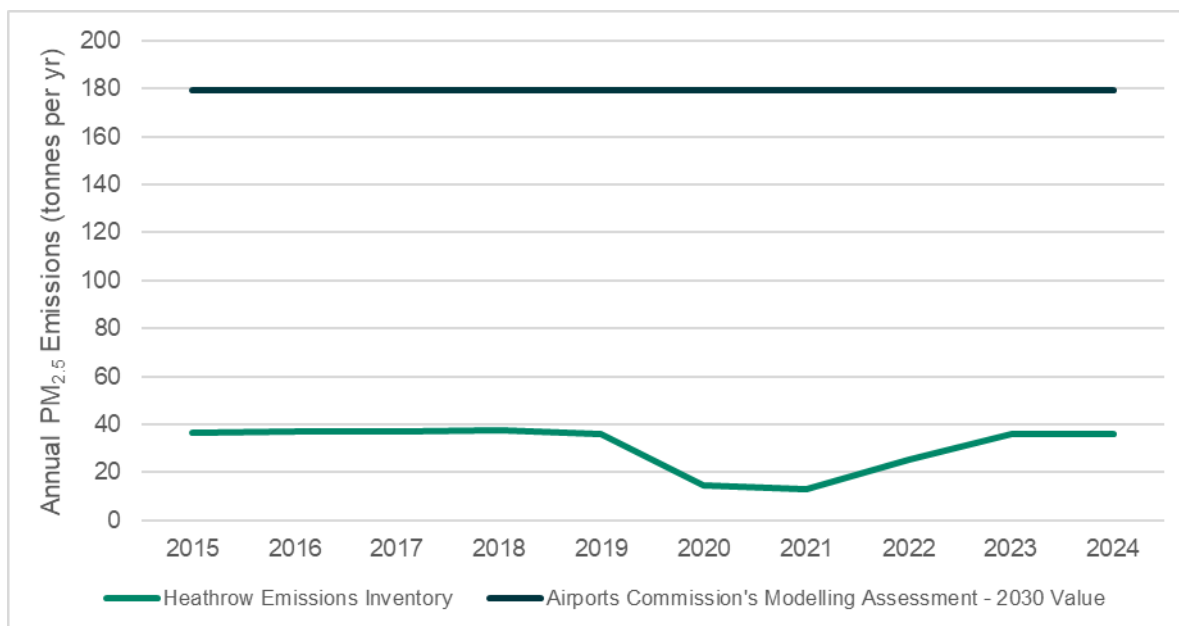
Note: Data from the Airports Commission's Modelling Assessment only available for 2030. A line has been used to highlight the 2030 value from the Airports Commission's Modelling Assessment for comparison with year-on-year data from the Heathrow Emissions Inventory.

Figure 5 Annual Emissions PM₁₀ from Aircraft LTO Cycle – Airports Commission’s Modelling Assessment and Heathrow Airport Airfield Emissions Inventory



Note: Data from the Airports Commission's Modelling Assessment only available for 2030. A line has been used to highlight the 2030 value from the Airports Commission's Modelling Assessment for comparison with year-on-year data from the Heathrow Emissions Inventory

Figure 6 Annual PM_{2.5} Emissions from Aircraft LTO Cycle – Airports Commission's Modelling Assessment and Heathrow Airport Airfield Emissions Inventory



Note: Data from the Airports Commission's Modelling Assessment only available for 2030. A line has been used to highlight the 2030 value from the Airports Commission's Modelling Assessment for comparison with year-on-year data from the Heathrow Emissions Inventory

Due to limited data availability at the time, the Airports Commission's modelling assessment provided an estimation for emissions index for engines which were confirmed to be in production, but not yet in operation. The emission index for these engines (now in operation) has been calculated and are outlined in Table 6.

The emission index from these engines that is available today is higher than estimated in the Airports Commission's modelling assessment. Based on the lead aircraft assignments in the Airports Commission's modelling assessment, this equates to approximately 38% of aircraft in the do-minimum scenario, and 41% of aircraft in the do-something scenario where the engine emissions have been underestimated.

Table 6 NOX Emission Index from “New” Engines

Engine	Aircraft	Aircraft Type	Take Off Emission Index (g/kg)			Climb Out Emission Index (g/kg)			Approach Emission Index (g/kg)			Idle Emission Index (g/kg)		
			ACMA ¹	ICAO	Difference	ACMA ¹	ICAO	Difference	ACMA ¹	ICAO	Difference	ACMA ¹	ICAO	Difference
PW1127 G	Post 2016 G2	Medium (MCAT 3)	11.3	19.3	+8.0	9.6	15.6	+6.1	3.4	9.6	+6.2	0.8	5.4	+4.6
CFM-LEAP-1B	Airbus A320	Medium (MCAT 4)	13.6	51.5	+37.9	11.6	23.1	+11.5	4.1	11.3	+7.3	1.0	4.6	+3.7
PW1524 G	Bombardier C Series	Small (MCAT 1)	21.5	27.1	+5.6	14.0	20.9	+6.9	2.3	10.8	+8.5	0.5	6.1	+5.6
GE9X	Boeing 777X	Heavy (MCAT 9)	8.0	29.3	+21.3	6.8	16.7	+9.9	2.4	9.6	+7.2	0.6	4.4	+3.9

¹Airports Commission's Modelling Assessment

Assumptions

Table 7 demonstrates the differing assumptions between the Airports Commission's modelling assessment and ICAO databank calculations which are likely to contribute to differences in emissions. The assumptions made for the ICAO databank calculations contribute to higher emissions.

Table 7 Methodology Assumptions - Aircraft

	Airports Commission's Modelling Assessment	ICAO Databank
Projected Emissions in 2030	NOX – 5,309.8 tonnes per year PM10/ PM2.5 – 179.3 tonnes per year Projections based on fleet projection as of 2015.	NOX – 12,549.7 tonnes per year PM10/ PM2.5 – 258.1 tonnes per year Projections based on fleet projection as of 2015.
Time in Mode	Information not provided for take-off, climb, or approach. Information for taxi provided by Promoters Taxi times: Provided separately for each taxi-route. A maximum taxi time of 900s (~15 minutes) given. An average of 572s (~10 minutes) given.	Assumed ICAO defaults: Take-off: 0.7 minutes Climb: 2.2 minutes Approach: 4.0 minutes Taxi & Idle: 26 minutes
Engine Selection	Weighted average of emissions from all engines within each MCAT Estimated emissions for engines which were not in production at the time of writing.	Raw emission rate based on a single engine. The engine identified for the 'lead' aircraft in each MCAT was chosen. Used real-life emissions for engines which were not in production at the time of writing in the Airports Commission's modelling assessment.
Thrust Settings	Information provided by promoters. Thrust settings based on MCAT: Take-off: 76% to 87% Climb: 76% to 87% Approach: Not provided Taxi & Idle: Not provided	Assumed ICAO defaults: Take-off: 100% Climb: 85% Approach: 30% Taxi & Idle: 7%

Ground Support Equipment (GSE)

Ground operations at the airport, such as those from GSE, also contribute to pollutant emissions. Table 8 outlines the annual emissions from GSE from the Heathrow Airport 2024 Emissions Inventory (Ricardo, 2025) and do-minimum scenario in the Airports Commission's modelling assessment. Figure 7, Figure 8, and Figure 9 show a comparison between the Heathrow Emissions Inventory data and the Airports Commission's modelling assessment data for NOX, PM10, and PM2.5.

It is shown in Table 8 that emissions from GSE has significantly reduced from 2014, with reductions in NOX of approximately one-third from 2014 to 2024 and reductions in PM of approximately two-thirds. The total annual emissions for 2030 estimated in the Airports Commission's modelling assessment are higher than the annual NOX emissions at Heathrow Airport in 2014 and are almost double of the annual emissions in 2024. For PM, the total annual emissions estimated in the Airports Commission's modelling assessment are between three to five times that of the 2024 emissions at Heathrow Airport. It can therefore be assumed that total emissions from GSE have been overestimated in the Airports Commission's modelling assessment and are likely to be lower than reported. The effect of brake and tyre wear has not been considered for GSEs in either the Airports Commission's modelling assessment or the Heathrow Airport emissions inventory.

The Airports Commission's modelling assessment assumed that the GSE fleet would be of the same age distribution in 2030 as in the baseline of 2009. Since the production of the Airports Commission's modelling assessment, several strategies have been implemented which aim to increase the number of electric GSE vehicles in use at the airport. By 2030, Heathrow Airport are aiming to reduce airside internal combustion vehicles and have all airside vehicles to be zero emissions where possible, with alternative fuel being used for specialist

vehicles (Heathrow Airport, 2022). This will significantly reduce tailpipe emissions from this source and will result in a smaller proportion of airport emissions being emitted from GSE by 2030.

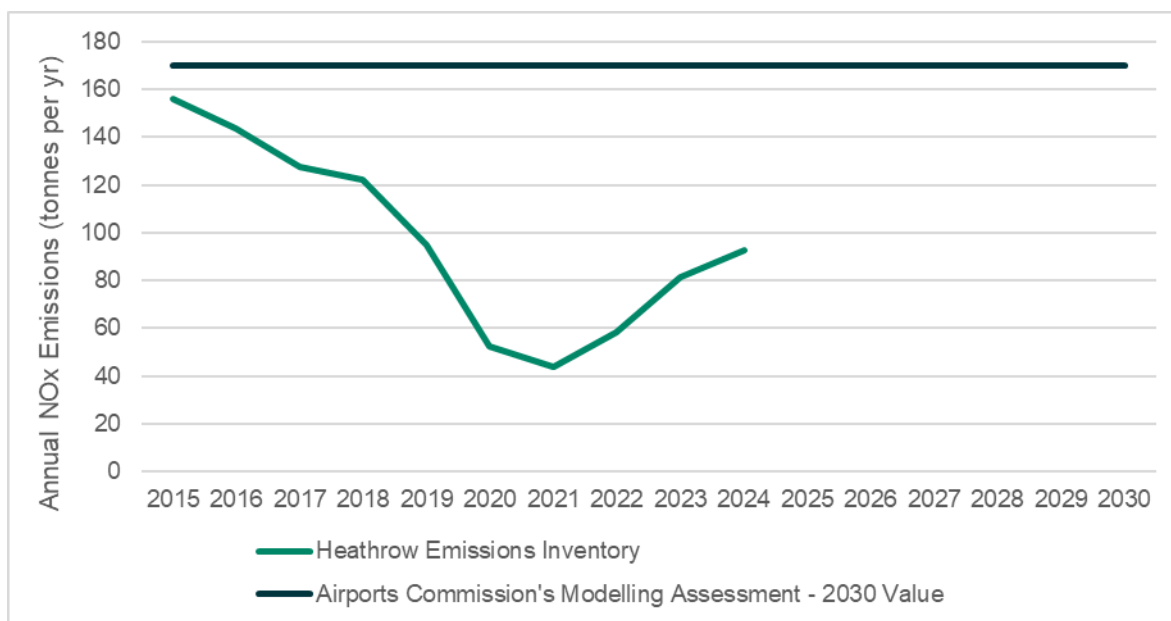
Table 8 Annual GSE Emissions

Pollutant	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Heathrow Emissions Inventory																
NOX (tonnes per year)	156.03	143.73	127.82	122	95.07	52.39	44.04	58.21	81.43	92.46	-	-	-	-	-	-
PM10 (tonnes per year)	10.83	9.75	9.04	8.67	6.37	3.71	3.16	4.25	3.77	3.51	-	-	-	-	-	-
PM2.5 (tonnes per year)	8.51	7.49	6.83	6.46	4.45	2.59	2.09	2.83	2.37	2.14	-	-	-	-	-	-
Airports Commission's modelling assessment																
NOX (tonnes per year)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	170.0
¹ PM10/PM2.5 (tonnes per year)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.0

Source: Heathrow Airport Airfield Emissions Inventory 2024 (Ricardo, 2025)

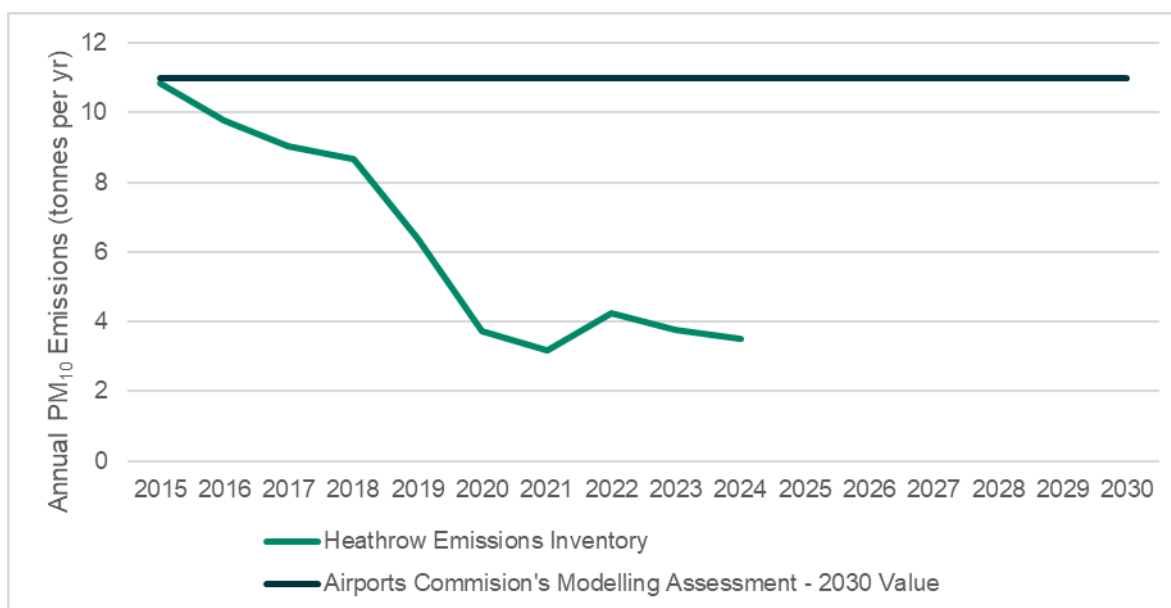
¹Data for PM10 and PM2.5 not provided separately

Figure 7 Annual NOx Emissions from GSE – Airports Commission’s Modelling Assessment and Heathrow Airport Airfield Emissions Inventory



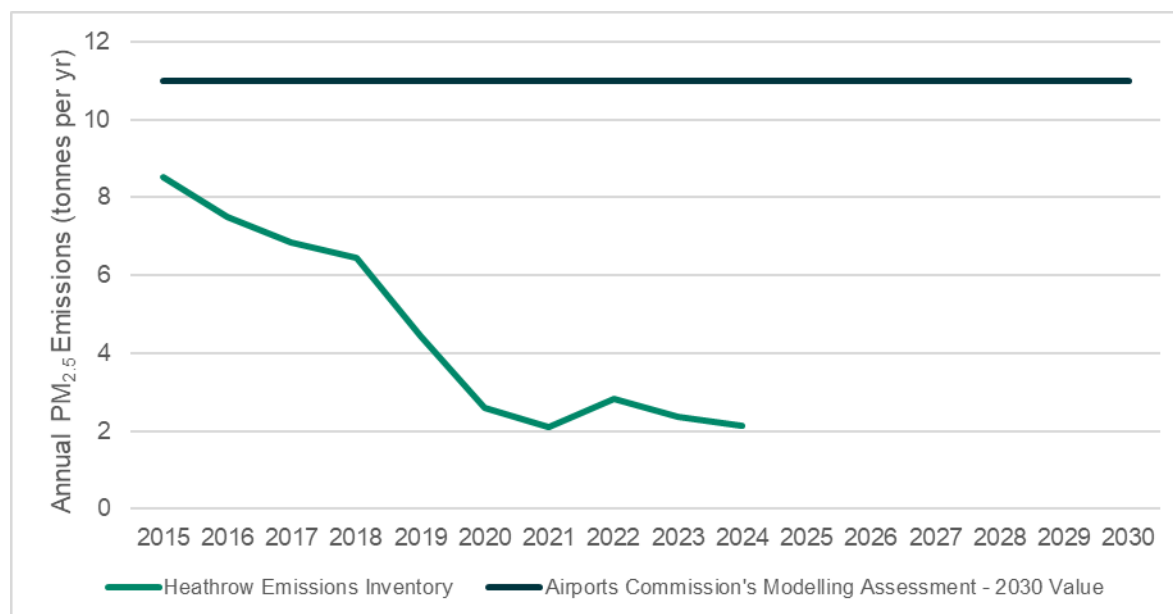
Note: Data from the Airports Commission's Modelling Assessment only available for 2030. A line has been used to highlight the 2030 value from the Airports Commission's Modelling Assessment for comparison with year-on-year data from the Heathrow Emissions Inventory

Figure 8 Annual PM₁₀ Emissions from GSE – Airports Commission’s Modelling Assessment and Heathrow Airport Airfield Emissions Inventory



Note: Data from the Airports Commission's Modelling Assessment only available for 2030. A line has been used to highlight the 2030 value from the Airports Commission's Modelling Assessment for comparison with year-on-year data from the Heathrow Emissions Inventory

Figure 9 Annual PM_{2.5} Emissions from GSE – Airports Commission’s Modelling Assessment and Heathrow Airport Airfield Emissions Inventory



Note: Data from the Airports Commission’s Modelling Assessment only available for 2030. A line has been used to highlight the 2030 value from the Airports Commission’s Modelling Assessment for comparison with year-on-year data from the Heathrow Emissions Inventory

Assumptions

Table 9 demonstrates the differing assumptions between the Airports Commission’s modelling assessment and Heathrow Emissions Inventory which are likely to contribute to differences in emissions.

Table 9 Methodology Assumptions - GSE

Assumption	Airports Commission’s Modelling Assessment	Heathrow Emissions Inventory
Fleet Turnover	Assumed that the GSE fleet would be of the same age distribution in 2030 as in the baseline of 2009	Based on real-life values which would consider a shift towards electric vehicles
Brake and Tyre Wear	Not Considered	Not Considered

Auxiliary Power Units (APUs)

Many aircraft utilise APUs to provide electrical power whilst the main engines are not running, for example for lighting and air conditioning while at the stand. The use of APUs can contribute significantly to pollutant concentrations. It was assumed in the Airports Commission’s modelling assessment that the APU run times at Heathrow Airport would remain unchanged from 2009. However, a change in operational policies at the airport now mean that aircrafts are not permitted to use APUs for the length of time assumed in the Airports Commission’s modelling assessment. Table 10 outlines the run-times assumed in the Airports Commission’s modelling assessment, and the permitted run-times as per the 2024 guidance published by Heathrow Airport (Heathrow Airport, 2024). It is encouraged that, for all aircraft, fixed electrical ground power (FEGP) is used as a first resort, with APU’s only to be used as a last resort. FEGP is currently provided at all stands at Heathrow Airport (Heathrow Airport, 2022).

Table 10 APU Running Times

Source	APU Run Times - Arrival	APU Run Times - Departure
Airports Commission’s Modelling Assessment ¹	Narrow-bodied Aircraft – 40 minutes per LTO cycle	
	Wide-bodied Aircraft – 80 minutes per LTO cycle	

Source	APU Run Times - Arrival	APU Run Times - Departure
Heathrow Airport - Use of Auxiliary Power Units	Narrow- and Wide-bodied Aircraft (excl. A380) – 10 minutes	Narrow-bodied Aircraft – 15 minutes
	A380 – 15 minutes	Wide-bodied Aircraft (excl. A380) – 30 minutes
		A380 – 60 minutes

Source: *Use of Auxiliary Power Units (Heathrow Airport, 2024)*

¹The same assumptions have been applied to arrivals and departures

Table 11 outlines the annual emissions from APUs from the Heathrow Airport 2024 Emissions Inventory (Ricardo, 2025) and do-minimum scenario in the Airports Commission's modelling assessment. Figure 10 and Figure 11 show a comparison between the Heathrow Emissions Inventory data and the Airports Commission's modelling assessment data for NOX, PM. In both reports, values for PM10 and PM2.5 are the same. Therefore, these have been reported together in Table 11 and Figure 11.

APU usage has decreased at Heathrow Airport since 2014, with fewer emissions in 2024 than in 2015. The estimated emissions in the Airports Commission's modelling assessment are higher than those in 2015 at Heathrow Airport for NOX and PM. Heathrow Airport currently have limits on APU usage, as outlined in Table 10. These limits are significantly lower than those assumed in the Airports Commission's modelling assessment. FEPG is also available at Heathrow Airport, however this was not applied within the Airport's Commission's modelling assessment. It is likely that this decrease in APU emissions will continue in future years as more airlines use the FEPG and APUs are phased out.

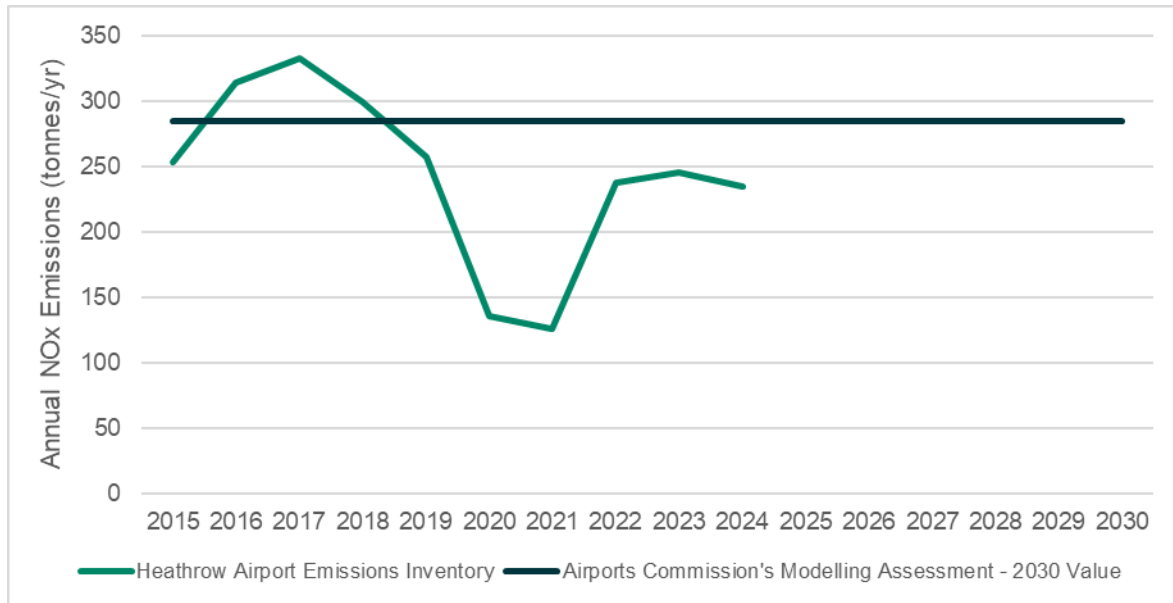
Table 11 Annual APU Emissions

Pollutant	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Heathrow Airport Airfield Emissions Inventory																
NOX (tonnes per year)	253.39	314.13	332.49	299.29	257.59	135.01	125.42	237.08	245.26	234.32	-	-	-	-	-	-
¹ PM10/ PM2.5 (tonnes per year)	4.34	5.49	6.06	5.32	4.78	2.29	2.27	4.36	4.37	4.16	-	-	-	-	-	-
Airports Commission's Modelling Assessment																
NOX (tonnes per year)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	284.7
¹ PM10/ PM2.5 (tonnes per year)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.7

Source: Heathrow Airport Airfield Emissions Inventory 2024 (Ricardo, 2025)

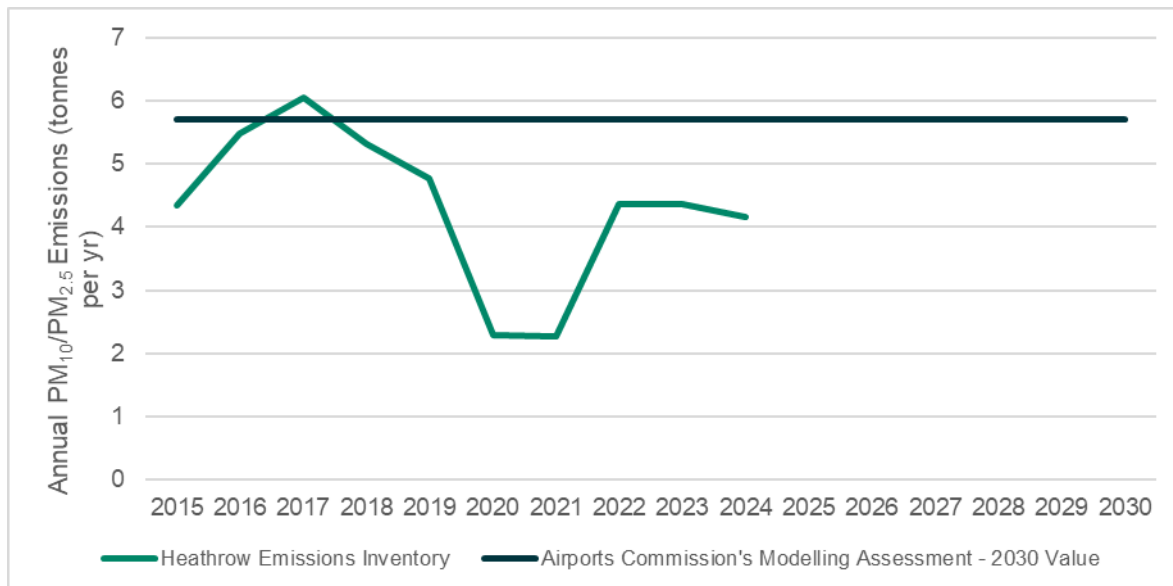
¹Data for PM10 and PM2.5 not provided separately

Figure 10 Annual NOx Emissions from APU – Airports Commission’s Modelling Assessment and Heathrow Airport Airfield Emissions Inventory



Note: Data from the Airports Commission's Modelling Assessment only available for 2030. A line has been used to highlight the 2030 value from the Airports Commission's Modelling Assessment for comparison with year-on-year data from the Heathrow Emissions Inventory

Figure 11 Annual PM₁₀ and PM_{2.5} Emissions from APU – Airports Commission’s Modelling Assessment and Heathrow Airport Airfield Emissions Inventory



Note: Data from the Airports Commission's Modelling Assessment only available for 2030. A line has been used to highlight the 2030 value from the Airports Commission's Modelling Assessment for comparison with year-on-year data from the Heathrow Emissions Inventory

Assumptions

Table 12 demonstrates the differing assumptions between the Airports Commission’s modelling assessment and Heathrow Emissions Inventory which are likely to contribute to differences in emissions.

Table 12 Methodology Assumptions - APU

Assumption	Airports Commission's Modelling Assessment	Heathrow Emissions Inventory
APU Timings	For arrival and departure: Narrow-bodied Aircraft – 40 minutes per LTO cycle Wide-bodied Aircraft – 80 minutes per LTO cycle	Based on real-life values. Current APU limits are: For arrival: Narrow- and Wide-bodied Aircraft (excl. A380) – 10 minutes A380 – 15 minutes Narrow-bodied Aircraft – 15 minutes For departure: Wide-bodied Aircraft (excl. A380) – 30 minutes A380 – 60 minutes
Use of Fixed Electrical/Plug-in Power Units	Not used	Use of Fixed Electrical/Plug-in Power Units included in reported emissions

Heating Plant

The Airports Commission's modelling assessment considered energy plant emissions in 2030. The assessment was based on information provided by the Promoter of the NWR scheme at that time, based on their assessment of the energy plant that was operational at the Airport in 2009. For the 2030 do-minimum scenario of that assessment, it was assumed that a complete replacement of heating and energy plant would have occurred by 2030, including the operation of the T2 biomass combined heating and power (CHP) plant (which is now operational), that all plant would have a NOX emission rate of no more than 40 mg/kWh, and that all plant would be located at the T2 and T5 energy centres. The Airports Commission's modelling assessment report makes no reference to PM emissions from energy plant, however DfT have provided the mass emissions data for NOX and PM10 from the energy plant that were used to inform the Airports Commission's modelling assessment. The aggregated mass emissions of the energy plant included in that assessment for 2019 and 2030, for both NOX and PM10, is provided in Table 13.

Table 13 Annual Emissions from Airport Energy Centre Plant – Airports Commission's Modelling Assessment

Pollutant	Airports Commission's modelling assessment		
	2009 Base	2030 DM	Change
NOX (tonnes per year)	284	86	-198
PM10 (tonnes per year)	26	7	-19

Table 13 shows that the assumptions made for the Airport Commission's modelling assessment led to a decrease in emissions from this source of ~70%, between 2009 and 2030. No current information on energy centre emissions at the Airport is available as energy plant emissions are not included as an individual source in the published Heathrow Airport Emissions Inventory reports. Whilst the assumption made in that assessment on reducing emissions between 2009 and 2030 is likely true, it is impossible to confirm whether emissions from these sources are reducing at the rate anticipated by that assessment.

4. Summary and Conclusions

A review has been undertaken to assess whether the conclusions of the Airports Commission's modelling assessment, used to inform the ANPS, would be the same when considering the evolving fleet and changes in airport strategies that have occurred since that assessment was undertaken.

Calculations have been undertaken to estimate the annual emissions from the fleet used in the Airports Commission's modelling assessment using the most recent available data from the ICAO. This analysis has shown that the emissions in the Airports Commission's modelling assessment are lower than those calculated using the ICAO data when considering the same aircraft fleet. It should be noted that it has not been possible to do an exact like-for-like comparison of the emissions data used to inform the Airports Commission's modelling and emissions data based on current engine information available in the ICAO databank. This is because the Airports Commission's modelling does not provide enough detail on the time-in-mode values and thrust settings that were provided by the promoter of that assessment, which may differ from the default values for time-in-mode and thrust settings assumed when calculating emissions based on the latest ICAO databank. This could contribute, to some extent, to the difference in emissions between the Airport Commission's modelling assessment and those calculated for this assessment. Despite this uncertainty in the emissions used to inform the Airports Commission's modelling, both their emissions and those that have been calculated using the current ICAO databank demonstrate that changes in operations at Heathrow due to the construction of the NWR are likely to lead to a ~40% increase in annual NOX emissions and a 50-60% increase in annual PM emissions. Whilst the relationship between emissions at source and contributions at receptor locations is not linear, this similarity provides some indication that it would lead to a comparable increase in aircraft related NOX contributions, if ignoring any change in emissions source location and receptor location.

A review of data published in Heathrow's annual emissions inventories has also been undertaken for comparison with the emissions data used to inform the Airports Commission's modelling. The Heathrow emission inventory shows that emissions in 2024 are lower than those reported in the Airports Commission's modelling assessment for their 2030 DM scenario. The inventory shows that emissions have increased since 2014 and it is not unreasonable to assume that this trend continues in future years, with emissions continuing to increase through to 2030. An increase in ATMs as a result of increased capacity will also increase emissions. The information provided by Ricardo in the emissions inventory also considers the fleet evolution at the airport, with newer aircraft being generally less polluting than older aircraft of a similar size. The increase in emissions due to the increased ATMs is offset, to some extent, by the evolving aircraft fleet. A higher proportion of A380's were assumed in the Airports Commission's modelling assessment than in reality, which will result in an overestimation of emissions. Additionally, emissions were estimated for several aircraft which were in production but not in operation at the time of the Airports Commission's modelling assessment. The emissions for these aircraft appear to be underestimated in the Airports Commission's modelling assessment. On balance, it is therefore likely that emissions from aircraft will be similar to those recorded in the Airports Commission's modelling assessment in 2030, based on trends in the Ricardo emissions inventory for NOX. PM emissions are significantly lower in the Heathrow Airport emissions inventory than the Airports Commission's modelling assessment and therefore are likely to be lower than those reported in the Airports Commission's modelling assessment if undertaken today.

For GSE, the emissions reported by Ricardo are significantly lower than those reported in the Airports Commission's Modelling Assessment. This is largely due to an evolving GSE fleet, with Heathrow Airport hoping to have a fully electric ground fleet by 2030. This would significantly reduce NOX emissions and, to a lesser extent, PM10 and PM2.5 emissions also. The GSE fleet assumed in the Airports Commission's modelling assessment was forecasted to be of the same age make-up as 2009, with no electric vehicles considered. It is therefore likely that emissions from GSE will be lower than those reported in the Airports Commission's Modelling Assessment in 2030. The impact of brake and tyre wear has not been considered in either the Heathrow Airport emissions inventory or Airports Commission's modelling assessment.

For APUs, the emissions reported by Ricardo are significantly lower than those reported in the Airports Commission's Modelling Assessment. This is largely due to an increase in restrictions on APU usage now being implemented at the airport. FEGP is widely available at the airport, and all aircraft are encouraged to use FEGP instead of APUs. No FEGP usage was considered within the Airports Commission's modelling assessment, and it was assumed that APUs would run for significantly longer than current permitted timings. It is therefore likely that emissions from APU will be lower than those reported in the Airports Commission's Modelling Assessment in 2030.

For the Airport's energy centre plant, there are limited data available on actual existing emissions. A review of the data used by the Airports Commission's modelling assessment shows for that assessment, the assumption was

made that emissions between 2009 and 2030 would fall considerably, due to the retrofitting of the energy centres and improving technology. Whilst there is no data available to compare those modelled assumptions with reality, the basis for the assumption remains true – a retrofitted energy centre with newer energy plant technology, required to meet the same energy demand, would likely have lower emissions due to advanced emissions technology.

Overall, it is considered the emissions used in the Airports Commission's modelling assessment are likely similar to 2030 emissions for NOX, based on conditions and emissions data currently available, and higher for emissions of PM10. An increase in aircraft emissions due to the NWR of a similar proportion to those estimated in the Airports Commission's modelling assessment have been calculated using the most recent ICAO databank. Although GSE and APU emissions are likely to be much lower than previously assumed, these contribute a smaller proportion of overall emissions than the aircraft. It is expected that the airside emissions are similar to those assumed in 2018 based on the trends in emissions from 2014 to 2024. Evolving fleets and aircraft engines will influence the total aircraft emissions, however, these changes are difficult to predict.

The indicative analysis suggests that, based on current evidence, the Government's conclusions for NO2 and PM10 impacts for the 2018 ANPS can be applied to the position as at 2026 (subject to the uncertainties identified in the analysis).

It should be noted that no assessment of PM2.5 was undertaken in the Airports Commission's modelling assessment, and therefore it is not possible to determine whether the original conclusions remain valid due to the introduction of more stringent limit values. The impacts of PM2.5 has been considered in a separate commission and can be found in the Review of PM2.5 Concentrations and Exposure report.

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