Statutory Consultation 2022

Preliminary Environmental Information Report

Volume 3: Appendix 12.2

GHG Methodology and Data

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1 INTRODUCTION

1.1.1 This document is an Appendix to **Chapter 12** of Volume 2 of the Preliminary Environmental Information Report (PEIR) for the proposed expansion of London Luton Airport from 18 million passenger per annum (mppa) to 32 mppa (the 'Proposed Development') by Luton Rising (a trading name of London Luton Airport Limited ('the Applicant')). It provides detailed methodology and technical information to inform the preliminary environmental impact assessment of the Proposed Development.

2 METHODOLOGY

2.1.1 This section outlines the methodology employed for assessing GHG emissions from the construction and operation of the Proposed Development.

2.1 2019 Baseline Methodology

2.1.1 An explanation of the methodology and assumptions for each element of the baseline assessment is set out in **Table 2.1**.

Table 2.1 2019 Baseline Methodology

Activity	Methodology
Airport operations	Baseline emissions data were taken from London Luton Airport Operations Limited (LLAOL) 2019 Carbon Footprint (Ref. 1): a. Energy use (electricity, natural gas and other fuels) – activity data is based on supplier invoices; emissions factors from Department for Business, Energy & Industrial Strategy (BEIS) conversion factors for company reporting (Ref. 2). b. Airport operational vehicles – activity data from fuel card data specifying volume and fuel type; emissions factors from UK Government data as above. c. Refrigerant use – activity data from refrigerant usage log; emissions factors from UK Government data as above. d. Fire training – activity data (fuel consumption) from email correspondence with operators; emissions factors from UK Government data as above. e. Aircraft engine testing – automated data based on aircraft reg, type and duration of test. f. Business travel – activity data converted from expenses costs. g. Waste management, water supply and water treatment – activity data from board reports; emissions factors from UK Government data as above.
Surface access journeys	Surface Access Modelling Inputs for Greenhouse Gas Assessment have been developed by the Applicant's transport planners and modellers (Ref. 3):

Activity	Methodology
	a. The passenger and staff catchment distribution (calculated by CBLTM zone) was converted to the CBLTM-LTN zoning system using suitable disaggregation factors. b. Total annual demand by mode for each CBLTM-LTN zone was calculated using the distribution for 2016, updated for 2019 data and taking account of the change in mode share as reported in Luton London Airport's Annual Monitoring Report (Ref. 4). For car journeys, the vehicle split between petrol, diesel and electric vehicles was taken from the Department for Transport's (DfT) Transport Analysis Guidance (TAG) Databook (Ref.. 5) for the baseline year and suitable emissions factors from UK Government data applied. For taxi, bus and rail journeys, suitable emissions factors from UK Government data were applied.
Air traffic movements	Air Traffic Movement (ATM) data (Ref. 6) was provided by the Applicant's aviation planning team: a. Annual numbers of flights for different makes and models of aircraft (fleet mix) were provided, broken down by world region split (Central and Eastern Europe; Domestic; Middle East; North America; Turkey, Near East and North Africa; Western Europe) and by aviation type (commercial aircraft, freight aircraft, business and general aircraft). b. For each world region split, an average flight distance was provided in km; this was converted to nautical miles for the purposes of the emissions calculator. The European Monitoring and Evaluation Programme (EMEP)/ European Environment Agency (EEA) Aviation Emissions Calculator (Ref. 7) was used to estimate the fuel consumption and CO_2 emissions for each model of aircraft and world region distance; this data was broken down between Landing and Take Off cycle (LTO) and Climb-Cruise-Descend (CCD) phases. Emissions were converted to CO_2e using the appropriate ratio for aviation fuel taken from the UK Government conversion factors.

2.1.2 The baseline GHG emissions arising from activities are based on the Greenhouse gas reporting: conversion factors 2019 developed by BEIS (Ref.. 8). These factors allow for the conversion of activity data into emissions of either CO_2 and/or CO_2e. Conversion factors used to develop the 2019 baseline are presented in **Table 2.2.**

Table 2.2 2019 Baseline conversion factors

Activity/material	Units	Conversion factor (kg CO_2e/unit)
Natural gas	kWh	0.18385
Diesel	litres	2.59411

Activity/material	Units	Conversion factor (kg CO_2e/unit)
Gas oil	litres	2.75821
Kerosene	litres	2.54042
Aviation fuel	litres	2.54306
Grid electricity (generation)	kWh	0.2556
Grid electricity (T&D losses)	kWh	0.0217
Petrol cars	Vehicle.km	0.18084
Diesel cars	Vehicle.km	0.17336
Electric cars	Vehicle.km	0.04720
Taxi	Vehicle.km	0.21024
Bus travel	Passenger.km	0.12076
Rail travel	Passenger.km	0.04115
Water supply	m^3	0.344
Water treatment	m^3	0.708

2.2 Future Baseline (DM) Methodology

2.2.1 Future baseline is a Do-Minimum (DM) scenario i.e. the Proposed Development is not built, and the airport continues to operate within its current consented 18 mppa capacity. Expected policy impacts (for example the phasing out of vehicles with internal combustion engines and the decarbonisation of the national electricity grid) are also included in this future baseline.

2.2.2 Generally the development of the future baseline and the assessment scenarios follow the same approach as for development of the baseline year, albeit activity data for future years is developed from a range of data sources provided by the Applicant's aviation planning team and the project design team, including specialists such as transport consultants and air quality specialists.

2.2.3 An explanation of the methodology and assumptions for each element of the future baseline assessment is set out in **Table 2.3**.

Table 2.3 Future Baseline (DM) Methodology

Activity	Methodology
Airport operations	Future operational emissions in the DM Baseline scenario are extrapolated from the 2019 London Luton Airport Operations Ltd (LLAOL) carbon footprint as follows: a. Airport and 3rd party tenant electricity demand assumes that the overall annual power consumption per passenger falls at 0.5% per year, but otherwise remains proportionate to passenger numbers. Emissions factors

Activity	Methodology
	for grid electricity are assumed to fall as per the UK Government's projections. (Ref. 9) b. Heating demand per square metre in T1 remains as per the 2019 footprint, with all heating from natural gas. The emissions factor for natural gas remains constant at 2021 levels. c. Energy consumption in airport operational and 3rd party vehicles is proportionate to passenger numbers; all airport vehicles are fossil-fuelled. Emissions factors for all airport vehicles remains constant at the levels in the 2019 carbon footprint. d. Fugitive emissions from refrigerants, water and waste remain proportionate to passenger numbers. e. Emissions from fire training are proportionate to ATM numbers. f. Emissions from business travel are proportionate to staff numbers.
Surface access journeys	Surface Access Modelling Inputs for Greenhouse Gas Assessment have been provided by the transport planners (Ref. 10): a. Annual passenger.km data (calculated as above) was provided for the DM baseline for 2027, 2039 and 2043. Passenger.km data provided was constant for each year, so these figures were applied to each year from 2023 to 2043. b. Car fuel type split (petrol – diesel – electric) was taken from the projections in the DfT's TAG Data book, and these percentages applied to car travel for passengers and staff. c. Emissions factors for petrol and diesel cars were assumed to remain constant at 2021 levels, while for electric vehicles the emissions per vehicle.km are assumed to reduce proportionally with projected grid carbon intensity figures published by the UK Government. d. The carbon intensity per km for travel by taxi, rail and bus are very likely to fall over the coming years, but in the absence of reliable projections they have been assumed to remain constant at 2021 levels as a worst case scenario.
Air traffic movements	Emissions calculations for the Future Baseline (DM) scenario have been carried out using the same methodology as for the 2019 Baseline described above, using ATM data provided by aviation planners.

Activity	Methodology
	The data provided takes account of improved energy efficiency for future models of aircraft in the fleet mix, where known, and also of the impact of current carbon pricing policy on passenger demand.

2.2.4 For future baseline modelling the most recent BEIS factors (Ref. 11) (from 2021) have been used and are listed in **Table 2.4**.

2.2.5 Carbon emissions factors vary over time and are published annually by UK Government (Ref. 12) for use in relation to corporate reporting of that specific year's emissions. Future emissions factors will differ from these, and in many cases will reduce in line with wider national trends towards decarbonisation, and through improved efficiency of vehicles etc. The significant expected future effects (electricity decarbonisation, vehicle efficiency) are discussed further in this document.

Table 2.4 Future Baseline (DM) conversion factors

Activity/material	Units	Conversion factor (kg CO_2e/unit)
Natural gas	kWh	0.18316
Diesel	litres	2.51233
Gas oil	litres	2.75857
Kerosene	litres	2.54014
Aviation fuel	litres	2.54514
Grid electricity (generation)	kWh	Variable; reducing
Grid electricity (T&D losses)	kWh	Variable; reducing
Petrol cars	Vehicle.km	0.17431
Diesel cars	Vehicle.km	0.16843
Electric cars	Vehicle.km	0.05031
Taxi	Vehicle.km	0.20826
Bus travel	Passenger.km	0.10227
Rail travel	Passenger.km	0.03549
Water supply	m^3	0.149
Water treatment	m^3	0.272

Grid decarbonisation assumptions

2.2.6 The future decarbonisation of the national grid will influence future emissions from the airport. The source of information used for this is the UK Government Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions (Ref. 13) for appraisal which provides forecasts for the carbon intensity of grid electricity in the future. This was most recently updated in 2021 (Ref. 14) from which **Table 2.5** provides carbon intensities for grid electricity.

2.2.7 The projected carbon intensity figures published by the UK Government aggregate the emissions from generation (Scope 2) and from transmission & distribution (T&D) losses (Scope 3) into a single figure. These have been disaggregated in **Table 2.5** on the assumption that emissions from generation account for 92% of the total, with T&D losses making up the remaining 8%. This ratio is based on an analysis of historic grid carbon data.

Table 2.5 Projected grid carbon intensities

Year	Emissions Factor (kg CO_2e/kWh)	
	Generation	T&D losses
2023	0.125	0.011
2024	0.136	0.012
2025	0.115	0.010
2026	0.085	0.007
2027	0.070	0.006
2028	0.065	0.006
2029	0.061	0.005
2030	0.048	0.004
2031	0.038	0.003
2032	0.033	0.003
2033	0.029	0.002
2034	0.026	0.002
2035	0.023	0.002
2036	0.019	0.002
2037	0.017	0.001
2038	0.017	0.001
2039	0.016	0.001
2040	0.014	0.001
2041	0.012	0.001
2042	0.011	0.001
2043	0.011	0.001

Surface Access Data

2.2.8 Emissions from surface access travel are derived from information provided by the Applicant's transport planners. **Table 2.6** shows annual passenger travel distances by mode.

Table 2.6: Passenger Travel Data (Annual)

Scenario	Car (Pass.km)	Taxi (Pass.km)	Bus (Pass.km)	Rail (Pass.km)
2019 BY	618,320,113	143,466,975	312,275,777	287,127,400
2027 DM 2039 DM 2043 DM	593,598,156	136,257,708	309,801,640	312,649,470
2027 DS	709,020,020	162,752,263	370,040,848	373,442,423
2039 DS	811,660,444	184,735,871	491,097,510	544,201,675
2043 DS	961,967,933	218,946,217	582,041,494	644,979,763

2.2.9 **Table 2.7** shows annual staff travel distances by mode.

Table 2.7: Staff Travel Data (Annual)

Scenario	Car (Staff.km)	Taxi (Staff.km)	Bus (Staff.km)	Rail (Staff.km)
2019 BY	85,354,400	77,594,909	7,329,119	10,846,606
2027 DM 2039 DM 2043 DM	85,354,400	77,594,909	7,329,119	10,846,606
2027 DS	91,458,086	83,143,715	9,134,390	12,693,549
2039 DS	104,468,492	94,971,357	13,289,050	16,184,197
2043 DS	112,222,319	102,020,290	18,719,569	20,036,063

Future Vehicle Fleet

2.2.10 The future make-up of the UK vehicle fleet has been taken from the UK Government TAG data book Table A 1.3.9 (Ref. 15) which provides proportions of vehicle kilometres by fuel type for the period to 2050. The data are represented in **Table 2.8.**

Table 2.8 Web TAG Data Book – Table A 1.3.9 (extract)

Year	Proportion of cars using petrol, diesel or electricity		
	Petrol	Diesel	Electric
2019	49.4%	49.9%	0.8%
2020	50.3%	48.7%	1.0%

Year	Proportion of cars using petrol, diesel or electricity		
	Petrol	Diesel	Electric
2021	51.1%	47.5%	1.4%
2022	51.9%	46.2%	1.9%
2023	52.6%	44.8%	2.6%
2024	53.1%	43.2%	3.7%
2025	53.2%	41.4%	5.4%
2026	53.2%	39.4%	7.3%
2027	53.1%	37.5%	9.4%
2028	52.9%	35.7%	11.4%
2029	52.6%	33.9%	13.5%
2030	52.1%	32.3%	15.6%
2031	51.5%	30.8%	17.7%
2032	50.8%	29.5%	19.7%
2033	50.0%	28.3%	21.7%
2034	49.1%	27.3%	23.5%
2035	48.3%	26.4%	25.3%
2036	47.4%	25.6%	27.0%
2037	46.5%	24.9%	28.7%
2038	45.6%	24.3%	30.2%
2039	44.8%	23.7%	31.6%
2040	43.8%	23.1%	33.1%
2041	43.0%	22.6%	34.4%
2042	42.2%	22.1%	35.7%
2043	41.4%	21.6%	37.0%

2.3 DS DCO-embedded Methodology

2.3.1 This section outlines the methodology employed for GHG emissions arising from the construction and operation of the Proposed Development for the Do-Something DCO scenario with embedded mitigation (DS DCO-embedded) such as increased low carbon on-site energy generation, the expected policy impacts of the future baseline also underpin this scenario.

Construction Emissions

Methodology

2.3.2 **Table 2.9** describes the methodology employed for GHG emissions arising from the construction activities.

Table 2.9 Do-Something DCO Scenario Methodology: construction

Activity	Methodology
Construction materials	Emissions for construction materials were calculated off a dataset of construction materials quantities from Project design engineers. This dataset contains the following; total concrete, total asphalt, total steel including both structural and rebar, total aggregates and total earthworks. The quantities were multiplied by the emissions factors (see **Table 2.10**) that were sourced from the Inventory of Carbon and Energy (ICE) database (Ref. 16). For earthworks the emission factor was assumed to be the same for aggregate. The density for concrete was assumed to be 2.4 tonnes per m^3.
Construction plant use estimates	Non-Road Mobile Machinery (NRMM) includes access platforms, dumpers, excavators, bulldozers, forklift, compressors, generators, mobile cranes, telehandlers and rollers. Total power required for each year was calculated based on the following information provided for each NRMM: a. assigned total number of machine days on site per each stage; b. number of hours of operation per day; c. type of fuel; and d. power output. Based on the power output per stage provided and number of working days, average annual power was calculated for each NRMM. This was then multiplied by BEIS conversion factors (see **Table 2.10)** to develop an estimate of CO_2e emissions, at this stage 40% power efficiency was considered, for diesel emissions were multiplied by 2.5 and for electric by 1.5.
Energy demand	Energy demand was estimated for equipment and facilities used during the construction based on the following information:

Activity	Methodology
	a. energy usage for each equipment; and b. ten working hours per day and 5.5 working days per week were assumed for all equipment. Estimated energy for each piece of equipment was calculated for each year which was then multiplied by BEIS conversion factors (see **Table 2.12**) to develop an estimate of CO_2e emissions.
Waste estimates	The GHG calculations for waste disposal was sourced from the BEIS conversion factors for the year 2021 (see **Table 2.13**). Following scenarios were used: construction waste - a scenario of closed loop waste disposal; demolition waste - a scenario of sending all material to landfill; hazardous waste - a scenario of sending all material to landfill. Transportation of waste from site to disposal was assumed to be 50 km and the transport Emission Factor of 0.12158 (kg CO_2e/tonne.km) was used to account for the vehicles used.
Land use change data	A revised biodiversity metric for the current proposal has yet to be carried out, but until this is available emissions from land use change have been based on estimates of areas of vegetation (assumed to be grassland) and woodland to be cleared during each of the three expansion phases. Factors soil and vegetation carbon per hectare for uncleared grassland and woodland were taken from European Commission guidelines for the calculation of land carbon stocks (Ref. 17). It was assumed that following clearance, all soil and vegetation carbon would be lost to the atmosphere, equally spread over the years of the relevant expansion phase. Soil and vegetation carbon was converted to carbon dioxide by multiplying by 44/12, the ratio of the mass of CO_2:C.
Water consumption and waste	Estimated water demand data was provided for following locations and operations: a. offices and compounds; b. concrete batching; c. bulk earthworks; and d. internal roads and landscaping mitigation.

Activity	Methodology
	Annual water usage was estimated based on the quantity of water used per day and amount of working days per month. Then % of water discharged was assigned to calculate the amount of water discharged. Annual water consumed and discharged were then multiplied by BEIS conversion factors (see **Table 2.14)** to develop an estimate of CO_2e emissions.
Construction worker transport	GHG emissions from construction worker transport were calculated using total amount of kilometres travelled per day in each year multiplied by the emissions factor for different type of vehicles (see **Table 2.15**). Following assumptions were used: a. 65 working days per quarter, with peak number of workers on site in each year of the construction; b. 60% of journeys to the site are made by car of which: 80% <40 miles; 15% between 40-80miles; and 5% 80-100 miles. c. 40% of journeys to the site are made by public transport, all assumed to be below 40miles (as above conservative scenario used with max value and return journey) d. Conservative scenario has been taken assuming max value for each type of mode and distance is a return journey. e. For car journeys the vehicle type share data was used from TAG data book as presented in **Table 2.8** accounting for changes in the road vehicle fleet.

Emissions factors

2.3.3 GHG emissions from construction have been calculated by applying GHG emissions conversion factors for 2021 published by BEIS (Ref. 18) to the estimated quantities of energy, water used, and waste generated during construction.

2.3.4 Embodied carbon in construction materials has been calculated by applying embodied carbon conversion factors from ICE database (Ref. 19).

2.3.5 The emissions factors used for the GHG emissions arising from construction activities are presented in **Table 2.10** to **Table 2.15.**

Table 2.10 Emissions factors for construction materials

Material	Emission factor kg CO_2e/unit
Total Concrete (m^3)	249.6
Total Asphalt (m^3)	142
Total Steel – Structural (tonnes)	1550
Total Steel – Rebar (tonnes)	1990
Total Aggregate (m^3)	17.928
Total Earthworks materials – site won (m^3)	0
Total Earthwork material – imported (m^3)	19.928

Table 2.11 Emissions factors for plant usage

Phase	Year	Emission factor by type of fuel kg CO_2e/unit		
		Petrol (average biofuel blend) kWh (Net Calorific Value (CV))	Gas oil kWh (Net CV)	Electricity (kWh)
Phase 1	2025	0.24227	0.27318	0.125
	2026	0.24227	0.27318	0.092
	2027	0.24227	0.27318	0.076
Phase 2a	2033	0.24227	0.27318	0.031
	2034	0.24227	0.27318	0.028
	2035	0.24227	0.27318	0.025
	2036	0.24227	0.27318	0.021
Phase 2b	2037	0.24227	0.27318	0.019
	2038	0.24227	0.27318	0.018
	2039	0.24227	0.27318	0.017
	2040	0.24227	0.27318	0.016

Table 2.12 Emissions factors for future electricity demand

Phase	Year	Emission factor (consumption-based, domestic) (kg CO_2e/kWh)
Phase 1	2025	0.125
	2026	0.092
	2027	0.076
Phase 2a	2033	0.031
	2034	0.028
	2035	0.025
	2036	0.021
Phase 2b	2037	0.019
	2038	0.018
	2039	0.017
	2040	0.016

Table 2.13 Emissions factor for waste during construction

Waste type	Emission factor (kg CO_2e/tonne)
Construction waste	0.989
Demolition waste	21.294
Hazardous waste	467.046

Table 2.14 Emissions factors for water consumption and waste

Phase	Year	Emission factor (kg CO_2e/m^3)	
		Water supply	Water Treatment
Phase 1	2025	0.149	0.272
	2026	0.149	0.272
	2027	0.149	0.272
Phase 2a	2033	0.149	0.272
	2034	0.149	0.272
	2035	0.149	0.272
	2036	0.149	0.272
Phase 2b	2037	0.149	0.272
	2038	0.149	0.272

Phase	Year	Emission factor (kg CO_2e/m^3)	
	2039	0.149	0.272
	2040	0.149	0.272

Table 2.15 Emissions factors for worker transport during construction

Phase	Year	Emission Factor by type (kg CO_2e/veh.km)		
		Petrol	Diesel	Electric
Phase 1	2025	0.17431	0.16843	0.027272
	2026	0.17431	0.16843	0.020104
	2027	0.17431	0.16843	0.016638
Phase 2a	2033	0.17431	0.16843	0.006796
	2034	0.17431	0.16843	0.006169
	2035	0.17431	0.16843	0.005504
	2036	0.17431	0.16843	0.004553
Phase 2b	2037	0.17431	0.16843	0.00405
	2038	0.17431	0.16843	0.003956
	2039	0.17431	0.16843	0.003745
	2040	0.17431	0.16843	0.003394

Operational Emissions

2.3.6 **Table 2.16** describes the methodology employed for GHG emissions arising from the operations of the Proposed Development.

Methodology

Table 2.16 Do-Something DCO Scenario Methodology: operations

Activity	Methodology
Airport operations	Future operational emissions in the DS DCO-embedded scenario are extrapolated from the 2019 London Luton Airport Operations Ltd (LLAOL) carbon footprint as follows: a. Annual electricity demand per passenger for T1 and T2 is assumed to fall at 0.5% per year from 2019 onwards, but otherwise remain proportionate to passenger numbers using each terminal. b. Heating demand for T1 is assumed to be gas fired up to 2039, then electrical from 2040 onwards.

Activity	Methodology
	c. Heating demand for T2 is assumed to be electrical from the outset. d. Heating demand per square metre is assumed to remain constant for both T1 and T2 at 2019 levels. e. Gas boilers are assumed to be 85% efficient, electrical heating is assumed to be from heat pumps, operating with a coefficient of performance (CoP) of 3.0. f. Emissions factors for grid electricity are assumed to fall as projected by the UK Government; the emissions factor for natural gas is assumed to remain constant at 2021 levels. g. Airport operational and 3rd party vehicles are assumed to transition to EVs at a linear rate, from 0% in 2019 to 100% in 2035. h. ICE vehicles are assumed to be 25% efficient, while EVs are assumed to be 80% efficient. i. Electricity demand for Dart Phase 1 is 7,500 MWh/yr from 2022 onwards, increasing at 1%/yr between 2027 and 2030. j. Electricity demand for Dart Phase 2 is 5,000 MWh/yr from 2032 onwards, remaining constant at this rate. k. Electrical heating demand for the new office and hotel space assumes counterfactual annual gas demands of 97 and 260 kWh per square metre respectively; it further assumes gas boiler efficiency of 85% and heat pump CoP of 3.0. All heating in the office and hotel is electric from the outset. l. Electrical heating demand for the New Century Park office, warehouse and hotel assumes counterfactual annual gas demands of 97, 103 and 260 kWh respectively, with gas boilers assumed to be 85% efficient and heat pumps operating with a CoP of 3.0. m. PV installed on car parks assume 2kW of panels per space open to the sky. Annual generation is assumed to be 820 kWh/kWp to 2038, 830 kWh/kWp from 2039 to 2042, and 830 kWh/kWp from 2043 onwards. n. PV installed on roofs assumes 40% of roof space is available for PV, with 1kW for every 1.6 square metres of available space. Annual generation is assumed to be 850 kWh/kWp for all roof-mounted PV.
Surface access journeys	Surface Access Modelling Inputs for Greenhouse Gas Assessment have been provided by the Applicant's transport planners (Ref. 20). Emissions from surface access journeys for passengers and staff have been carried out using the same methodology as for the DM Baseline scenario described above.

Activity	Methodology
	Surface access data were provided by transport planners to 2043; beyond this date it is assumed that the modal split for 2043 remains constant, which is also a conservative assumption. The surface access assessment beyond 2043 does take account of a shift from petrol and diesel engine cars to EVs, and of the ongoing decarbonisation of the UK electricity grid.
Air traffic movements	Future ATM data (Ref. 21) was provided by the Applicant's aviation planners for each year from 2023 to 2043 for the "Core Case" – this is the Do Something scenario. Emissions calculations for the Do Something scenario have been carried out using the same methodology as for the 2019 Baseline described above. The data provided takes account of improved energy efficiency for future models of aircraft in the fleet mix, where known, and also of the impact of current carbon pricing policy on passenger demand. ATM data are provided for the period to 2043. Beyond this date, it is assumed that the projected fleet mix and world region split for 2043 remain constant to 2050; this is a conservative and precautionary assumption as it is very likely that further improvements to aircraft engine efficiency will be achieved during this period.

Emissions factors

2.3.7 Calculations for surface access journeys and ATMs for the Do Something scenario have been carried out using the same emissions factors as for DM scenario, which are listed in **Table 2.4**.

3 EMISSIONS CALCULATIONS

3.1.1 This section provides a breakdown of emissions for construction and operation (including airport operations, surface access, and ATMs) for each year, for the DM Baseline and the Do-Something DCO scenarios.

Operations – DM Baseline

3.1.2 GHG emissions arising from the operation of the Proposed Development for the DM Baseline scenario have been presented in **Table 3.1**.

Table 3.1 DM Baseline: Operational GHG emissions (tCO_2e)

	Reporting category				
Year	Airport operations	Surface access	ATMs (LTO)	ATMs (CCD)	Total
2025	11,823	170,113	149,266	940,807	1,272,009
2026	12,483	168,567	147,195	922,793	1,251,038
2027	11,658	166,866	145,157	905,093	1,228,774
2028	10,490	165,129	144,451	900,891	1,220,961
2029	9,923	163,283	143,768	896,974	1,213,948
2030	9,712	161,064	143,077	892,932	1,206,785
2031	9,545	158,855	142,689	888,329	1,199,418
2032	9,068	156,749	141,993	884,334	1,192,144
2033	8,688	154,675	141,288	880,289	1,184,940
2034	8,490	152,654	140,619	876,463	1,178,226
2035	8,325	150,672	139,926	872,491	1,171,414
2036	8,224	148,691	139,219	868,436	1,164,570
2037	8,117	146,808	138,884	863,306	1,157,115
2038	7,969	145,063	138,551	858,261	1,149,844
2039	7,889	143,375	138,216	853,131	1,142,611
2040	7,918	141,720	138,214	853,117	1,140,969
2041	7,881	139,955	138,214	853,117	1,139,167
2042	7,822	138,364	138,214	853,117	1,137,517
2043	7,727	136,874	138,210	853,090	1,135,901
2044	7,702	136,192	138,210	853,090	1,135,194
2045	7,691	134,981	138,210	853,090	1,133,972

	Reporting category				
Year	Airport operations	Surface access	ATMs (LTO)	ATMs (CCD)	Total
2046	7,665	133,847	138,210	853,090	1,132,812
2047	7,605	132,746	138,210	853,090	1,131,651
2048	7,573	131,698	138,210	853,090	1,130,571
2049	7,549	130,697	138,210	853,090	1,129,546
2050	7,534	129,742	138,210	853,090	1,128,576
Total	**227,071**	**3,839,380**	**3,654,622**	**22,688,600**	**30,409,673**

Construction – DS DCO Embedded

3.1.3 GHG emissions arising from the construction of the Proposed Development for the DS DCO Embedded have been presented in **Table 3.2** for each year of the Proposed Development.

Table 3.2 DS DCO-embedded: construction GHG emissions (tCO_2e)

Phase	Year	Reporting category							
		Construction materials	Materials transport	Plant use	Energy use	Waste (including transport)	Land use change	Water and wastewater	Worker transport	Total
Phase 1	2025	12,580	5,796	28,013	239	624	15,801	68	1,234	64,292
	2026	10,591	3,459	28,013	119	624	15,801	68	1,303	59,912
	2027	1,530	748	28,013	33	624	15,801	68	997	47,746
Phase 2a	2033	35,805	8,251	64,762	149	1,150	40,487	185	1,510	152,116
	2034	35,011	8,662	64,762	127	1,150	40,487	185	2,064	152,272

Phase	Year	Reporting category								
		Construction materials	Materials transport	Plant use	Energy use	Waste (including transport)	Land use change	Water and wastewater	Worker transport	Total
	2035	42,300	11,043	64,762	128	1,150	40,487	185	2,926	162,808
	2036	27,031	6,435	64,762	89	1,150	40,487	185	2,280	142,249
Phase 2b	2037	2,144	2,881	48,459	29	724	8,552	72	1,220	64,021
	2038	12,922	4,356	48,459	42	724	8,552	72	1,703	76,761
	2039	15,947	3,863	48,459	71	724	8,552	72	1,764	79,388
	2040	18,088	4,053	48,459	45	724	8,552	72	874	80,804
	Total	**213,946**	**59,547**	**536,924**	**1,071**	**9,372**	**243,559**	**1,233**	**17,875**	**1,082,369**

Operation – DS DCO Embedded

3.1.4 GHG emissions arising from the construction of the Proposed Development for the DS DCO Embedded have been presented in **Table 3.3** for each year of the Proposed Development.

Table 3.3 DS DCO-embedded: GHG emissions (tCO_2e)

			Reporting category		
Year	**Airport operations**	**Surface access**	**ATMs (LTO)**	**ATMs (CCD)**	**Total**
2025	12,545	191,220	162,328	1,019,510	1,385,603
2026	13,215	194,694	164,919	1,024,551	1,397,379
2027	13,018	197,835	167,493	1,036,671	1,415,017
2028	12,809	195,156	166,243	1,031,140	1,405,348
2029	14,319	192,380	165,027	1,025,587	1,397,313
2030	12,723	189,205	163,780	1,019,335	1,385,043
2031	11,194	186,081	162,857	1,012,227	1,372,359
2032	10,268	183,111	161,597	1,005,169	1,360,145
2033	9,694	180,214	160,322	997,585	1,347,815
2034	9,171	177,412	159,053	989,630	1,335,266
2035	8,539	174,688	157,750	981,001	1,321,978
2036	7,306	172,000	156,430	971,912	1,307,648
2037	6,526	187,578	171,258	1,113,479	1,478,841
2038	5,823	195,063	179,755	1,215,714	1,596,355
2039	5,587	206,973	191,834	1,339,665	1,744,059
2040	5,474	212,000	198,406	1,411,550	1,827,430
2041	5,115	219,701	207,571	1,502,463	1,934,850
2042	4,901	228,987	217,927	1,601,780	2,053,595

			Reporting category		
Year	**Airport operations**	**Surface access**	**ATMs (LTO)**	**ATMs (CCD)**	**Total**
2043	3,154	234,144	224,584	1,675,505	2,137,387
2044	3,125	233,065	224,584	1,675,505	2,136,279
2045	2,904	231,151	224,584	1,675,505	2,134,144
2046	2,637	229,358	224,584	1,675,505	2,132,084
2047	2,554	227,617	224,584	1,675,505	2,130,260
2048	2,519	225,959	224,584	1,675,505	2,128,567
2049	2,430	224,377	224,584	1,675,505	2,126,896
2050	2,229	222,866	224,584	1,675,505	2,125,184
Total	**189,779**	**5,312,836**	**4,911,217**	**33,703,005**	**44,116,837**

GLOSSARY AND ABBREVIATIONS

Term	Definition
ATM	Air Transport Movement
BEIS	Department for Business, Energy & Industrial Strategy
CCD	Climb-Cruise-Descend
DCO	Development Consent Order
DM	Do-Minimum Scenario
DfT	Department for Transport
DS DCO Embedded	Do-Something DCO scenario with embedded mitigation
EEA	European Environment Agency
EMEP	European Monitoring and Evaluation Programme
LTO	Landing Take-off cycle
MPPA	Million Passengers Per Annum
NRMM	Non-Road Mobile Machinery
TAG	Transport Analysis Guidance
T&D	Transmission and Distribution

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