

## Appendix 5 Construction Energy Assessment Calculations

Construction energy is rarely monitored and as a consequence there are very little complete and rigorous historic data sources on which to base an assessment. The construction energy calculation for the G2 Development has therefore been based upon the only relevant available data from Heathrow Terminal 5 (T5) extension. The T5 development is near completion so it provides up to date information of a substantive airport extension. BAA has recorded electricity and diesel fuel used in the process of construction. This is shown in Table A5.1 and A5.2.

**Table A5.1 Heathrow - T5 Electricity used for Construction**

<b>T5 Construction Electricity</b>	<b>Total</b>	<b>Total CO<sub>2</sub></b>
<b>Years</b>	<b>kWh</b>	<b>Tonnes</b>
Apr-03 to Mar-04	26,153,046	11,246
Apr-04 to Mar-05	28,255,456	12,150
Apr-05 to Mar-06	36,428,268	15,664
Apr-06 to Mar-07	50,000,979	21,500
<b>Total</b>	<b>140,837,748</b>	<b>60,560</b>

**Table A5.2 Heathrow T5 Diesel and Petrol used for Construction**

		<b>Ultra Low Sulphur Gasoline (ULSG) conversion for gasoline = 2.3154 kgCO<sub>2</sub>/litre Ref DEFRA</b>	<b>Ultra low Sulphur Diesel (ULSD) conversion for diesel = 2.6304 kgCO<sub>2</sub>/litre Ref DEFRA</b>		<b>Total</b>	
		<b>Fuel type</b>	<b>CO<sub>2</sub> emissions</b>		<b>CO<sub>2</sub> emissions</b>	
<b>from</b>	<b>to</b>		<b>tonnes of CO<sub>2</sub></b>		<b>tonnes of CO<sub>2</sub></b>	
		<b>litres</b>		<b>litres</b>		
Sep-02	Mar-03	979320	2268	41353	109	2376
Apr-03	Mar-04	7998755	18520	821292	2160	20681
Apr-04	Mar-05	5065805	11729	925642	2435	14164
Apr-05	Mar-06	3776711	8745	880017	2315	11059
Apr-06	Mar-07	2518377	5831	636070	1673	7504
<b>Total</b>			<b>47093</b>		<b>8692</b>	<b>55785</b>

In order to estimate the G2 construction energy and the associated CO<sub>2</sub> emissions an extrapolation was made from the T5 data. To extrapolate from the T5 data the construction parameters were compared for each development, see Table A5.3 and Table A5.4.

**Table A5.3 Comparison of built areas**

<b>Comparison of T5 and SG2 quantities</b>	<b>T5</b>	<b>SG2</b>	<b>Factor</b>
Built area - fitted out space m2	344000	413000	1.20
Stands and aprons	56	65	1.16

**Table A5.4 Comparison of Bulk Quantities**

<b>Bulk quantities</b>	<b>T5</b>	<b>SG2</b>	
			<b>Extrapolation Factors F(concrete)</b>
Structural concrete m3	945000	2067816	
PQ concrete m3	335000		
ref BAA T5 data			
Total Structure & PQ Concrete	1280000	2067816	1.62
<b>Bulk quantities</b>	<b>T5</b>	<b>SG2</b>	<b>F(concrete)</b>
Earthworks	9100000	8680000	0.95

Ref Construction Methodology

Extrapolation factors have been derived on the basis of built areas, bulk materials and quantity of earthworks. The factors have been weighted differently for each energy type as can be seen in Table A5.5.

**Table A5.5 Weighted Extrapolation Factors for Construction Energy**

<b>Factors for extrapolation of G2 Construction Energy from T5 data</b>		<b>Extrapolation Factors</b>
F(diesel emissions)	40% F(concrete) + 40%F(earthworks)+ 20% F(built area)	1.27
F(electrical emissions)	20% F(concrete) + 20%F(earthworks)+ 60% F(built area)	1.23

The extrapolated data for G2 is shown in Table A5.6

**Table A5.6 Construction CO<sub>2</sub> Emissions Forecast**

<b>Construction Emissions Forecast</b>		
Electricity	<b>T5</b>	<b>G2 forecast=</b> T5 x F(electrical emissions)
	Tonnes of CO <sub>2</sub>	Tonnes of CO <sub>2</sub>
<b>Total</b>	<b>60,560</b>	<b>75,361</b>
Diesel/Petrol	<b>T5</b>	<b>G2 forecast =</b> T5 x F(diesel CO <sub>2</sub> emissions)
	Tonnes of CO <sub>2</sub>	Tonnes of CO <sub>2</sub>
<b>Total</b>	<b>55,785</b>	<b>70,847</b>

**Table A5.7 G2 Airport Development Phased Construction**

Source: Construction Methodology (Appendix 2, Volume 1)

Phase	Total Passenger Capacity mppa	Earth-works	Infrastructure	Surface access	Airfield	Airfield Infrastructure	Terminal	Commercial Developments	Const Emissions % of Total
Phase 1 Jan 2011 to 2015	45mppa	Majority of earthworks, landscaping and bunding will be completed in Phase 1	Extension of existing water distribution system. New 132kV Electricity supply. Construction of Waste Management facility. Ground-coupled heat pump 500 piles constructed. Aviation fuel storage tanks and distribution system.	Local road Diversions connecting with M11. Terminal 2 forecourt construction. Coach and Bus Station. Surface level Car Parking 10,300 spaces	New Runway constructed to its full length. Two new Taxi ways connecting with existing airfield plus a single new parallel taxi-way adjacent to new runway. 54 new passenger stands, 1 cargo stand and 4 long stay stands. Piers 5&6 will be completed in phase 1.	Airside fire station, Air traffic control tower. Airfield operations building. Approach Lighting. Control posts. Enlarged Sanitation and fuel facility. Enlarged snow-base facility. Modified fire training ground. Navigational systems. Perimeter Track and rendezvous Point. Surface movement radar. Fire training ground	Phase 1 will provide a terminal building to handle 15mppa 42,000m2 but fitted out initially for 10mppa (33,840m2	Hotels - one full service Hotel 400 bedrooms. One new Maintenance Hangar. One new Cargo transit shed. General Aviation Hangars. Freight, industrial and catering facilities - 29,000m2	80%

Phase	Total Passenger Capacity mppa	Earth-works	Infrastructure	Surface access	Airfield	Airfield Infrastructure	Terminal	Commercial Developments	Const Emissions % of Total
Phase 2 2017	50mppa	Neutral cut and cover. Localised landscaping	Extension of existing Potable Water distribution system. Main incoming 132kV substation to be completed. GCCHP additional 250 piles added (Total 750 piles)	Northern access road development. Forecourt Terminal 2 completed. Coach and Bus Station completed. Surface Level Car Parking 2,700 spaces	Main Runway width extended. Taxiways on NE edge and second parallel taxi way to be completed. New taxiway to serve Pier 7. 50% of Pier 7 and 7 new passenger stands and one cargo stand associated with Pier 7	Airside infrastructure to support new stands	Complete fit-out of Terminal 2 to increase capacity to 15mppa	The commercial developments will be demand led. Hotel full service Hotel adjacent to Terminal 2 up to 550 bedrooms. 2/3 new Hotels in the CTA area providing 1000 rooms plus conference facility. New service station on North side. Cargo 255 of a second Cargo transit shed to be constructed	2.5%
Phase 3 2021	55mppa	Neutral cut and cover. Landscaping associated with local roads	Extension of existing Potable Water distribution system. GCCHP additional 250 piles added (Total 1250 piles)	Surface Level Car Parking 4,850 spaces	Extension of Taxi-way that serves Pier 7. 3 new passenger stands in Pier 7	Airside infrastructure to support new stands	Extend Terminal 2 for 20mppa increasing floor area by 18,100m <sup>2</sup>	The commercial developments will be demand led. One new Hotel in Fen Area 300 bedrooms. 50% of Second cargo transit shed. Freight, industrial facilities 37,000m <sup>2</sup> . One new office block 7000m <sup>2</sup>	2.5%
Phase 4 2024	60mppa	Neutral cut and cover. Landscaping associated	Extension of existing Potable Water distribution	Surface Level Car Parking and of decked and multi- storey car	Second parallel Taxi-way to be completed. 50% of Taxiway to	Airside infrastructure to support new stands	Extend Terminal 2 for 25mppa increasing floor	The commercial developments will be demand led. One new Hotel in	5%

Phase	Total Passenger Capacity mppa	Earth-works	Infrastructure	Surface access	Airfield	Airfield Infrastructure	Terminal	Commercial Developments	Const Emissions % of Total
		with commercial local roads	system. GCCHP additional 250 piles added (Total 1000 piles)	park development in CTA area 5,100 spaces	Serve Pier Apron 8. Rapid exit Taxi-way to serve 23L Runway. New passenger stands constructed in Pier 8. 50% of Pier 8 to be completed		area by 17,500m2	Fen Area 300 bedrooms. 75% of Second cargo transit shed. Freight, industrial facilities 44,000m2. 50% of office development adjacent to Endeavour House 7000m2.	
Phase 5 2028	68mppa	Neutral cut and cover. Landscaping associated with commercial local roads	Extension of existing Potable Water distribution system and foul drainage systems. GCCHP additional 250 piles added (Total 1250 piles)	Decked and multi- storey car park development in CTA area 8,200 spaces	Taxi-ways to serve Pier 8	Airside infrastructure to support new stands	Terminal 2 increased to handle 33mppa adding 18,100m2 of gross floor area	The commercial developments will be demand led. One new Hotel in Fen Area 300 bedrooms and one new Hotel in Northside providing 300 bedrooms. 100% of Second cargo transit shed. Freight, industrial facilities 52,000m2. 50% of office development adjacent to Endeavour House 7000m2. Retail logistic centre in Northside area 2500m2 and 9 lorry loading bays	10%

The construction emissions have therefore been phased in accordance with the construction activity this is reflected in Table A5.8.

**Table A5.8: Construction Emissions over a Phased Construction programme**

<b>G2 Construction Electricity</b>					
<b>tonnes of CO<sub>2</sub></b>		<b>77,546</b>			
<b>G2 Construction Diesel/Petrol</b>					
<b>tonnes of CO<sub>2</sub></b>		<b>70,847</b>			
	<b>Phase 1</b>	<b>Phase 2</b>	<b>Phase 3</b>	<b>Phase 4</b>	<b>Phase 5</b>
	<b>2015</b>	<b>2017</b>	<b>2021</b>	<b>2024</b>	<b>2028</b>
Electricity	80% of total	2.50%	2.50%	5%	10%
	62037	1939	1939	3877	7755
Year 1	11415	969	485	1280	1939
Year 2	12345	969	485	1280	1939
Year 3	15944		485	1280	1939
Year 4	21837		485		1939
Year 5	496				
Diesel/Petrol	80% of total	2.50%	2.50%	5%	10%
	56677	1771	1771	3542	7085
Year 1	2437	886	443	1169	1771
Year 2	21197	886	443	1169	1771
Year 3	14396		443	1169	1771
Year 4	11222		443		1771
Year 5	7595				

### **Construction Energy for G1**

The expansion of the Single Runway Airport to 35 million passengers a year, G1 development, has an associated construction programme of the Terminal extension, hotels, retail etc. The energy used in the G1 construction process has been estimated on the basis of the built areas, airside areas and car park areas of the G2 and G1 developments; see Table 5.9. The factors used for extrapolation of the G2 Construction energy for G1 development are summarised in Table A5.10. This construction energy has been phased over the period of 2008 to 2014 as shown in Table A3.2 in Appendix 3 detailing the calculation of the base case.

**Table A5.9 Comparison of Bulk materials of G2 and G1 and extrapolation factors for construction energy emissions**

<b>G1 Construction Energy</b>			
<b>Extrapolation Factors</b>	<b>G1</b>	<b>G2</b>	<b>F (extrapolate)</b>
	<b>m2</b>	<b>m2</b>	
Built Area (fitted out spaces)	131,502	413,000	0.32
Airside areas & ancillaries	91,100	388,000	0.23
Car Park Area	274,374	1716000	0.16
G1 Construction Energy in tonnes of CO <sub>2</sub>			

<b>G1 Construction Energy</b>			
<b>Extrapolation Factors</b>	<b>G1</b>	<b>G2</b>	<b>F (extrapolate)</b>
	<b>m2</b>	<b>m2</b>	
year			
2008	1000		
2009	3500		
2010	6000		
2011	6000		
2012	6000		
2013	6000		
2014	4200		
Total	32700		

**Table A5.10: Summary of G1 Construction Energy Emissions**

<b>Fdiesel/petrol= 60% Fairside areas+ 40% car parks+20% built areas</b>	
<b>Felectricity= 20% Fairside areas+ 20% Fcar parks+ 40% Fbuilt areas</b>	
<b>G1 Extrapolation factors to be applied to SG2 data</b>	
Fdiesel/petrol =	0.24
F electricity =	0.21
<b>G2 Construction Energy CO<sub>2</sub> emissions (tonnes of CO<sub>2</sub>)</b>	
Diesel/Petrol	70847
Electricity	77546
<b>G1 Construction Energy CO<sub>2</sub> emissions (tonnes of CO<sub>2</sub>)</b>	
Diesel/Petrol	16758
Electricity	15998
Total	32756