A Second Runway for Gatwick

Appendix

A11

Carbon

YOUR LONDON AIRPORT
Gatwick

Gatwick Airport Ltd

Carbon

441734R(01)

8TH MAY 2014

RSK GENERAL NOTES

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EXECUTIVE SUMMARY

This report provides an appraisal of the carbon emissions associated with the development of a second runway and associated facilities at Gatwick Airport (R2). The report provides information requested by the Airport's Commission (the Commission) in Module 8: Carbon of its Appraisal Framework, and explains how Gatwick's Updated Scheme Design (USD) for R2 responds to its carbon objective *to minimise carbon emissions in airport construction and operation*.

Gatwick Airport Ltd (Gatwick) has been recording its carbon footprint since 2008. Since then its total absolute Greenhouse Gas (GHG) emissions and GHG emissions per passenger have declined, despite an increase in total passenger numbers. Gatwick is committed to continuing to reduce its carbon footprint.

Gatwick's R2 Masterplan, Engineering Plans, Surface Access Strategy and Mitigation Strategies which form part of its USD demonstrate how carbon emissions would be minimised in the construction and operation of R2.

In terms of the operational phase of R2, Gatwick's USD incorporates a range of leading edge and innovative technologies and strategies that would minimise direct and indirect emissions whilst ensuring resilience to climate change. Whilst absolute levels of GHG emissions are predicted to increase, Gatwick's USD would lead to a reduction in emissions on a per passenger basis in 2040 and 2050 compared to the single runway in 2040. Key aspects of Gatwick's operational strategies to minimise carbon emissions include:

- An operationally efficient airfield layout;
- A Surface Access Strategy that would continue to underpin growth in passenger and staff public transport access and support wider sustainable travel patterns and low carbon modes of transport;
- Highly efficient building design, technology and management systems;
- Zero carbon energy strategy, including an integrated approach to managing airport energy, waste and water resources; and
- Although outside of Gatwick's direct control, Gatwick would also continue to work with the relevant air traffic control authorities to reduce emissions associated with aircraft flight paths, stacking and sub-optimal routing in the air.

In terms of the construction of R2, Gatwick considers that it is unrealistic at this early stage of the design and planning of R2 to produce an accurate quantitative assessment of the construction carbon emissions or to be too prescriptive of construction carbon mitigation. While high level estimates have been made by the Commission during Phase 1 of its work, the methodology and scope used is not known and thus difficult to use as a comparative figure. It is possible to qualitatively appraise likely construction carbon impacts of the shortlisted options based on the overall scale of facilities being developed and the likely level of complexity involved in the construction operations. In this regard the proposed site at Gatwick is predominantly greenfield land. Compared to options at Heathrow, demolition activities and related land clearance would be limited to a relatively small number of residential and commercial properties. Gatwick's proposal is also a relatively non-complex engineering project - it does not require the relocation and rebuilding of displaced major infrastructure or major tunnelling works, nor does it require the remediation and transportation of significant quantities of known and unknown historic landfill.

Gatwick's strategy to minimise construction carbon emissions would draw on experience of other major infrastructure projects such as the construction of the Olympic park in London. Key aspects of Gatwick's strategies to minimise carbon emissions would include:

- A Code of Construction Practice developed during the early planning stages to enable clear and achievable strategies and targets to be implemented (i.e. Construction Worker Transport Strategy, Construction Waste Management Strategy and a Sustainable Materials Strategy);
- Minimising embodied carbon emissions from concrete through a Sustainable Materials Strategy which specifies the use of low carbon concrete mixes and a Masterplan which minimises total concrete in the design of R2;
- Utilising energy efficient and low carbon solutions during on-site operational activities and employing novel means of self-sustainability through the waste to biogas facility;
- A Construction Worker Transport Strategy which minimises the use of private vehicles and related traffic congestion;
- An innovative Construction Waste Management Strategy which optimises rates of re-use and recycling through the use of a concrete crushing plant; waste consolidation centre; site tanker/de-watering facility; and a construction consolidation centre.

The construction and operation of R2 fulfils the Commission’s carbon objective to minimise carbon emissions in airport construction and operation.

1 INTRODUCTION

1.1 Background and Aims

In September 2012, the Government announced the creation of an independent Airport Commission (the Commission) to advise on options for meeting the UK's international connectivity needs. In 2013 Gatwick Airport Ltd's (Gatwick's) proposal for a wide spaced runway at Gatwick Airport, capable of fully independent operations, was short-listed by the Commission for detailed appraisal.

This report has been prepared by RSK and forms part of Gatwick's Updated Scheme Design (USD) to the Commission. It assesses the carbon performance of Gatwick's second runway proposal and associated development (referred to in this report as 'R2') against Module 8: Carbon of the Commission's Appraisal Framework document and explains how Gatwick's USD responds to the Commission's carbon objective:

'To minimise carbon emissions in airport construction and operation'.

The Commission identifies five areas where carbon emissions may change as a result of an airport scheme:

- Increased airport capacity leading to a net change in air travel;
- Departure and arrival route changes through altered flight operations;
- Construction of new facilities and surface access infrastructure;
- Airside ground movements and airport operations; and
- Changes in non-aviation transport patterns brought about by a scheme's surface access strategy.

This report draws on other parts of Gatwick's USD. Its overall purpose is to:

i) Forecast carbon emissions for the operation of R2;
ii) Qualitatively asses the carbon impact of the construction of R2;
iii) Explain how Gatwick proposes to minimise carbon emissions in the construction and operation of R2; and
iv) Demonstrate how the proposal performs against the Commission's Appraisal Framework.

The net change in operational carbon emissions have been assessed relative to the current 'Baseline' carbon emissions (2012) and a Single Runway (R1) Base Case (2040).

The emissions forecasts for the Base Case have factored in assumed 'mitigation' which would be expected at Gatwick in 2040 regardless of R2 (i.e. general improvement in aircraft technology and energy efficiency improvements). In a number of respects however, R2 presents opportunities to reduce carbon emissions beyond reductions that would be expected if Gatwick was to remain a single runway/two terminal operation. Such reductions arise as a result of the opportunities the R2 development creates to improve sustainable surface access by airport passengers and airport employees, along with the introduction of new state of the art energy efficient facilities, which would not be secured within the airport's current infrastructure. This approach has been based on realistic and conservative estimates alongside detailed strategies for utilities (e.g. energy, waste and water use) and surface access.

Further additional carbon emission reductions, which are difficult to quantify and have therefore not been factored into the assessment calculations, are provided in Section 7.

Due to a lack of detailed design data at this early stage of the R2 proposal, a qualitative assessment of the scope and scale of carbon emissions associated with the construction phase has been carried out. However, we note the Commission's Phase 1 estimation of construction carbon emissions and provide some commentary on this.

The carbon impacts that are quantified in this report are based on Gatwick's Masterplan option for a new wide spaced runway to the south of the existing runway and with a new terminal between the runways. For aircraft to access the existing terminals from the proposed new runway, aircraft would have to taxi across the existing runway. Gatwick's Masterplan submission also identifies a possible alternative solution which includes taxiways around the ends of the existing runway (End Around Taxiways, EATs), which would reduce or eliminate the need for aircraft to cross the existing runway. Appendix C of this report summarises how the alternative option with end around taxiways would affect the results of the appraisal.

It should be noted that the modelling results presented in this report reflect air traffic and passenger forecasts based on the assumption that with R2, Gatwick would grow to serve 83mppa in 2040 and 95mppa in 2050, with annual air transport movement of 496,214 and 559,231 respectively.

1.2 Terminology

Carbon modelling forecasts have been made using the following assessment scenarios:

Baseline ~ Refers to the latest complete (2012) operational carbon footprint which represents the current status of the airport.

Base Case (2040) ~ Refers to the single runway (R1) airport in the 2040 assessment year with current infrastructure and growth of the airport to serve some 45 million passengers per annum (mppa).

R2 (2040) ~ Refers to the expansion of the current airport, which includes the new second runway and its associated terminal and ancillary buildings for the 2040 assessment year (83mppa).

R2 (2050) ~ Refers to the expansion of the current airport, which includes the new second runway and its associated terminal and ancillary buildings for the 2050 assessment year (95mppa).

1.3 Structure of Report

This report is structured as follows:

Section 2 provides a review of the relevant policy and regulatory context regarding carbon emissions in the UK and its implications for Gatwick and the second runway proposal.

This is followed in Section 3 by a description of Gatwick's current approach to carbon management, including recent initiatives, schemes, and performance that have facilitated a continual reduction in carbon emissions since 2008, as well as strategies and goals to encourage and deliver further improvement in years to come.

Section 4 describes Gatwick's second runway proposal in greater detail with regards to its impact upon carbon emissions for both the construction and operational phases of the development.

Section 5 details the appraisal methodology for both operational and construction carbon emissions, including data availability; reporting standards applied; scope of assessment and emissions sources; along with key assumptions used. A detailed breakdown of assumptions is presented in Appendix A, while emissions factors applied for carbon forecasting are presented in Appendix B.

Section 6 provides a breakdown of operational carbon emissions for the second runway in 2040 and 2050 compared against the Base Case (2040). Results have been displayed in terms of total absolute GHG emissions, and GHG emissions per passenger (PAX). This section also provides a qualitative assessment of the construction carbon emissions of R2, providing an appraisal of the expected emissions sources and activities and their implications upon the carbon impact of the development.

Gatwick's plans to mitigate carbon emissions are provided in Section 7, covering both operational and construction phase emissions.

2 POLICY AND REGULATORY CONTEXT

Gatwick's second runway proposal would be developed within the context of the changing policy and legislative framework for carbon emissions in the UK.

2.1 Climate Change Act 2008

The Legislative framework for reducing greenhouse gas emissions has been detailed in the Climate Change Act 2008. The Act set out a legally binding target to reduce overall UK emissions by at least 80% below 1990 levels by 2050. The Climate Change Committee's (CCC) current assessment of how this target can be met assumes that gross CO_2 emissions from UK aviation in 2050 should not exceed 2005 levels. In order to meet this goal the government have introduced National Carbon Budgets (NCB) which restrict total amount of greenhouse gas emissions the UK can emit over a 5 year period. Due to limits posed by the NCB's, it is accepted that emissions from other sources must be reduced in order to facilitate the capacity growth of a second runway and its resultant increase in total absolute emissions.

2.1.1 Low Carbon Transition Plan

Following the Climate Change Act, the UK Low Carbon Transition Plan was published in 2009 which detailed a strategy required to cut carbon emissions by 34% by 2020 (based on 1990 levels) in order to meet NCB's and facilitate meeting the long term target of 80% by 2050. In particular the plan highlights the use of low carbon energy generation, improved energy efficiency, and cleaner cars as key areas in order to reduce total UK carbon emissions.

While the UK's national carbon target for 2050 is clear, there is however some uncertainty surrounding the forecasting of the future carbon intensity of the national grid along with the implementation of renewable energy and nuclear power within the UK's future energy matrix.

2.2 Emissions Trading Schemes

2.2.1 EU ETS

With regard to the wider context of recognising global climate change, countries committed to the Kyoto Protocol such as the UK must meet emission reduction targets primarily though national measures. Coinciding with the Kyoto Protocol's commitment periods, the Emissions Trading System (EU ETS) has been developed as a market based mechanism to facilitate cost effective ways for reducing emissions by auctioning and trading 'allowances'.

A small element of Gatwick Airport's operations is regulated by EU ETS and hence the airport undergoes an annual verification audit as well as a requirement to monitor and report carbon dioxide emissions. As of 1st January 2012, aircraft operators are required to surrender one allowance for each tonne of carbon dioxide (CO_2) they emit during the reporting year. Currently the involvement of the EU ETS for aircraft operators is the subject of ongoing dispute between the EU and non-EU airlines.

2.2.2 CRC Energy Efficiency Scheme

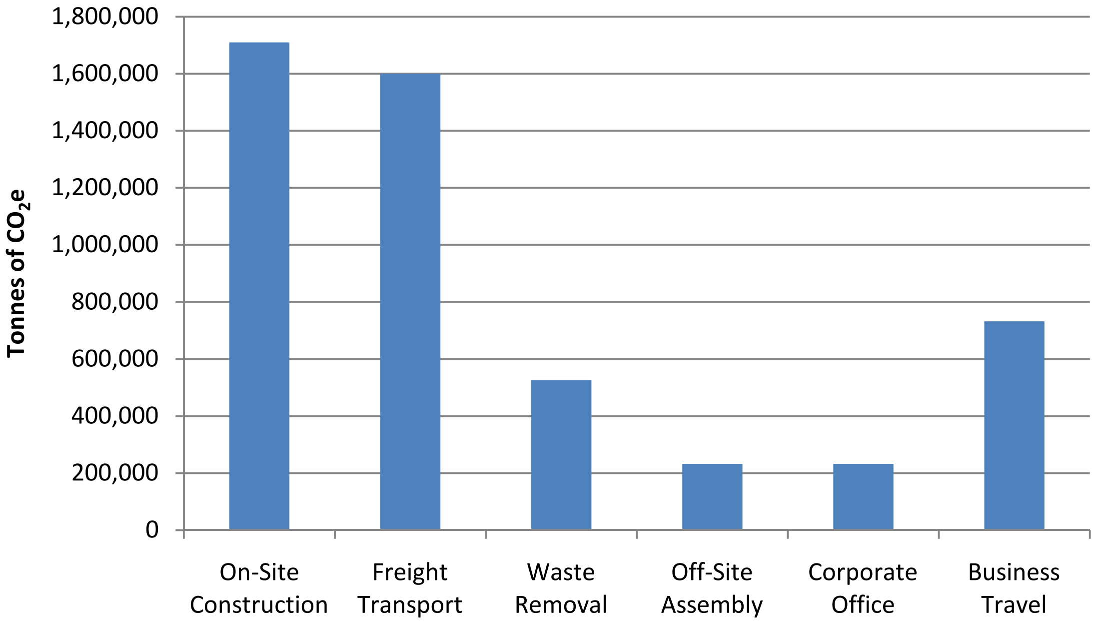
On a national level, the Carbon Reduction Commitment (CRC) Energy Efficiency Scheme is a UK mandatory emissions trading scheme designed to target emissions not already covered by the EU ETS with the aim of encouraging better understanding of energy use for large businesses whose annual half-hourly metered electricity consumption is above 6,000MWh. Due to the size of Gatwick's operation, the airport is obliged to participate in the CRC.

2.3 Construction Carbon Emissions

At present there is no uniformly accepted protocol for the collection and assessment of emissions from construction sites. Construction emissions (including manufacture and transport) contribute approximately 10% of UK carbon emissions; therefore such activities represent significant potential for helping achieve the government's climate change targets. However, in recent years a growing number of organisations and industrial bodies within the construction industry have become increasingly committed to and supportive of sustainable construction practice and minimising carbon emissions where possible. Current voluntary initiatives include the Strategy for Sustainable Construction, which in 2008 set a target of a 15% reduction in carbon emissions by 2012.

In 2010 The Strategic Forum for Construction produced a study which estimated the breakdown of carbon emissions associated with construction processes in England during 2008, as displayed in Figure 1. This gives an example of a typical UK emission profile for a construction development, which we could expect to be loosely reflective of Gatwick's R2 proposal.

Figure 1. Breakdown of Carbon Emissions (tCO_2e) from Construction Processes and Associated Transport in England During 2008



Source: The Strategic Forum for Construction, Carbon: Reducing the footprint of the construction process (2010).

According to this study, on-site construction activities and freight transport contribute the largest source of construction emissions, with 34% and 32% respectively. Business travel (15%) and waste removal (10%) also contribute a modest impact to total carbon emissions. This example is purely for reference purposes only and does not represent an accurate profile of construction carbon emissions for an airport development, nor does the study take account of the embodied carbon of materials or staff commuting. Additionally, due to the introduction of new and more innovative technology in future years, it could be expected that the emission profile displayed in Figure 1 may change considerably.

3 GATWICK'S CURRENT CARBON MANAGEMENT STRATEGY AND PERFORMANCE

Gatwick is committed to a low carbon future. To meet that commitment it already has in place a range of strategies and action plans which directly or indirectly contribute to reducing the airport's carbon emissions.

In recognition of Gatwick's demonstrable commitment to carbon management, Gatwick have gained the Carbon Trust Standard Accreditation and the ACI Airport Carbon Accreditation. As of April 2014, Gatwick has been officially re-certified for the Carbon Trust Standard, demonstrating continual and effective response to climate change through governance, carbon accounting and carbon management.

This section of the report briefly summarises the action plans and strategies being progressed by Gatwick. It then reports recent trends in Gatwick's carbon footprint which shows a continual decline in operational emissions since 2008.

3.1 Current Initiatives

3.1.1 S106 Legal Agreement

In 2008 Gatwick signed a S106 Legal Agreement with West Sussex Council and Crawley Borough Council to outline how the airports operation, growth and environmental impacts would be managed responsibly. An element of the strategy has been the development of a carbon vision. This is outlined in Gatwick's 2010 - 2020 'Decade of Change' sustainability strategy.

3.1.2 Decade of Change Strategy and Carbon Management Action Plan

In 2010 Gatwick published a 10 year sustainability strategy entitled 'Decade of Change', to ensure the airport continues to grow sustainably. Action plans and goals have been set across a number of economic, social and environmental issues, including carbon emissions, energy management and waste management as well as surface access. All of these strategies contribute directly or indirectly to reducing Gatwick airport related carbon footprint.

3.1.3 Carbon Management Action Plan

The Carbon Management Action Plan sets out a carbon vision for the airport that defines a low carbon roadmap for Gatwick. Its aims are to:

- Reduce carbon emissions by 50% by 2020 (total known CO_2 at 1990 baseline vs 2020 Scope 1 & 2 emissions); and
- Demonstrate commitment through investment in innovation, achieving accreditations and delivering compliance to relevant standards.

Gatwick aims to achieve its objectives and goals by:

- Engaging with airport employees and passengers to ensure they support Gatwick's approach;
- Working with business partners to deliver innovative work programmes;
- Working with government on new and emerging legislation; and
- Maintaining a strong relationship with the airport's key local authorities.

The results of the latest (2012) performance report, as shown in Figure 2 later in this section, highlights how the success of the strategy has facilitated a continual decline in operational emissions across Scopes 1, 2 and 3.

Efficiency improvements within the airport along with pioneering aircraft strategies such as Continual Climb Operations (CCO), Continuous Descent Approach (CDA), and the application of single-engine taxiing demonstrate Gatwick's commitment to meeting and exceeding aforementioned climate change goals.

3.1.4 Energy Management Action Plan

Gatwick's Energy Management Action Plan supports the reduced carbon emissions targets.

The Action plan includes targets to:

- Reduce energy consumption by 20% by 2020 (against 1990 baseline); and
- Source 25% of energy from renewable sources by 2020.

The success of this plan has been witnessed by a decline in energy use since 2006. In recent years this has been facilitated by the introduction of new Building Management Systems (BMS) and energy saving equipment to improve energy efficiency.

3.1.5 Construction Waste Strategy and Action Plan

Gatwick's Construction Waste Strategy and Action Plan was developed to ensure the most cost effective and environmentally sustainable management of construction waste. This has been designed to meet, and in parts exceed, aspirations set out by Defra in the Waste Strategy for England 2011, and complies with treatment requirements under the WRAP Quality Protocol of recovered materials from inert waste.

The plan adopts and follows the waste hierarchy which prioritises the most environmentally sustainable approaches to waste and resource management at Gatwick Airport, ensuring construction waste is dealt with to the highest possible standards.

The major objectives of this plan are to:

- Improve waste management procedures, with the goal of no untreated waste sent to landfill, along with achieving a 70% waste recycling rate by 2020; and
- Embrace innovation to drive improvements to waste management practices.

Current waste management practices at the airport have reached and exceeded the targets set in 2012 for recycling 95% of excavation waste, 95% of demolition waste and 90% of general construction waste, largely due to the reuse and recycling of concrete and asphalt on-site.

Improvements in waste management improve energy consumption profiles and reduce carbon emissions.

3.1.6 Sustainable Materials Strategy

Gatwick's Sustainable Materials Strategy aims to enable construction designers and teams to identify, source and use construction materials with a low embodied environmental impact across their manufacture, use and disposal. The strategy is applicable to those teams, individuals and suppliers who are responsible for the design of construction projects, and the specification and procurement of construction materials or components at Gatwick Airport. This has been facilitated by Gatwick's managed storage and processing area for re-use of construction materials on-site which has been in operation since the late 1990's.

3.1.7 Airport Surface Access Strategy

Developed in 2012, Gatwick's Airport Surface Access Strategy (ASAS) 2012-2030 for Gatwick looks at how people including passengers and staff travel to Gatwick and what transport infrastructure is needed for both current and future demand. The vision of the ASAS is to:

- Be the best connected and accessible UK airport, delivering integrated surface transport;
- Contribute to the sustainable economic growth of the local community and of the UK economy; and
- Lead the way for best practice in surface access strategies, with innovation at its core.

In response to this vision, Gatwick has already achieved its 2012 target of 40% public transport mode share for non-transfer passengers, with a further target of 45% now set.

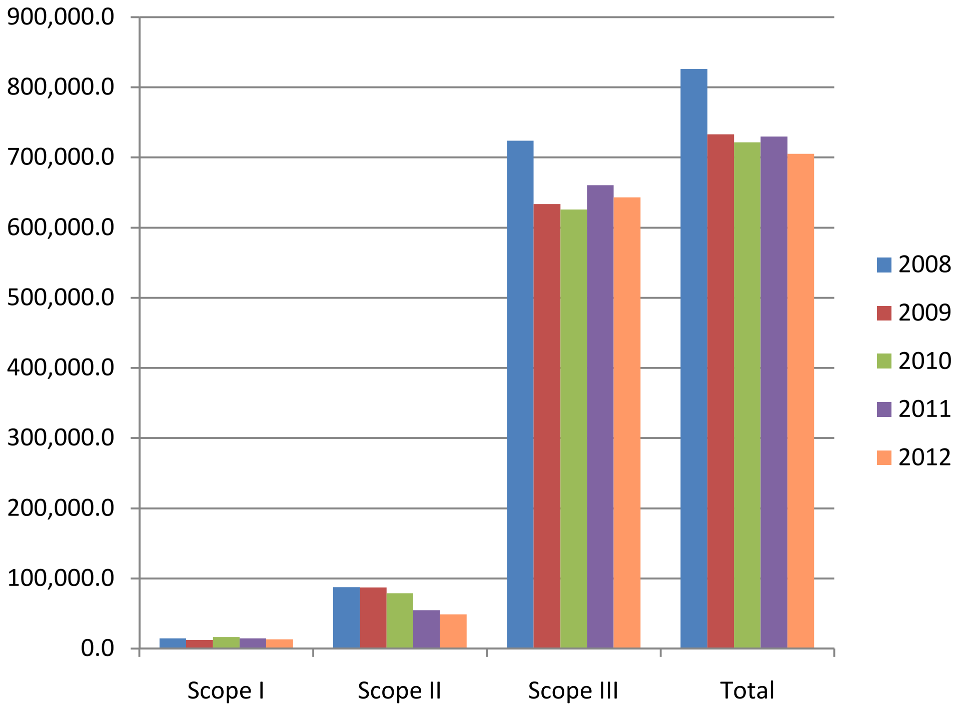
Emissions from passenger surface access contributed approximately 25% of Gatwick's 2012 carbon footprint; hence targeting these emission sources within Gatwick's USD surface access strategy would provide significant opportunity for further carbon emission reduction.

3.2 Gatwick's Current Carbon Performance

Gatwick have been recording the airport's annual carbon footprint since 2008 for Scopes 1, 2 and 3 in accordance with the Greenhouse Gas Protocol and related guidance.

As shown in Figure 2[1], Gatwick's total absolute carbon emissions have reduced by 14.6% between 2008 and 2012 (825,990 tCO2e in 2008 versus 705,113.8 tCO2e in 2012). This decline in carbon emissions has been facilitated by Gatwick's ongoing sustainability strategies such as its Carbon Management Action Plan and the other strategies and initiatives which also directly or indirectly reduce carbon emissions.

Figure 2. Comparison of 2008 to 2012 GHG emissions for Gatwick Airport (tCO_2e)



[1] Please note that carbon emissions displayed are not directly comparable due to changes in metering arrangements as well as annual fluctuations to emissions factors used.

Table 1 displays the airport's continuing reductions of GHG emissions per passenger (PAX) for all Scopes since 2008[2].

Table 1. GHG Emissions per Passenger since 2008 ($kgCO_2e$)

Scope	GHG Emissions per Passenger ($kgCO_2e$/PAX)				
	2008	2009	2010	2011	2012
Scope 1	0.48	0.38	0.53	0.43	0.39
Scope 2	2.90	2.70	2.52	1.63	1.32
Scope 3	23.95	19.58	19.95	19.62	18.80
Total	**27.33**	**22.67**	**23.00**	**21.69**	**20.61**

Results from the most up to date (2012) assessment are displayed in Table 2.

Table 2. 2012 Absolute GHG Emissions by Scope/ Source (tCO_2e)

Scope / Source	GHG Emissions (tCO_2e)
Scopes 1	13,202.5
Scope 2	48,824.2
Scope 3	643,087.1
Total	**705,113.8**
Of Which Aircraft Emissions	*393,659.5*

It can be seen in Table 2 that Gatwick's 2012 GHG emissions occur principally from Scope 3 (other indirect emissions) sources, relating to approximately 91% of total emissions. Scope 2 ''electricity (indirect) emissions'' is the next largest source at approximately 7%, followed by Scope 1 ''direct emissions'' which represents approximately 2% of Gatwick's total 2012 GHG emissions.

Aircraft emissions account for the majority of Scope 3 emissions (61%), followed by passenger surface transport (28%), Gatwick staff commuting (6%) and third party electricity (4%). Emissions from water & wastewater, waste, third party fuel & gas, and Gatwick business travel each account for less than 1% of Scope 3 emissions.

[2] Please note that carbon emissions displayed are not directly comparable due to changes in metering arrangements as well as annual fluctuations to emissions factors used.

4 PROPOSALS FOR SECOND RUNWAY

4.1 Overview

Gatwick has developed a Masterplan identifying the airport facilities that would be needed to increase passenger capacity up to some 95mppa in 2050. This includes the development of a second runway and associated taxiways and stands, a new ‘midfield’ terminal and piers, and a range of airside and landside ancillary facilities, collectively called ‘R2’. The development of R2 would have a carbon impact during its construction and operation.

4.1.1 Operational Carbon Emissions

This report quantifies the carbon impacts based on a new wide spaced runway to the south of the existing runway and with a new terminal between the runways. This scenario would require aircraft to taxi across the existing runway to access the existing terminals from the new runway. Gatwick's Masterplan submission identifies a possible alternative solution which would enable taxiing around the ends of the existing runway. This would reduce or even eliminate the need for aircraft to cross the existing runway. This alternative option, with End Around Taxiways (EATs), is summarised in Appendix C of this appraisal.

The modelling results presented in this report reflect air traffic and passenger forecasts based on the assumption that with R2 Gatwick would grow to serve 83mppa in 2040 and 95mppa in 2050, with annual air transport movement of 496,214 and 559,231 respectively.

During the operation of the airport, the greatest impact of the R2 proposal upon carbon emissions would be largely from Scope 3 emission sources, in particular from the aircraft Landing and Take-Off (LTO) cycle as a result of additional air traffic movements (ATM’s); along with the increased demand on surface access (both passenger and staff commuting) required to facilitate passenger capacity increase. Other Scope 3 emissions from R2 would arise from 3rd party energy/fuel use, water consumption, and waste. Direct emissions from fuel and gas (Scope 1), along with indirect emissions from electricity consumption (Scope 2), would also arise during the operation of the new terminal and related ancillary buildings.

Gatwick has developed innovative strategies for R2 which would support the objective of minimising carbon emissions during operation. These include:

- Airport Masterplan
- Surface Access Strategy
- Engineering Plans, including:
    - *Energy Strategy*
    - *Waste Strategy*
    - *Water Strategy*

4.1.2 Construction Carbon Emissions

The main factors influencing the construction carbon impact of the proposal include:

- On-site emissions from energy use and fuel burn in construction compounds, plant, machinery and vehicles;
- Embodied carbon – The cumulative release of carbon emissions along the entire materials supply chain: from mining, through production and processing, to manufacture and construction.
- Transportation of materials and construction worker transport to and from the site;
- Waste removal; and
- Associated off-site construction works such as improvements to passenger surface access.

Gatwick intend to reduce the carbon impact of R2 through detailed planning and engagement with constructors/architects/engineers in the early design stages in order to identify clear and achievable targets and strategies. At this early stage of the proposal the following strategies have been identified:

- Importance of design to minimise volume of materials used;
- Materials re-use and low carbon specification via a Sustainable Materials Strategy;
- Efficient operational practice on site to reduce emissions from plant and machinery;
- Reducing reliance on private cars by adopting a Construction Worker Transport Strategy to; and
- A Construction Waste Management Plan which minimises waste sent to landfill.

4.2 Gatwick's Carbon Objective

During the development by Gatwick of the USD for R2, including its Masterplan, Engineering Plans and Surface Access Strategy, Gatwick has taken into account the Commission's objective "***to minimise carbon emissions in airport construction and operation***". This has involved building upon Gatwick's wide range of current initiatives and track record for minimising construction and operational carbon emissions.

5 APPRAISAL METHODOLOGY

5.1 Operational Carbon Emissions

5.1.1 Data Collection

The latest calendar year (2012), for which Gatwick's carbon footprint assessment is complete, has formed the existing baseline to this assessment.

In order to forecast future emissions in 2040 and 2050, data (where available) has been provided by Gatwick's consultant team.

Where data has not been available or is incomplete, baseline figures from the 2012 carbon footprint have been factored accordingly to reflect predicted future scenarios, such as expected resource demands (i.e. fuel use). This has been conducted by taking account of variables such as an increase in ATMs and total passenger numbers, along with assumptions made by RSK. These assumptions have been based on a realistic approach by predicting trends in future scenarios whilst taking into account carbon mitigation measures which are embedded in the airport's operations now as well as those that are expected in the future. A summary of these measures and a distinction between embedded and additional mitigation is presented in Section 5.1.5.

Table 3 displays the origin of raw data that has been used as the basis for forecasting emissions in 2040 and 2050.

Table 3. Source of Raw Data for each Emissions Source

Scope	Emissions Source	Origin of Raw Data	USD Source Material
I	Gas consumption	Arup	Energy Report
	Fuel	RSK (2012 Baseline)	N/A
	Refrigerants	RSK (2012 Baseline)	N/A
II	Electricity consumption	Arup	Energy Report
III	3rd party gas consumption	Arup	Energy Report
	3rd party fuel	RSK (2012 Baseline)	N/A
	3rd party electricity	Arup	Energy Report
	Water and wastewater	CH2MHILL	Water and Flood Risk Report
	Waste	Helistrat & RSK (2012 Baseline)	Water Report
	Gatwick business travel	RSK (2012 Baseline)	N/A
	Gatwick staff commuting	Arup RSK (2012 Baseline)	Surface Access
	Passenger surface access	Arup & RSK (2012 Baseline)	Surface Access
	Aircraft LTO cycle	ICF SH&E & Ricardo-AEA	London Traffic Report and Air Quality

Table 4 displays the origin of key influencing variables that have been used in this assessment.

Table 4. Source of key Influencing Variables

Variable	Origin of Raw Data	USD Source Material
No. of ATMs	ICF SH&E	London Traffic Report
No. of passengers	ICF SH&E	London Traffic Report
No. of staff	ICF SH&E	London Traffic Report
Aircraft fleet mix data	ICF SH&E	London Traffic Report
Aircraft taxi in and hold times	Ricardo-AEA	London Traffic Report

Appendix A gives a full breakdown of the assumptions used for each emissions source.

5.1.2 Reporting Standards Applied

Although no formal standards exist for assessing and reporting airport Greenhouse Gas Emissions (GHG), this assessment has been undertaken in accordance with the *Greenhouse Gas Protocol Corporate Standard; Revised Edition; World Resources Institute & World Business Council for Sustainable Development; March 2004'* and *'ISO 14064-1 Specification with guidance at the organisational level for quantification and reporting of greenhouse gas emissions and removals; 2006'.*

GHG assessments quantify all six Kyoto GHGs where applicable, and are measured in terms of tonnes of carbon dioxide (CO_2) equivalence (tCO_2e), where equivalence means having the same warming effect as CO_2 produced over a period of 100 years, which is commonly referred to as a Global Warming Potential (GWP). The six Kyoto gases as shown in Table 5 are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6) and perfluorocarbons (PFCs).

Table 5. The Kyoto Greenhouse Gases

Greenhouse Gas	Chemical Formula	GWP (CO_2e)
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous oxide	N_2O	298
Hydro fluorocarbons	HFCs	Depends on specific gas

Sulphur hexafluoride	SF_6	22,800
Perfluorinated compounds	PFCs	Depends on specific gas

This carbon forecasting assessment has been calculated using the latest (2nd December 2013) GHG emissions factors published by DEFRA/ DECC, along with assumptions made by RSK. Results have been broken down by Scopes 1, 2 and 3 for absolute GHG emissions and by intensity factor (per passenger and per air traffic movement).

Appendix B provides a full breakdown of the emissions factors used in this carbon forecasting assessment.

5.1.3 Emissions Sources

The above mentioned standards (Section 5.1.2) break down emissions sources into three categories or scopes based on a company's established organisational boundary. The current organisational boundary has been used since the 2009 carbon footprint assessment year and is maintained throughout all assessment scenarios in this report.

Scope 1 – 'Direct Emissions'

Scope 1 "direct emissions" relate to direct GHG emissions from sources owned or controlled by Gatwick, including:

- The generation of electricity, heat, or steam e.g. from the combustion of fuels in stationary sources (e.g. boilers);
- The transportation of materials, products, waste, and employees in company owned or controlled vehicles and plant; and
- Fugitive GHG emissions e.g. refrigeration gas losses from air conditioning systems.

Scope 2 – 'Electricity (Indirect) Emissions'

Scope 2 "electricity (indirect) emissions" are a special category of indirect emissions from the generation of purchased electricity or steam that is consumed in company-owned or controlled equipment or operations. Electricity purchased by Sofitel Hotel, where Gatwick has limited influence, is not therefore reported under this Scope. It should be noted, however, that Gatwick's Scope 2 emissions will include emissions from various tenants where no sub-metering is in place to quantify this tenant consumption. Quantifiable tenant electricity consumption is included within Scope 3.

Scope 3 – 'Other Indirect Emissions'

Whilst optional under the GHG Protocol, a range of Scope 3 GHG emissions have been included in this assessment (where appropriate activity data exists) in order to ensure a robust and comprehensive assessment and to identify opportunities for innovative GHG management. It should be noted that where these emissions sources are owned or controlled by Gatwick (e.g. where the transportation of products is undertaken using vehicles owned or controlled by the company) that these activities are included within Scope 1.

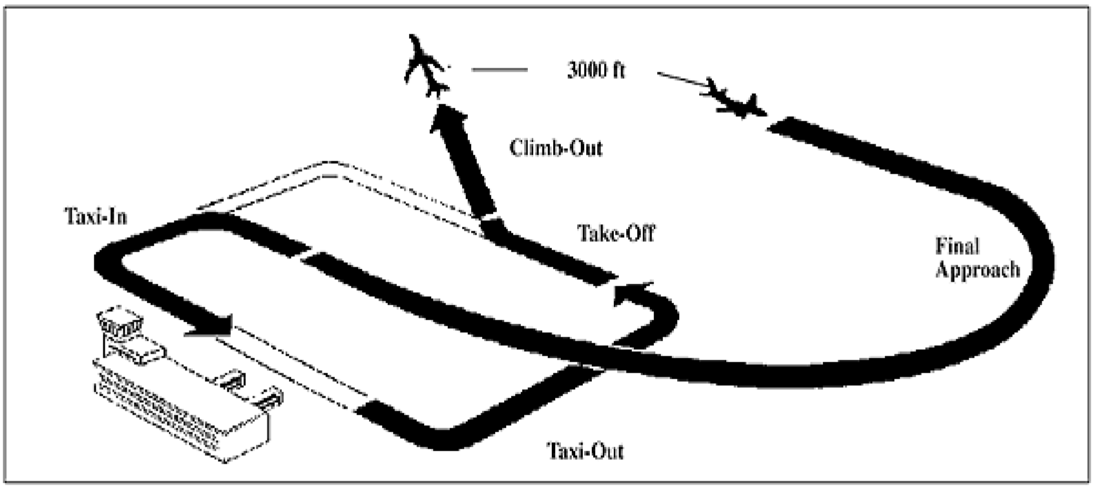
'Scope 3' emissions include:

- Aircraft landing and take-off, including aborted landings ('go-arounds');
- Passenger surface access;
- Gatwick staff commuting;
- Gatwick business travel;
- Waste;
- Third party electricity consumption;
- Third party fuel consumption;
- Transmission and distribution losses (T&D losses);
- Construction & maintenance activities;
- Third party vehicles & Ground Services Equipment;
- Water & wastewater; and
- Aircraft Auxiliary Power Units (APUs).

5.1.4 The ICAO Landing & Take-Off Cycle (LTO)

Emissions from aircraft movements have been modelled in accordance with the *International Civil Aviation Organization (ICAO) Landing & Take-Off cycle (LTO)* – as shown in Figure 3.

Figure 3. ICAO LTO Cycle



The LTO cycle includes flight activities near the airport that take place below the altitude of 3,000 feet (1,000m) including taxi in, taxi out, take-off, climb-out, and approach and landing. Emissions from aircraft above 3,000 feet including in the climb to cruise altitude, cruise, and descent from cruise altitude belong to the airlines rather than the airport under ICAO definitions and are excluded from the assessment.

The time in each phase of the LTO cycle has been multiplied by ICAO performance data to produce CO_2 emission numbers. To calculate emissions we have taken into account: prevailing wind direction 70:30 (west/east); projected industry performance data for new and modified aircraft; and various taxiing pathways. Hold times have been based on data provided by Gatwick. Taxiing speed has been assumed to be 10m/s to ensure commonality with other studies (e.g. ground noise assessment).

5.1.5 Key Assumptions

Existing Mitigation

As summarised earlier in this report, Gatwick already have a comprehensive approach to carbon management as evident in the 'Decade of Change' sustainability strategy and related Action Plans and Strategies. In addition, the aviation sector as a whole is continuing to find ways to reduce emissions through technological innovation. As such, actions and measures will continue to be brought forward at Gatwick irrespective of the plans for R2. The single Base Case (45mppa in 2040) would therefore have a reduced carbon impact per passenger in the future compared with the current carbon footprint, even allowing for a growth of passengers and aircraft operations on the single runway. Table 6 identifies continuing mitigations that are assumed would apply in the future to both the R1 Base Case and R2 Development case.

Table 6. Mitigation Assumed Within Carbon Calculations for Gatwick

Assumed Mitigation	
Aircraft	• Assumes a continuous upgrade of aircraft fleet would be implemented as outlined in the ICF SH&E air traffic forecasts • Assumes a 10% reduction in emissions during the taxi-in phase due to expected common practice application of 'engine off taxiing' by 2040 – This involves shutting off an engine when taxiing to and from the runway and hence reducing fuel burn. • Assumes all aircraft would minimise the use of their Auxiliary Power Units (APU's) through the maximisation of Fixed Electrical Ground Power (FEGP) when the aircraft is on the airport stand.
Surface Access	• Assumes that committed schemes (as of 2014) for surface access would be implemented as per design, such as Crossrail and Thameslink rail programmes; capacity enhancement of Brighton Main Line (rail); along with road improvements to the M25, M23, A23 and A24. • A 20% efficiency improvement for rail emissions is assumed due to the continued electrification of rail transport.
Energy	• Assumes energy efficiency improvements to current R1 buildings such as lighting, heat recovery and BMS would be incorporated by 2040.

Assumed Mitigation	
Fuels	• Assumes an increase in the use of efficient/ hybrid/ biofuel vehicles and plant on site would be made to reflect predicted industry best practice in 2040 - This is reflected in a 10% efficiency improvement for fuel use compared to the Baseline (2012).
Waste	• Assumes a continuation of ongoing initiatives in the 'Decade of Change' and hence no change to current (2012) waste management arrangements for R1 in 2040.
Water	• Assumes that design principles which are good practice now would become standard practice by 2040, and active leakage would decline over time due to improvement leakage management practice – This is reflected in a 5% water efficiency improvement for R1 Base Case (2040) projections compared to the Baseline (2012).
Refrigerant Gases	• Assumes use of refrigerant and air–conditioning gases would be limited to those with the lowest GWP rating, whilst ensuring refrigerant plants are efficient and leakage is minimized – This is reflected in a 10% efficiency improvement compared to the Baseline (2012).

A range of mitigation measures and initiatives not included in this forecasting assessment may at some point be implemented by Gatwick, such as those proposed for aircraft emissions in The Sustainable Aviation Carbon Road Map (2012).

Additional Mitigation as a Result of R2

Additional mitigation measures have been assumed within this report's calculations where the development of R2 is expected to have a fundamental impact upon the airport's operations which would not be expected under the Base Case (2040) conditions. These are shown in Table 7.

Table 7. Additional Mitigation Assumed Within Calculations (R2 Only)

Additional Mitigation Embedded Within R2	
Aircraft	• R2 layouts and airfield strategy would minimise taxi-in and taxi-out route lengths and minimise hold times.

Additional Mitigation Embedded Within R2	
Surface Access	• A 60% public transport share (50% rail & 10% bus/coach) for passenger surface access is assumed for the R2 scenario as per Gatwick's USD Surface Access Strategy which includes: new routes; more frequent services; and increased capacity; • A 40% public transport share (20% rail & 20% bus/coach) for staff commuting has been assumed for the R2 scenario as per Gatwick's USD Surface Access Strategy; and • The above improvements would be facilitated by major infrastructure changes within and around the airport boundary as a result of R2, such as the Gatwick Gateway - allowing seamless connectivity between transport modes.
Energy	• Electricity supply for R2 would be generated by on-site solar photovoltaics (PV) (3MW) and supplemented by grid electricity (11MVA); • Gas and heat supply for R2 would be supplied by an on-site biomass Combined Heat and Power (CHP) unit (3MWe), along with gas boilers (6MWe) fuelled by mains gas and biogas up to 1.5MWe; and • Assumes all R2 buildings would be designed and built to the latest standards of energy efficiency (i.e. efficient building envelope; passive design to reduce heat gains; and low energy lighting) and sustainability (i.e. BREEAM, CEEQUAL)
Water	• Where applicable, roof-based rainwater harvesting would be built into new buildings and used for toilet flushing and other non-potable requirements.
Waste	• A 75% (2040) and 80% (2050) recycling rates of operational waste are achieved due to enhanced airport recycling facilities.

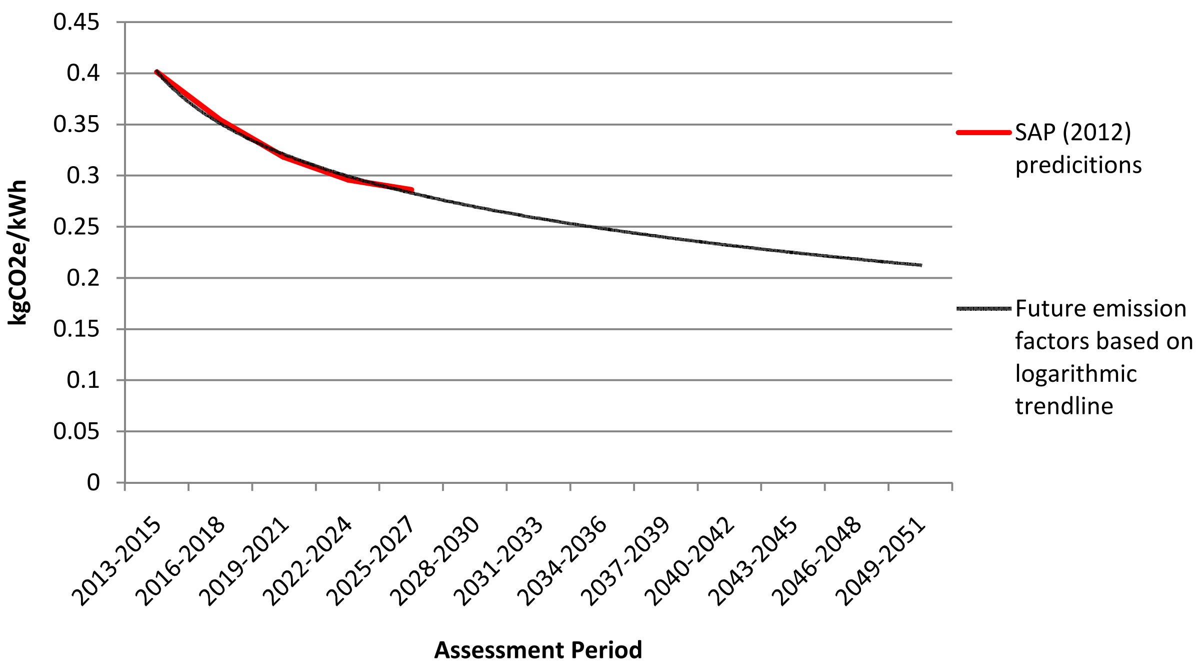
Further mitigation measures for R2 based on more innovative and state of the art solutions have been qualitatively assessed in Section 7. This includes measures that are outside of the conservative approach. A detailed description and appraisal of how such measures can be implemented and their potential to minimise carbon emissions is also provided. Gatwick will consider the viability of these opportunities once more detailed design data has been devised.

Carbon Intensity of Electricity

Due to the uncertainty surrounding the carbon intensity of the national electricity grid beyond 2023, there is some debate as to the extent and scale of further decarbonisation. The most up to date predictions for future electricity emission factors has been sourced from The Standard Assessment Procedure's (SAP) paper entitled 'Proposed Carbon Emission Factors and Primary Energy Factors'. This paper considers the extent to which emission factors should reflect changes in the fuel supply chain in the future, demonstrated by a series of 15 yearly average emission factors up to the year 2028. SAP is the methodology used by the Government to assess and compare the energy and environmental performance of dwellings and helps to set relevant policy initiatives. No other reputable sources predict the carbon intensity of grid electricity beyond this point, hence RSK have estimated future emission factors based on a logarithmic trend line of SAPs current predictions between 2012 and 2028. Some previous forecasts are considered to have been over optimistic with regards to the rate of decarbonisation of the grid supplied electricity.

A logarithmic trendline has been used as it follows the current rate of change and continues this trend throughout the assessment period. Between the years' of 2028 and 2050, RSK have assumed this rate of change will continue as depicted in Figure 4 by a continual decrease in carbon intensity, albeit at a decelerating rate over time.

Figure 4. Predicted Electricity Emissions Factor from 2012 to 2050



As can be seen in Figure 4, the predicted emissions factors for 2040 and 2050 which have been used in this assessment are as follows:

Electricity Intensity Factor

2040 ~ 0.275kgCO_2e/kWh

2050 ~ 0.220kgCO_2e/kWh

Electricity T&D Losses

The carbon intensity of transmission and distribution (T&D) losses within the national electricity grid have been assumed to follow the same rate of decline as predicted for electricity consumption.

2040 ~ 0.02365kgCO_2e/kWh

2050 ~ 0.01892kgCO_2e/kWh

Carbon Intensity of Water

Due to the influence of grid electricity in powering water distribution networks, the carbon intensity for water consumption has been assumed to follow the same rate of decline as predicted for electricity consumption:

2040 ~ 0.198kgCO2e/m^3

2050 ~ 0.189kgCO2e/m^3

A full breakdown of assumptions for each emissions source is displayed in Appendix A.

5.2 Construction Carbon Emissions

While high level estimates of construction carbon emissions have been made by the Commission during Phase 1 of its work, it is considered unrealistic to produce an accurate quantitative assessment of construction carbon emissions at this stage due to lack of data (i.e. origin of construction workers; how materials will be manufactured; origin and mode of material transportation; as well as the total volume of materials used).

A qualitative assessment is considered to be a more appropriate method based on an understanding of the overall size and complexity of the shortlisted developments and any specific known difficulties in construction. Section 6 provides an appraisal of the carbon emission sources and impacts associated with expected construction activities for R2 (On-site energy use; transport and distribution; waste; and off-site activity). Once more expansive design data (i.e volume of materials) becomes available, a quantitative assessment of carbon emissions would then be possible, in accordance with relevant methodologies such as the Environment Agency's Carbon Calculator tool. Reference is also given to initial forecasting estimates by the Commission for construction carbon emissions.

Section 7 provides an appraisal of how construction emissions would be minimised through design and mitigation solutions.

5.3 References

Principle Emission Factor References

- 2013 Guidelines to DEFRA / DECC's GHG Conversion Factors for Company Reporting (December 2013);
- Proposed Carbon Emission factors and Primary Energy Factors for SAP 2012, *Technical Papers Supporting SAP 2012*, SAP (2012).

Reporting Protocol References

- GHG protocol – A Corporate Accounting and Reporting Standard, April 2004;
- The DEFRA/DECC – Guidance for businesses and organisations on how to measure and report their greenhouse gas (GHG) emissions, August 2011.

Raw Data/ Consultant References

- Future aircraft fleet mix provided by ICF SH&E via 'Secondary Fleet Mix Forecasts for Gatwick Airport Ltd, 30 April 2014';
- Total staff numbers provided by ICF SH&E via 'Employee Forecast for Gatwick Airport Ltd' document, 30th April 2014';
- Total ATMs provided by ICF SH&E via '1.2 Ground Noise, Air Quality and Carbon Op 0,1,2,3, 2040,50' document, 30 April 2014;
- Total passenger numbers provided by ICF SH&E via 'Busy & day Option 1,2,3, 2030,40,50' document, 30 April 2014;
- Aircraft Taxi In & Hold Times provided by Ricardo-AEA via email on 5th June 2013;
- Electricity and gas consumption in kWh provided by Arup via email on 25th March 2014;
- Water consumption in cubic meters provided by CH2M HILL via email on 17th March 2014;
- Total waste tonnage provided by Helistrat via roundtable discussion at Gatwick Airport on 13th March 2014;
- Public transport share for non-transfer passengers and staff commuting provided by Arup via interim review presentation at Gatwick Airport on 13th March 2014.

6 ASSESSMENT OF SECOND RUNWAY

6.1 Operational Carbon Emissions

6.1.1 Absolute GHG Emissions

Based on the assumptions set out in Section 5, including the assumed mitigation measures for the R1 Base Case (2040) and the R2 2040 and 2050 cases, calculations have been made for absolute carbon emissions in Scopes 1, 2 and 3. These calculations are shown in Table 8 alongside the Baseline 2012 calculations.

It should be noted that the carbon impacts quantified in this report are based on Gatwick's Masterplan option that requires aircraft to taxi across the existing runway in order to access the existing terminal from the new runway. An alternative option in Gatwick's Masterplan, that uses EATs, is summarised in Appendix C of this report.

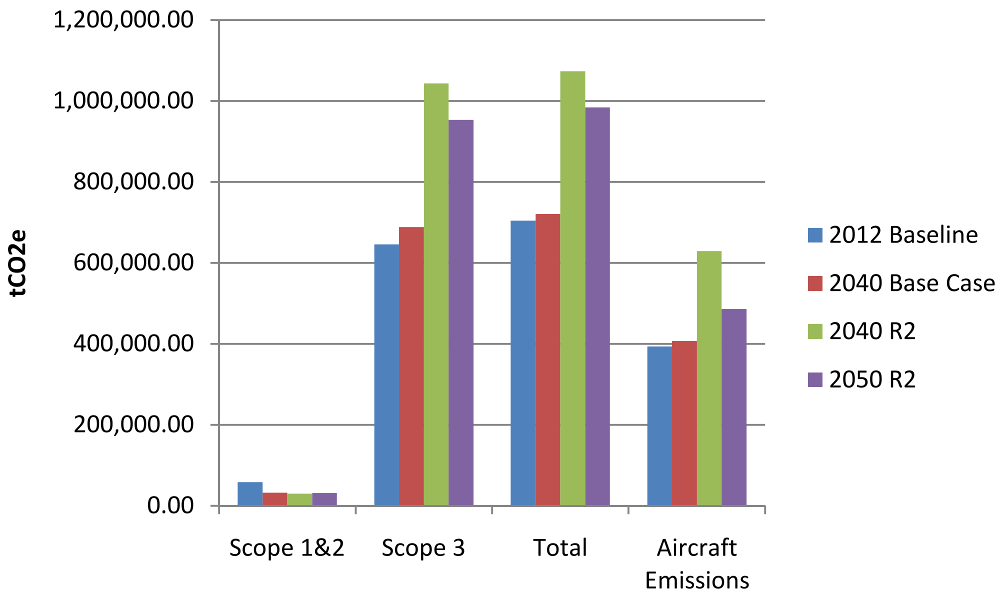
The carbon modelling results presented in this report for R2 are based on Gatwick's passenger and air traffic forecasts that assume Gatwick would grow to serve 85mppa in 2040 and 95mppa in 2050 with annual air transport movement of 496,214 and 559,231 respectively.

Table 8. Projected Breakdown of Absolute GHG Emissions (tCO2e) for R2

Emissions Scope & Source		Total Emissions (tCO_2e)			
		2012 Baseline 34 Million pax	2040 Base Case 45 Million pax	2040 R2 83 Million pax	2050 R2 95 Million pax
Scope 1	Gas	10,560.6	12,483.1	5,300.9	6,232.7
	Fuel	1,047.1	1,206.7	2,225.8	2,601.2
	Refrigerants	1,587.8	1,879.7	3,467.0	4,051.7
	Sub-total	**13,195.5**	**15,569.5**	**10,993.6**	**12,885.7**
Scope 2	Electricity Consumption	45,085.4	17,081.8	19,028.3	18,686.9
	Sub-total	**45,085.4**	**17,081.9**	**19,028.3**	**18,686.9**
Scope 1 + 2	**Sub-total**	**58,280.9**	**32,651.4**	**30,022.0**	**31,572.6**
Scope 3	3rd Party Gas	1,044.9	1,234.6	524.3	616.4
	3rd Party Fuel	5,114.8	5,881.5	10,848.1	12,677.9
	3rd Party Electricity	27,815.2	10,525.7	11,725.1	11,514.8
	Electricity – T&D Losses	3,855.0	1,469.0	1,634.6	1,607.1
	Water & Wastewater	665.8	813.7	1,377.6	1,241.9
	Waste	355.2	467.2	443.7	545.0
	Business Travel	71.2	115.5	145.8	159.0
	Staff Commuting	39,115.8	46,418.9	54,640.3	57,830.0
	Passenger Surface Access	174,105.3	214,830.9	332,695.4	380,796.0
	Aircraft	393,659.7	406,815.0	629,210.0	486,400.0
	Sub-total	**645,802.8**	**688,635.1**	**1,043,244.8**	**953,126.7**
	Total	**704,083.8**	**721,286.4**	**1,073,266.8**	**984,562.1**

Figure 5 displays a comparison of GHG emissions by Scope for both R2 scenarios against the Base-Case (2040) projection. (Note. Aircraft emissions are a sub-section of Scope 3 emissions).

Figure 5. Projected Total Absolute GHG Emissions (tCO2e) for the R2



As displayed in Table 8 and Figure 5, total emissions for both R2 assessment years show an increase from the Base Case (2040) scenario; a trend closely matched by total Scope 3 emissions. However both Scope 3 and total emissions are predicted to decline considerably between 2040 and 2050 for the second runway. This is predominantly due to the predicted decline in aircraft emissions due to the continuing evolution of aircraft engine and airframe technology, and the progressive retirement of older aircraft

Also within Scope 3, emissions from passenger surface transport rise in proportion with total respective passenger numbers, whilst emissions from staff commuting and business travel rise as total staff employed rises.

Scopes 1 and 2 show a similar decrease in emissions between the Baseline (2012) and all future projections for 2040 and 2050, due to improvements in fuel efficiency, energy efficient buildings as well as reduction in the carbon intensity of the national electricity grid. It is also apparent that despite the introduction of a second runway and related ancillary buildings, the operational carbon footprint of Gatwick's owned and controlled emissions (Scope 1) and electricity consumption (Scope 2) will in fact be less than that forecasted for the R1 Base Case (2040).

Table 9 displays the percentage contribution of overall GHG emissions for each scope and for each of the largest contributing sources.

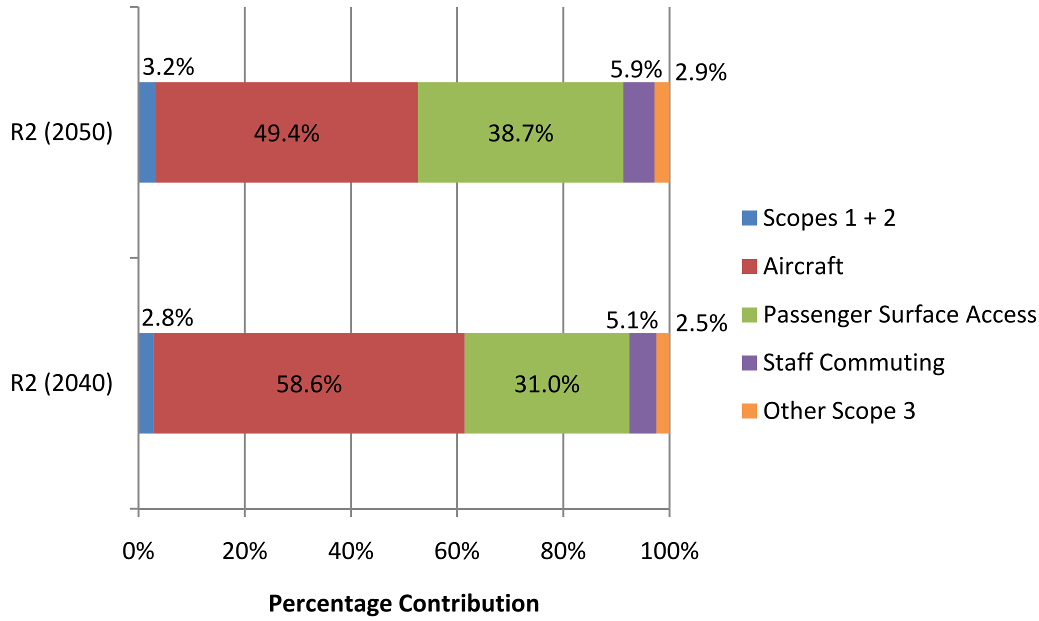
Table 9. Percentage Contribution of each Emission Scope and Largest Contributing Sources

Emissions Scope & Source	Percentage breakdown of total GHG Emissions			
	Baseline (2012)	Base Case (2040)	R2 (2040)	R2 (2050)
Scope 1	**1.9%**	**2.2%**	**1.0%**	**1.3%**
Scope 2	**6.4%**	**2.4%**	**1.8%**	**1.9%**
Scope 3	**91.7%**	**95.5%**	**97.2%**	**96.8%**
Aircraft emissions	55.9%	56.4%	58.6%	49.4%
Passenger surface access	24.7%	29.8%	31.0%	38.7%
Staff commuting	5.6%	6.4%	5.1%	5.9%

As seen in Table 9, Scope 3 contributes over 90% of total emissions in each assessment scenario, and increases between the Baseline (2012) and all future projections. The contribution of aircraft emissions shows a marginal increase between the Baseline (2012) and the second runway in 2040; however this then decreases significantly over the next ten years, contributing less than half of total emissions by 2050. In contrast, by 2050, emissions from transport related activities (passenger surface access and staff commuting) account for a much greater proportion of the Gatwick's total emissions profile. With a 10% rise in total passenger numbers between 2040 and 2050, emissions from surface access rise accordingly and thus represent a greater proportion of total emissions for R2 (31.0% in 2040 versus 38.7% in 2050).

Figure 6 further displays the changing profile of emissions for R2 in 2040 and 2050, most notably showing a decline in aircraft emissions and an increased contribution of emissions from passenger surface access. Scopes 1 and 2, along with the remaining Scope 3 emissions (3rd party energy use; water and wastewater; waste; and business travel) show little deviation in their overall contribution during 2040 and 2050.

Figure 6. Emissions Profile for R2 in 2040 and 2050



6.1.2 GHG Emissions per Passenger

Table 10 displays GHG emissions per passenger for each scenario, broken down by scopes 1, 2, and 3, and aircraft emissions. This is presented in $kgCO_2e$.

Table 10. Projected GHG Emissions per Passenger ($kgCO_2e$) for R2

Scope / Source	GHG Emissions ($kgCO_2e$/PAX)			
	Baseline (2012) 34 Million pax	Base Case (2040) 45 Million pax	R2 (2040) 83 Million pax	R2 (2050) 95 Million pax
Scopes 1 & 2	1.70	0.73	0.36	0.33
Scope 3	18.88	15.30	12.57	10.03
Total	**20.58**	**16.03**	**12.93**	**10.36**
Of Which Aircraft Emissions	11.51	9.04	7.58	5.12

As explained in Section 6.1.1, whilst total GHG emissions are predicted to increase, this is accompanied by a progressively greater passenger capacity, such that there are significantly lower emissions per passenger between the Base Case (2040) and R2 in 2040. Between 2040 and 2050, total emissions per passenger decline by a further 19.9% for the R2 scenarios, with a similar decline for Scope 3 and aircraft emissions.

Figure 7 displays the declining trend of projected GHG emissions per passenger for all Scopes between the Baseline (2012) and future assessment scenarios. (Note. Aircraft emissions are a sub-section of Scope 3 emissions).

Figure 7. Projected GHG Emissions per Passenger ($kgCO_2e$) for R2

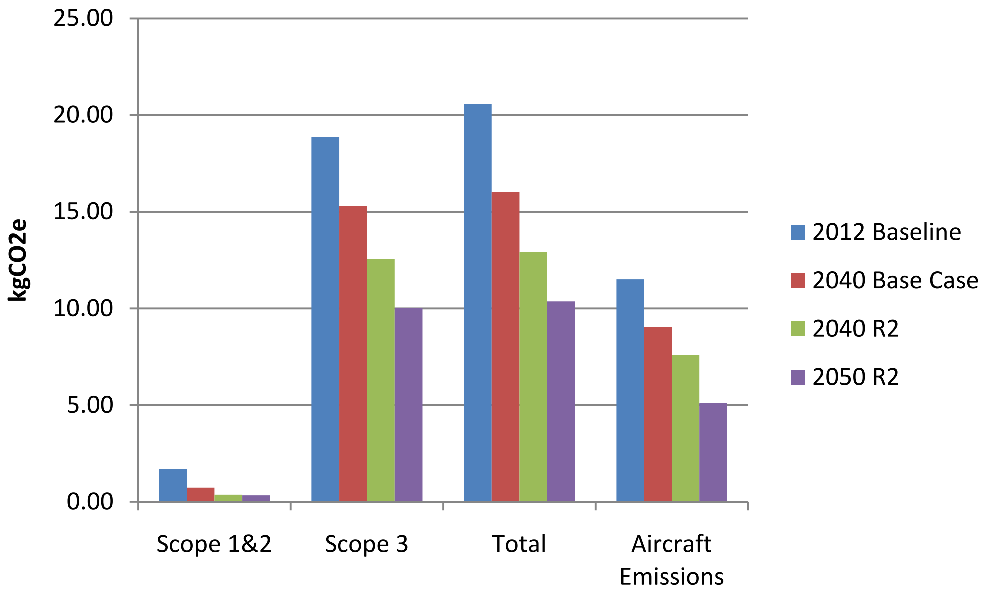


Table 11 displays the percentage change of GHG emissions per passenger for each Scope and each of the largest contributing sources between the Base Case (2040) and the R2 in 2040 and 2050.

Table 11. Percentage Change of GHG Emissions per Pax Between the Base Case (2040) and R2 in 2040 and 2050

Emissions Scope & Source	Percentage Decrease in GHG emissions per pax between Base Case (2040) and the Second Runway	
	R2 (2040)	R2 (2050)
Scopes 1 & 2	**-50.1%**	**-54.4%**
Scope 3	**-17.9%**	**-34.4%**
Total emissions	**-19.3%**	**-35.3%**
Aircraft emissions	-16.1%	-43.4%

As can be seen in Table 11, all Scopes and largest contributing sources for the second runway show a decline in GHG emissions per pax compared to the Base Case (2040). By 2050, with a passenger capacity of 95 million for R2, aircraft emissions per pax are 43.4% less than the Base Case (2040). This major improvement in carbon efficiency, particularly between 2040 and 2050, is due to the progressive retirement of older aircraft and the continued introduction of larger capacity and more fuel efficient aircraft.

As evident in this report's calculations, the mitigation measures employed within the USD Engineering Plans for R2 contribute to a significant reduction in emissions compared to the Base Case (2040). In 2050, carbon emissions per passenger are forecasted to reduce by 48.2% for electricity, 76.3% for gas, 27.7% for water, and 44.7% for waste compared to the current R1 airport in 2040.

6.2 Qualitative Construction Carbon Assessment

This section identifies the main emissions source and carbon impact of the expected activities and processes required to construct R2. The main construction carbon impacts – such as on-site construction, freight transport, and waste removal - have been identified from the Strategic Forum for Construction's categorisation as identified in Figure 1 of this report. A table is provided for each of these construction activities with some commentary on how construction of R2 would intrinsically perform.

Table 12 provides a commentary of the expected carbon impact of R2's on-site construction activities.

Table 12. Carbon Impact of On-Site Construction Activities

On-Site Construction Activities	Commentary on R2
On-Site Plant and Machinery	
Construction activities include powering plant and ancillary equipment on-site for all activity concerning any chemical, electrical or mechanical apparatus (i.e. demolition and land clearance, site drainage, runway and terminal construction; waste treatment). Particular fuels may include diesel, gasoil, petrol, LPG, propane and electricity.	As the R2 site at Gatwick is predominantly Greenfield land, demolition activities and related land clearance for Gatwick's construction strategy would be limited to the relatively small number of residential and commercial properties directly affected. This phase of construction is likely to be relatively straightforward in comparison to other short-listed options. The R2 Masterplan requires a relatively low quantity of significant engineering works beyond the construction of the airfield such as tunnelling or major road diversions. There is no requirement for compensatory off-site relocation of critical infrastructure Energy and fuel use associated with demolition and construction on-site would be kept to a minimum through modern construction standards and efficient equipment.

On-Site Construction Activities	Commentary on R2
On-Site Transport	
Use of heavy and light vehicles for transporting material and personnel within the construction site. Traditionally used fuels for vehicles such as petrol and diesel have a significantly higher carbon footprint than electrically powered versions.	The R2 Masterplan and phased construction strategy would ensure disruption and queuing of vehicles on-site would be kept to a minimum.
On-Site Accommodation	
Temporary offices and accommodation on-site are typically poorly insulated and in comparison to permanent structures they often do not have building management controls which facilitate efficient operation. As a result, while cheap to build and quick to erect, temporary buildings on-site consume a significant quantity of energy relative to their size.	Gatwick proposes to address these issues through the design of efficient energy efficient compounds. Gatwick has, for example, identified an opportunity in its construction waste strategy to supply on-site accommodation/offices with hot water produced from a biogas boiler, which utilises on-site food waste. Gatwick's USD waste strategy.

Table 13 provides a commentary of the expected carbon impact of R2's off-site construction activities.

Table 13. Carbon Impact of Transport and Distribution

Transport and Distribution	Commentary on R2
Freight Transport	
Use of heavy and light vehicles for transporting material, plant and waste outside of the airport boundary;	There is less congestion of the road network around Gatwick such that it can be expected that disruption and increased road traffic emissions during the construction phase would be less than Heathrow options. Gatwick is well located and would seek to source construction material locally in accordance with a Sustainable Materials Strategy for R2. Gatwick intend to use a dedicated railhead close to the construction site enabling construction materials to be transported by rail which would reduce heavy road traffic and resultant emissions on the road network. A Construction Worker Transport Strategy would be also be developed and designed to manage and reduce construction worker traffic on the road network.
Staff Commuting and Business Travel	
Staff commuting to site via cars, trains, and buses and visitors to site (i.e. surveyors/architects/planners) from a range of origins, throughout pre-planning through entire life cycle of the project.	With less congestion of the road network around Gatwick that it can be expected that disruption and increased road traffic emissions during the construction phase would be less than Heathrow options. Gatwick is also very well served by rail and other public transport services. Hence construction workers would be expected to have a high propensity to use public transport, facilitated by a Construction Worker Transport Strategy

Table 14 provides a commentary of the expected carbon impact of waste removal during the construction of R2.

Table 14. Carbon Impact of Waste Removal

Waste Removal	Commentary on R2
Waste sent to landfill/recovery/treatment during the demolition and construction phases and its associated transport emissions.	The proposed R2 site contains no historical landfills, nor past uses of heavy industry such as gas works or chemical plant. It is expected that the vast majority of construction and demolition waste arising from R2 can therefore be re-used or recycled on site, minimising transport related emissions. Gatwick have already achieved a 96% recycling of construction, demolition, and excavation waste from its projects and expects that this can be maintained and exceeded for the R2 scheme. Gatwick have prepared a Construction Waste Management Plan in accordance with the Commission's Appraisal Framework which sets out the strategy and actions which Gatwick intend to implement, with the goal of minimising waste sent to landfill and hence maximising re-use and recycling of construction waste.

Table 15 provides a commentary of the expected carbon impact of off-site activity during the construction of R2.

Table 15. Carbon Impact of Off-Site Assembly

Off-Site Assembly	Commentary on R2
Off-site activities required during the construction of R2 include: • Extraction of raw materials and associated energy use of plant and machinery; • Off-site manufacture, processing and assembly of material products/ components and associated energy use of plant and machinery; and	Gatwick's USD Surface Access Strategy would enhance Gatwick's already efficient local transport networks which would improve connectivity with local and non-local suppliers, hence reducing congestion emissions. Gatwick's Sustainable Materials Strategy would also be reviewed for R2 to ensure suppliers continue to source materials with low carbon embodied impacts where possible.

Table 16 provides a commentary of the expected carbon impact of Gatwick's off-site corporate offices associated with the construction of R2.

Table 16. Carbon Impact of Gatwick's Corporate Offices

Corporate Offices	Commentary on R2
Energy use would occur from Gatwick's off-site permanent offices which directly enable the construction of R2 to occur (i.e. project management; health, safety and environmental management systems; and finance and legal activities etc).	Gatwick already maintains dedicated energy management systems for all corporate offices, which include regular audits and the use of efficient and low energy lighting and ICT equipment. Gatwick intend to maintain these systems during the construction of R2 and employ more innovative measures where applicable - therefore energy use would be kept to a minimum.

6.3 Quantified Estimates for Construction Emissions

Consultants on behalf of the Commission produced some estimates[3] for construction carbon emissions during the Commission's Phase 1 Assessment of submitted options. For Gatwick they estimated construction carbon emissions of 690,000tCO_2e, compared to 750,000tCO_2e for Heathrow Hub North runway, and 800,000tCO_2e for the North West runway at Heathrow. It is understood that the predictions were based on runway, taxiway and terminal build only. According to these estimates Gatwick's proposal would have the lowest embodied carbon option of these single runway growth footprints. It is unknown at this stage what methodology and scope has been applied by the consultants for forecasting carbon emissions. It is considered however, that these predictions have considerably underestimated carbon emissions for all options. Furthermore we believe the difference in emissions between Gatwick and both Heathrow options may be much greater than currently represented due to the significantly greater complexity of the Heathrow options, including for example requiring critical infrastructure to be replaced and dealing with the significant extent of known and unknown landfill on the Heathrow sites.

[3] Leigh Fisher & Jacobs (2013). *London Gatwick Airport 2nd Runway Option, Group: Dispersed, Reference No. 65*. Airports Commission

7 FURTHER REDUCTION OF CARBON IMPACTS

Gatwick's R2 proposals – through its Masterplan, Surface Access Strategy and Engineering Plans incorporate a range of measures that would reduce carbon emissions from the operation of R2. This section summarises the mitigation measures which are incorporated in Gatwick's R2 USD.

The construction of R2 would also be progress-based on best available construction techniques, drawing on the Olympics etc. This section summarises measures Gatwick proposes to undertake to reduce construction carbon emissions.

Opportunities for further emission reduction take into account potential changes in the technology, operational practice and the regulatory environment which may be expected in the future. These methods have been broken down by each emission source and in some instances may cross refer to other areas of the USD. In some cases emission reduction may also improve the airport's resilience to climate change.

It is important to note that these measures have not been directly factored into any modelling calculations for second runway scenarios; instead they represent opportunities to further reduce emissions beyond those projected in Section 6.1.

7.1 Operational Carbon Emissions

7.1.1 Aircraft

In terms of managing aircraft emissions, Gatwick would continue to implement industry best practice for R2 and build upon current successful aircraft schemes such as Continual Climb Operation (CCO), Continuous Descent Approach (CDA) and engine-off taxiing.

The USD for R2 provides an efficient airfield layout which would minimise taxi-in and taxi-out distances whilst also minimising hold times by ensuring efficient flow of airfield traffic. This would significantly minimise carbon emissions by reducing fuel burn and ensuring less distance is travelled to and from the runway. Furthermore, Gatwick intend to implement Fixed Electrical Ground Power (FEGP) on all aircraft stands to minimise use of the aircraft's own Auxiliary Power Units (APUs) and hence reduce fuel burn.

Gatwick would continue to explore and support further emissions reduction schemes such as those proposed in The Sustainable Aviation Carbon Road Map (2012), which suggests a range of potential mitigation opportunities for continual emission reduction. These include:

- Increasing the bio-fuel proportion of aircraft fuel;
- Increasing the energy output (per unit of mass/volume) of fuel burnt;

- Improving the aerodynamic efficiency in the design of aircraft to reduce drag;
- Reducing the weight of aircraft (ie. In the structural design; engine; and cabin) to improve fuel efficiency;
- Introducing remote starting concepts;
- Improving airborne flight efficiency (i.e. cruising at reduced speeds; reducing airborne holding; improved climb and descent profiles); and
- Incentive schemes that favour the use of the highly efficient aircraft.

Gatwick would also continue to work with the relevant air traffic control authorities to reduce emissions associated with aircraft flight paths, stacking and sub-optimal routing in the air.

7.1.2 Surface Access

Gatwick's USD Surface Access Strategy, including the Gatwick Gateway, sets out a detailed strategy for providing efficient transport access to/from and around Gatwick. The strategy would support a passenger public transport mode share of 60% and a staff mode share of 40% and would reduce emissions from the use of private cars and traffic congestion. The proposed Gatwick Gateway would provide seamless connectivity between transport modes and would offer improved sustainable transport options for local users.

Further initiatives are proposed to reduce carbon emissions, such as through incentives to staff and passengers to use electric and hybrid vehicles.

7.1.3 Energy

Gatwick's USD Energy Strategy as outlined in the Engineering Plans seeks to generate as much of its energy requirements on-site - this includes a series of initiatives such as Biomass CHP, generation of biogas fuel from waste and passive and active renewable energy technologies in building design to minimise energy use, reduce the airports reliance on mains electricity/gas and minimise carbon emissions.

In order to ensure continual emission reduction and energy resilience over the lifetime of R2, Gatwick's proposals include expansion of the solar PV array and other renewable technologies in the design of R2 facilities on and off-site. Other new and innovative technologies would be considered as they become viable during the lifetime of the R2 project.

The strategy also assists in energy supply security and resilience to climate change and provides for export of surplus heat from the CHP unit to other buildings on-site, further reducing energy consumption of the airport as a whole.

7.1.4 Waste

Through Gatwick's USD Waste Strategy, a 75% (2040) and 80% (2050) recycling rate of operational waste is expected to be achieved as a result of R2's dedicated Integrated Waste Management Recycling facilities and an increase in operational waste could create economies of scale to support the development of further airport recycling initiatives. The interactions and symbiosis between the energy, waste and water systems for R2 in a sustainable resource management strategy demonstrates Gatwick's commitment to managing resources efficiently.

Opportunities for further emission reduction include:

- Development of an anaerobic digestion facility to process organic waste from the airport;
- Encouraging airlines to minimise the waste they produce, and promote on board segregation of waste to facilitate recycling;
- Development of a 'Biogas to Vehicle Fuel' facility to utilise biogas in the airport bus or support fleet; and
- Use of liquid digestates from the anaerobic digestion plant as an additive to treat contaminated surface water to reduce surface water treatment processes.

7.1.5 Water

Gatwick's USD Water Strategy for R2 includes roof-based rainwater harvesting and greywater recycling (where applicable) which would reduce imported water consumption and likewise total wastewater. Additional measures proposed to further reduce the carbon impact of water at Gatwick include the opportunity for a site-wide surface water harvesting system.

7.2 Construction Carbon Emissions

Gatwick considers that it is unrealistic at this early stage of the design and planning of R2 to produce an accurate quantitative assessment of the construction carbon emissions or to be too prescriptive of construction carbon mitigation.

Gatwick's strategy to minimise construction carbon emissions would draw on the experience of other major infrastructure projects such as the construction of the Olympic Park in London. Insight and lessons learned from the Olympic Delivery Authority (ODA) Learning Legacy provides a perfect example of how modern major construction projects can be sustainably managed. Drawing off these examples, this section describes a range of carbon mitigation opportunities which Gatwick would consider during the development of R2 in order to minimise carbon emissions associated with the construction phase.

7.2.1 Planning and Construction Strategy

Experience from the 2012 Olympics has shown that early collaboration between architects, engineers and contractors who support sustainability principles is vital in order to set realistic and achievable carbon targets and develop optimal design briefs and materials specifications. Gatwick recognise that sufficient planning during the design stages of the R2 development would enable innovative building and construction strategies (i.e. Modern Methods of Construction) to be reviewed and employed where suitable.

Gatwick's Code of Construction Practice Strategy for R2 would detail a commitment to manage and mitigate carbon emissions, which would include a Construction Worker Transport Strategy; Sustainable Materials Strategy; and a Construction Waste Management Strategy.

7.2.2 Embodied Carbon

Learning Legacy case studies of the Olympic Park have shown that 2 key strategies were used to reduce the embodied carbon emissions of infrastructure, which resulted in a 35-38% reduction in carbon emissions from concrete – This involved minimising concrete through design; and specifying the use of low carbon concrete mixes. Both strategies would actively feed-into R2's Masterplan and Code of Construction Practice.

The first strategy involved designing structures with less material than conventional practice by incorporating innovative design and engineering solutions where possible. By reducing concrete demand by approximately 15% less than original estimates, a saving of 120,000 tonnes of aggregate was made at the Olympic Park, equating to a saving of 20,000tCO_2e of embodied carbon.

The second strategy for reducing carbon emissions from concrete involved the use of low carbon concrete mixes, raising the average percentage cement substitutions (Pulverised Fuel Ash (PFA) and Ground Granulated Blast Furnace Slag (GGBS)) to 32% from the UK average of 18%, and achieving an average of 25% recycled aggregate. Gatwick intend to review the current Sustainable Materials Strategy for R2 in order to prioritise the purchase of low carbon embodied materials and develop site-specific targets for cement substitution and improving the recycled aggregate content of concrete used.

The specification of low carbon concrete mixes at Olympic Park was facilitated by an on-site ready mix concrete batching plant adjacent to the railhead, which provided a site specific concrete supply chain and eliminated approximately 60,000 heavy vehicle movements. Considering R2 would be constructed in a series of 'phases' over a long term period, the use of an on-site batching plant at Gatwick would improve the efficiency of the supply chain and allow greater self sufficiency, as well as reducing transport emissions.

7.2.3 On-site Construction Activities

Plant and Machinery

During the construction of R2, Gatwick intend to minimise on-site carbon emissions by seeking the most energy efficient methods applicable. This would include:

- Utilising fuel efficient and electric/hybrid/bio-fuel plant on-site;
- Deployment of separate electricity generators for both daytime (high demand) and evening (low demand) in order to avoid over production; and
- Minimising excessive night time lighting and where unavoidable (i.e. Security lighting), use energy efficient technology (i.e. fluorescent, LED).

Emissions would be further reduced by connecting the site to the national electricity grid as early as possible which would minimise the amount of diesel used to power generators.

Accommodation

Gatwick proposes to minimise the carbon emissions from on-site accommodation and facilities through the design and specification of energy efficient compounds. Gatwick has, for example, identified an opportunity in its Construction Waste Strategy to supply on-site accommodation with hot water produced from a biogas boiler, which utilises on-site food waste.

7.2.4 Transport and Distribution

Freight

Gatwick is committed to delivering as much of the construction of R2 and associated works as is practicable by sustainable modes of transport. Gatwick intends to use a dedicated railhead for the movement of construction materials and removal of excess spoil. The Crawley New Yard site has been identified as an ideal location for the railhead, allowing access to the Brighton Main Line and hence good links to suppliers of materials and aggregate quarries. The railhead would greatly reduce carbon emissions from road transport and associated traffic congestion. Gatwick also intend to implement a Construction Worker Transport Strategy to minimise traffic congestion around the R2 site by consolidating movements of workers, materials and plant.

Furthermore, Gatwick's current Sustainable Materials Strategy would be revised for R2 to ensure the prioritisation of re-used materials as well as those produced locally where practicable, in order to reduce the carbon impacts of shipping and freight transport. The strategy would also encourage the procurement of suppliers and sub-contractors who actively commit to using fuel efficient and/or electric/hybrid/bio-fuel vehicles when moving materials to and from site.

Staff Commuting/Business Travel

Gatwick's Construction Worker Transport Strategy for R2 would also aim to minimise the use of private vehicles and related carbon emissions by encouraging staff to commute and travel via public transport. This would be achieved by:

- Providing incentives and subsidised fares for use of low carbon transport such as rail and bus to and from the R2 site;
- Providing additional 'R2 dedicated' bus services during peak work hours; and
- Provide opportunity for staff and visitors to offset transport emissions.

Due to the ongoing phased construction of R2, transport links and connectivity for staff would continually improve over time.

7.2.5 Waste

Gatwick's USD Construction Waste Strategy for R2 has been designed to the highest standards of current waste and resource management practice and follows the waste hierarchy principles, prioritising re-use and recycling of construction and demolition material at Gatwick.

Table 17 provides a summary of the strategy's components and its impact on minimising carbon emissions.

Table 17. Construction Waste Strategy

USD Construction Waste Strategy for R2	
Component	**Commentary**
Concrete Crushing Plant	• Enables direct processing of materials on site (e.g. concrete, asphalt, brick, timber, etc); • Reduces transportation movements on site; and • Allows direct re-use of materials on site under the WRAP Quality Protocol.
Waste Consolidation Centre	• Source segregation onsite would prevent double handling of materials; • Allows temporary storage of materials on-site awaiting processing – hence reducing further transportation to off-site locations; • Allows bulk segregated loads to be sent direct to a recycling process off site; • Optimises recycling rates and rebates; • Reduces transportation movements on site; • Hazardous waste storage and segregation; and • Enables efficient management of skip deliveries.
Site Tanker/De-watering Facility	• On-site septic tank collection service from compounds (where no connections to sewer are available) and accommodation, etc; • Provides silt and sediment treatment facility for site drainage facilities, dewatering activities, oil interceptors, bunds and road-sweeping; • Dedicated discharge point and meter to sewer on-site would reduce transportation movements off site; • Allows re-use of solid phase through blending on site; and • Would help prevent surface water contamination.

USD Construction Waste Strategy for R2	
Component	**Commentary**
Construction Consolidation Centre	• Optimises construction deliveries to the R2 site; • Reduces waste through the process of Just-in-Time deliveries; • Reduces traffic congestion; • Enables utilisation of reverse logistics i.e. return of unused material, packaging and pallets; and • Would provide multimodal transport network linkage (i.e. road and railhead).
Biomass Boiler	• Enables food waste and biogas to generate hot water for use in the on-site accommodation and/or concrete batching plant; and • Would allow re-use of the plant during airport operational phase once construction is complete.

In conjunction with a site remediation strategy, soil washing techniques and bioremediation would also be used where viable which would significantly minimise off-site disposal, treatment and related transport emissions.

8 CONCLUSIONS

This report provides information requested by the Airport's Commission in Module 8: Carbon of its Appraisal Framework, and explains how Gatwick's USD for R2 fulfils the carbon objective '*to minimise carbon emissions in airport construction and operation*.'

Gatwick has been recording its carbon footprint since 2008, and during that time its total absolute GHG emissions and GHG emissions per passenger have declined, despite an increase in total passenger numbers. Coupled with active commitments outlined in the 'Decade of Change', Sustainable Materials Strategy, and the Surface Access Strategy, Gatwick have displayed a strong track record for managing carbon emissions. This knowledge and experience hence forms the basis for the successful implementation of R2. Through Gatwick's R2 Masterplan, Engineering Plans (energy, waste, water) and Surface Access Strategy, innovative mitigation strategies have been developed which would ensure the carbon impact of R2 will be minimised.

Whilst total absolute carbon emissions for the airport's operational phase are predicted to increase with the addition of a second runway, this is accompanied with a significantly greater passenger capacity; hence GHG emissions per passenger are considerably lower for both second runway scenarios (2040 and 2050) compared to the Base Case (2040). This change is particularly evident between 2040 and 2050, largely due to the continued retirement of old aircraft and the gradual introduction of new and more fuel efficient aircraft from the mid 2030s onwards.

The interactions and symbiosis between the energy, waste and water systems for R2 create an integrated sustainable resource management strategy, which contributes to a significant reduction in forecasted emissions against the Base Case (2040) - By 2050, GHG emissions per passenger are forecasted to reduce by 48.2% for electricity, 76.3% for gas, 27.7% for water, and 44.7% for waste compared to the current R1 airport in 2040.

Furthermore, the Surface Access Strategy featuring the Gatwick Gateway would significantly improve the airport's transport links and increase the share of public transport use.

While the R2 proposal is still in its very early stages of planning, Gatwick have drawn from the insights and lessons learned from the Olympic Park construction, and have begun to develop a range of site-specific mitigation strategies to minimise carbon emissions (i.e. from on-site construction activities; transport and distribution; waste removal; as well as minimising embodied carbon). This includes a Sustainable Materials Strategy; Construction Workers Transport Strategy; and a Construction Waste Management Strategy - these would be refined and updated on an ongoing basis to reflect environmental best practice. However due to the relatively simple engineering works, little demolition, and no relocating of major infrastructure required, the carbon impact of the construction phase at Gatwick would be small in comparison to other short-listed options.

APPENDIX A – MODELLING ASSUMPTIONS

Emissions Source	Key Modelling Assumptions
Scope 1 – Gatwick Gas	• Gas consumption data provided by Arup for regulated consumption for the airport including terminal and airside buildings • The breakdown of Scope 1 (91%) and Scope 3 (9%) gas consumption has been assumed to represent the same share as shown in the 2012 carbon footprint • No decarbonisation of mains gas from 2013
Scope 1 – Gatwick Fuels	• For the 2040 and 2050 assessment years', baseline (2012) data has been factored up (multiplied) by the respective passenger number increase. • Assumes a 10% improvement in efficiency from 2013 to 2040/50 to reflect improvements in industry best practice (i.e use of hybrid/biofuel vehicles where possible) • No change in the breakdown of fuels used for on-site operations • No change in emission factors from 2013 • Includes a 3% biofuel proportion in petrol & diesel fuels
Scope 1 – Gatwick Refrigerant Gases	• For the 2040 and 2050 assessment years', baseline (2012) data has been factored up (multiplied) by the respective passenger number increase. • No change in the breakdown of refrigerant gases types used on-site • Assumes a 10% reduction in refrigerant GWP from 2013 to 2040/50 to reflect improvements in industry best practice.
Scope 2 – Gatwick Electricity	• Electricity consumption data provided by Arup for regulated and unregulated consumption for the airport including terminal and airside buildings • RSK have estimated future emission factors beyond 2028, based on a logarithmic trend line of SAP's current predictions between 2012 and 2028 • The breakdown of Scope 2 (63.8%) and 3rd party (36.2%) electricity consumption (Scope 3) has been assumed to represent the same share as calculated in the 2012 carbon footprint. • Transmission and Distribution (T&D) losses have been assumed to represent 8.6% of the total electricity consumption as calculated in the 2012 carbon footprint • The emissions factor for T&D losses in 2040 and 2050 have been assumed to follow the same rate of decline as estimated for electricity consumption

Scope 3 – 3rd Party Gas	• Gas consumption data has been provided by Arup for regulated consumption for the airport including terminal and airside buildings • The breakdown of Scope 1 (91%) and Scope 3 (9%) gas consumption as been assumed to represent the same share as shown in the 2012 carbon footprint • No decarbonisation of mains gas from 2013
Scope 3 – 3rd Party Fuels	• For the 2040 and 2050 assessment years', baseline (2012) data has been factored up (multiplied) by the respective passenger number increase. • Assumes a 10% improvement in efficiency from 2013 to 2040/50 to reflect improvements in industry best practice (i.e use of hybrid/biofuel vehicles where possible) • No change in the breakdown of fuels used for on-site operations • No change in emission factors from 2013 • Includes a 3% biofuel proportion in petrol & diesel fuels
Scope 3 – 3rd Party Electricity	• Electricity consumption data provided by Arup for regulated and unregulated consumption for the airport including terminal and airside buildings • RSK have estimated future emission factors beyond 2028, based on a logarithmic trend line of SAP's current predictions between 2012 and 2028 • The breakdown of Scope 2 (63.8%) and 3rd party (36.2%) electricity consumption (Scope 3) has been assumed to represent the same share as calculated in the 2012 carbon footprint. • Transmission and Distribution (T&D) losses have been assumed to represent 8.6% of the total electricity consumption as calculated in the 2012 carbon footprint • The emissions factor for T&D losses in 2040 and 2050 have been assumed to follow the same rate of decline as estimated for electricity consumption
Scope 3 – Water & Wastewater	• Water consumption data provided by CH2MHILL for daily average cubic meters for 'scheme with embedded mitigation' – This has been multiplied accordingly to give annual consumption figure. • Due to lack of data for the Base Case (2040), the Baseline (2012) has been factored (multiplied) by passenger number increase alongside an estimated 5% improvement in efficiency to reflect improvements in industry best practice (i.e low water appliances, improved leak detection management) • The emissions factor for water has been assumed to follow the same rate of decline as predicted for electricity consumption • Wastewater volume has been assumed to equal water consumption • Assumes no carbonisation of water treatment beyond 2013.

Scope 3 – Waste	• Total waste tonnage figures and estimates for 75% (2040) and 80% (2050) operational recycling and a 1% waste to landfill share provided by Helistrat • Other waste management arrangements (i.e re-use and recovery) have been apportioned based on above share of recycling and landfill and data provided for the Baseline (2012) carbon footprint • Includes direct emissions from waste, not indirect.
Scope 3 – Gatwick Business Travel	• For the 2040 and 2050 assessment years', baseline (2012) data has been factored up (multiplied) by the respective increase in Gatwick 'Management & Professional' staff. • Assumes no shift in breakdown of transport mode or destination • Aircraft emissions include an 8% uplift factor to allow for non-optimal routing
Scope 3 – Gatwick Staff Commuting	• Staff commuting data for public transport (20% rail and 20% bus/coach) share provided by Arup in the USD Surface Access Strategy – Share of other modes (i.e car, taxi, and motorcycle) have been apportioned based on share of public transport (above) and data provided for the Baseline (2012) carbon footprint • Carbon intensity of rail transport has been assumed to decline by 20% • Assumes no improvement in emission factors for transport modes from 2013 (expect rail) • No shift in breakdown of transport mode, work patterns (i.e full time vs part time) and origin • Assumes no changes in traffic congestion
Scope 3 – Passenger Surface Transport	• Passenger surface access data for public transport (50% rail and 10% bus/coach) share provided by Arup in the USD Surface Access Strategy – Share of other modes (i.e car, taxi, and motorcycle) have been apportioned based on share of public transport (above) and data provided for the Baseline (2012) carbon footprint • Carbon intensity of rail transport has been assumed to decline by 20% • Assumes no improvement in emission factors from 2013 expect rail • No shift in transport origin breakdown • Assumes no changes in traffic congestion

Scope 3 – Aircraft	• Aircraft fleet mix provided by ICF SH&E • Assumes a 10% reduction in emissions during the taxi-in phase due to engine off 'taxiing'. • Assumes no change in the bio-fuel proportion of aircraft fuel • Assumes remote starting will not be introduced • Assumes that there will be no significant modifications to the aircraft that are already in service. • Assumes a 70:30 (West: East) prevailing wind direction • Airfield strategy does not include use of End Around Taxiways (EATs) • Assumed that aircraft designated as 'others' will have the same performance as the weighted mean of all the identified aircraft. • Where performance data is not available for a particular aircraft type we have used either manufacturers projected data (which may be expressed as a value relative to another aircraft type) or if this is not available the data for the aircraft type which we deem to be closest in performance.

APPENDIX B – EMISSIONS FACTORS

Table 18. 2013 and Future Projected Emissions Factors

Emissions Source	Notes	Emissions Factor	Unit	Reference
Gas	Natural gas	0.18404	($kgCO_2e/kWh$)	DEFRA 2013
Diesel	Average biofuel blend	2.60080	($kgCO_2e/l$)	DEFRA 2013
Gasoil	--	2.93430	($kgCO_2e/l$)	DEFRA 2013
Petrol	Average biofuel blend	2.21440	($kgCO_2e/l$)	DEFRA 2013
LPG	--	1.49290	($kgCO_2e/l$)	DEFRA 2013
Propane	--	2,724.4	($kgCO_2e/l$)	DEFRA 2013
R134A	--	1,300	($kgCO_2e/kg$)	DEFRA 2013
R407C	--	1,526	($kgCO_2e/kg$)	DEFRA 2013
R410A	--	1,725	($kgCO_2e/kg$)	DEFRA 2013
Electricity	UK, generated	0.44548	($kgCO_2e/kWh$)	DEFRA 2013
	Transmission & distribution losses	0.03809	($kgCO_2e/kWh$)	DEFRA 2013
Electricity (2040)	UK, generated	0.275	($kgCO_2e/kWh$)	RSK
	Transmission & distribution losses	0.02365	($kgCO_2e/kWh$)	RSK
Electricity (2050)	UK, generated	0.220	($kgCO_2e/kWh$)	RSK
	Transmission & distribution losses	0.01892	($kgCO_2e/kWh$)	RSK
Water	Water supply	0.34411	($kgCO_2e/m^3$)	DEFRA 2013
Water (2040)	Water supply	0.198	($kgCO_2e/m^3$)	RSK
Water (2050)	Water supply	0.189	($kgCO_2e/m^3$)	RSK
Wastewater	Water treatment	0.70850	($kgCO_2e/m^3$)	DEFRA 2013
Waste re-used	--	21.0	($kgCO_2e/tonne$)	DEFRA 2013
Waste recycled	--	21.0	($kgCO_2e/$ tonne)	DEFRA 2013
Waste recovered	Combustion	21.0	($kgCO_2e/$ tonne)	DEFRA 2013
Waste landfilled	Commercial & industrial	199.0	($kgCO_2e/$ tonne)	DEFRA 2013
Private car	Average car, unknown	0.19023	($kgCO_2e/vkm$)	DEFRA 2013
Rail	National rail	0.04904	($kgCO_2e/pkm$)	DEFRA 2013
Rail (2040/50)	--	0.03923	($kgCO_2e/pkm$)	RSK
Taxi / Minicab	Black cab	0.15294	($kgCO_2e/vkm$)	DEFRA 2013
Bus / Coach	Coach	0.02932	($kgCO_2e/pkm$)	DEFRA 2013
Motorcycle	Average	0.11891	($kgCO_2e/vkm$	DEFRA 2013
Flight*	Domestic	0.17276	($kgCO_2e/pkm$)	DEFRA 2013

Notes

- DEFRA 2013 - Guidelines to DEFRA / DECC GHG Conversion Factors for Company Reporting (December 2013)

- *The emissions factor for planes has been used for staff commuting, business travel and passenger surface transport. This figure is not related to calculations made for the aircraft emissions associated with the ICAO LTO cycle.

- vkm = vehicle kilometer; pkm = passenger kilometer

APPENDIX C – R2 WITH EATs

Table 19. Projected total absolute GHG Emissions for With and Without EATs (tCO_2e)

Emissions by Scope/Source	R2 (2040) 83 Million pax		R2 (2050) 95 Million pax	
	With EATs	Without EATs	With EATs	Without EATs
Aircraft emissions	632,749.0	629,210.0	487,856.0	486,400.0
Scope 3	1,046,783.8	1,043,244.8	954,582.7	953,126.7
Total	**1,076,805.8**	**1,073,266.8**	**986,018.1**	**984,562.1**
GHG per passenger (Kg/CO2e)	*12.97*	*12.93*	*10.37*	*10.36*

For both 2040 and 2050 the 'with EATS' versions show small but insignificant increases in CO_2 emissions both on an absolute and per passenger basis.