APPENDIX 16

CWA DIVERSION AIRPORT ANALYSIS

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Subject: Estimated CO2 Emissions: CPT with CWA vs JNB as alternate

Reference: PACE Summary Report: CWA Diversion Airport Analysis Rev D Oct 10, 2022

Mr. Wilkinson,

The following is offered as an amending statement to the detailed analysis previously provided to Cape Wineland-Aero by PACE Aerospace and IT.

The detailed studies provided specific fuel burn and payload benefits for a variety of aircraft and route structures when CWA was employed as an CPT arrival alternate vs other currently available South African airports.

This amending statement addresses the issue of CO2 emissions. The report did not directly include a summary or projection of the cumulative CO2 reductions. It required that it be derived from the route by route and aircraft specific fuel burn estimates provided.

Therefore; for the purposes of a generalized CO2 discussion, PACE recommends that a generalized CO2 reduction in the range of 3-5% be proffered as the benefit of using CWA as an CPT alternate. This is based on the assumptions that:
a) The frequency of flights to CPT will increase regardless of alternate selected. The exact frequency increase is unknown at this time.
b) The range of saving is generalized over a both wide body and narrow body operations
c) Alternates other than JNB were considered in the analysis.
d) Reductions in reserve fuel was frequently traded for increased payload. Hence the saving is based on planned block fuel consumption which included higher payloads.

Hopefully this material will assist you in your presentation and discussion of CO2 emissions related to use of the CWA as a alternate.

Best Regards,

T. H.

Tobias Handschuck
Head of Aircraft Performance

CWA Diversion Airport Analysis
Analysis Summary Report

Internal Approval				
Responsibility	**Name**	**Department**	**Date**	**Signature**
Written by	Jonatan Yamazaki	PACE GmbH	10.10.2022	
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Customer Approval				
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Revision History

The revision history lists all updates, modifications and corrections made to this document from its first publication onwards.

Version	Date	Modified by	Modified pages	Reasons
1.0, Rev A	20.06.22	Jonatan Yamazaki	all	Initial version
1.0, Rev B	22.06.22	Jonatan Yamazaki	Section 5.4	Addition of section 5.4
1.0, Rev C	15.07.22	Jonatan Yamazaki	3 116-129 123 120, 127 131	- Section 5.4 added to the Table of contents; - CO_2 emissions added to Sections 5.3 and 5.4; - Added note about MFC limitation - airport ADD results added to sections 5.3.5 and 5.4.5; - Reference 12 added.
1.0, Rev D	10.10.22	Jonatan Yamazaki	6, 7, 55, 56, 66, 67, 110, 121, 122, 128, 129, 135, 136	Added route ATL-CPT for B77W and for B787-9.

1 Introduction

The objective of the project is to evaluate the fuel weight savings with the use of CWA as alternate airport at destination instead of current alternate airports (PLZ or JNB) for flights inbound Cape Town International Airport.

The purpose of the analysis is to demonstrate commercial advantages for Domestic, Regional and International airlines in using CWA as alternate airport in the future.
The analysis are based on aircraft performance data developed by PACE and calibrated for the specific aircraft types using public domain data sources.

Two different types of analysis were performed:

1. **Fuel Uplift Saving**: How much more payload the aircraft could carry because of reduction of fuel that needs to be on board using CWA as alternate airport at destination. This is obtained by assuming the same takeoff weight for both scenarios.
2. **Fuel Burn Saving**: How much fuel is saved, maintaining the same payload, because the aircraft is lighter using CWA as alternate airport at destination. This is obtained by assuming the same payload, for both scenarios.

1.1 Purpose of the document

This analysis summary report provides an overview of the aircraft (chapter 2), routes (chapter 3), assumptions (chapter 4), and results obtained (chapter 5).
Finally, chapter 6 provides a conclusion of the analysis.

2 Aircraft

Table 1 – List of Aircraft

Aircraft	MRW (kg)	MZFW (kg)	MTOW (kg)	MLW (kg)	Layout variant	OWE (kg)	Number of PAX seats
A320-200 CFM56-5A1	73900	61000	73500	64500	Basic Layout	45300	150
B737-800 CFM56-7B26	79333	62732	79016	66361	FlySafair Layout	45075	189
B787-9 GEnx-1B-64	254465	186584	252651	192777	Basic Layout	132902	302
CRJ100 CF34-3A1	23247	19959	23133	21319	Basic Layout	13835	50
ERJ135 AE 3007	20500	16000	20000	18500	Basic Layout	11426	37
E-190 CFM34-10E	51960	40900	51800	44000	Basic Layout	27900	98
B77W GE90-115B1	353000	237682	351533	251290	Basic Layout	168600	402

The performance database for the A320-200, B737-800 and for the B787-9 were already available as part of the standard PLMS aircraft sample database.

The performance database files for the following aircraft were generated as part of this project:

- B77W (B777-300ER)
- CRJ100
- ERJ135
- E190

The performance data is created using the Pacelab APD software, and calibrated using public domain information (references [2] thru [7]).

The aircraft database, that is loaded into PLMS, is attached to this report (refence [1]).

3 Routes

The routes analyzed in this project are subdivided in two groups. The routes in the first group, presented in Table 2, consider the PLZ airport as diversion. The airports in the second group, presented in Table 3, consider the JNB airport as diversion.
For both groups, the applicable aircraft are marked with a "x" mark in the corresponding column.

Table 2 – Domestic routes, inbound CPT, PLZ as diversion

	A320	B737-800	CRJ 100	E190	ERJ 135
Johannesburg International (JNB)	x	x	x	x	
Johannesburg Lanseria (HLA)		x			
Durban (DUR)	x	x	x		
Port Elizabeth (PLZ)		x		x	
Bloemfontein (BFN)		x		x	x
East London (ELS)		x			
Kimberley (KIM)					X

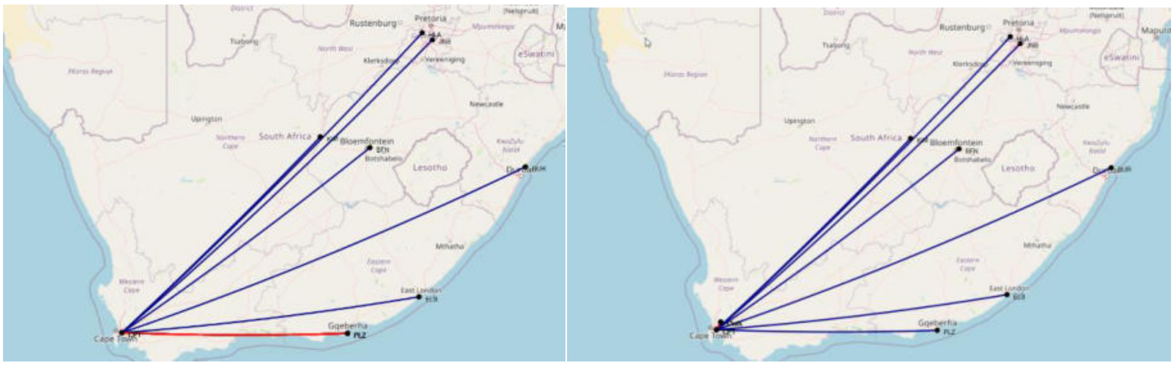

Figure 1 – PLZ and CWA as diversion airports

Table 3 – Regional/International routes, inbound CPT, JNB as diversion

	B737-800	B77W	B787-9	E190
Windhoek (WDH)	x			x
Harare (HRE)				x
Walvis Bay (WVB)				x
Maun (MUB)				x
Victoria Falls (VFA)				x
Nairobi (NBO)	x			x
Addis Ababa (ADD)	x	x	x	
London (LHR)		x	x	
Amsterdam (AMS)		x	x	
Dubai (DXB)		x		
Frankfurt (FRA)			x	
Doha (DOH)		x		
Istanbul (IST)			x	
Atlanta (ATL)		x	x	

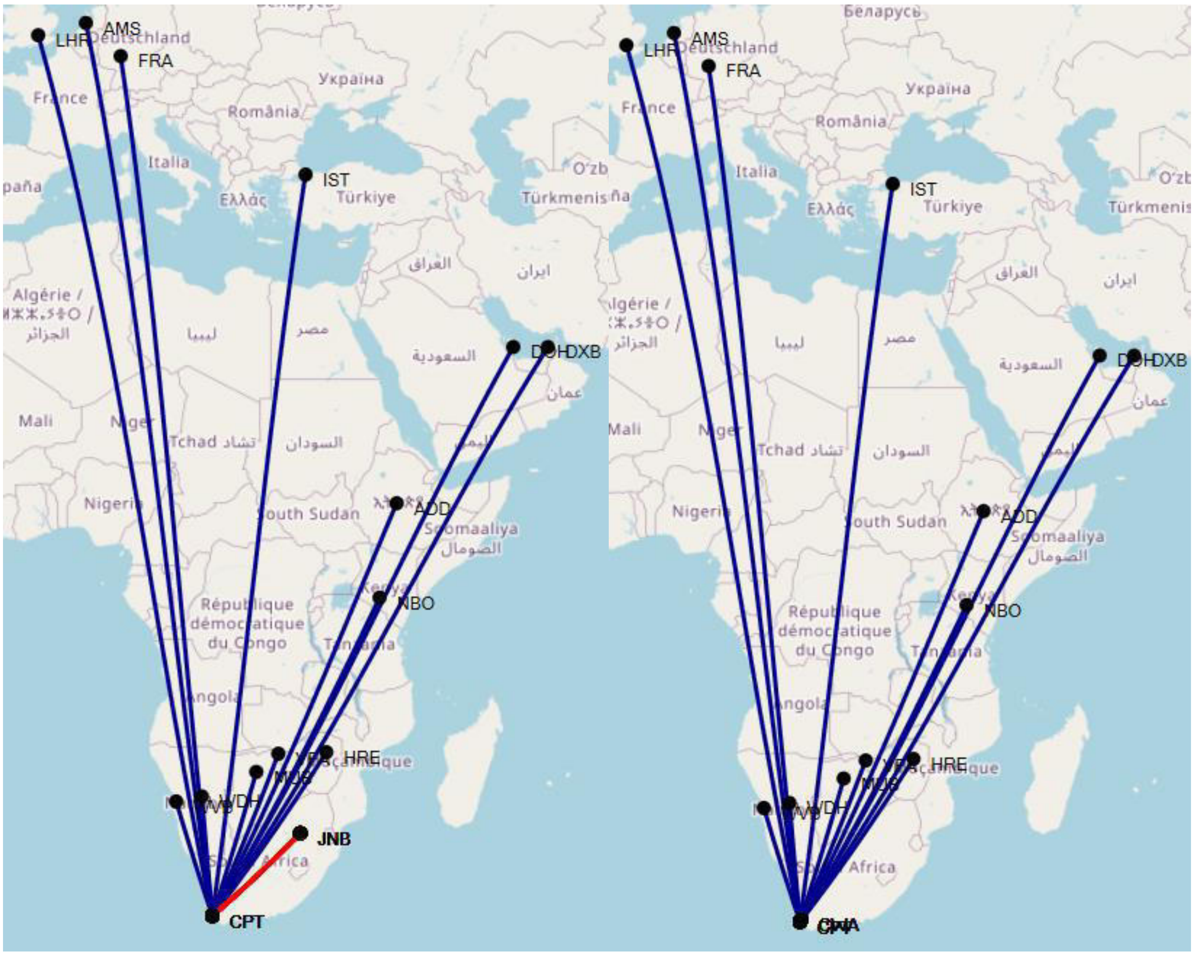

Figure 2 – JNB and CWA as diversion airports

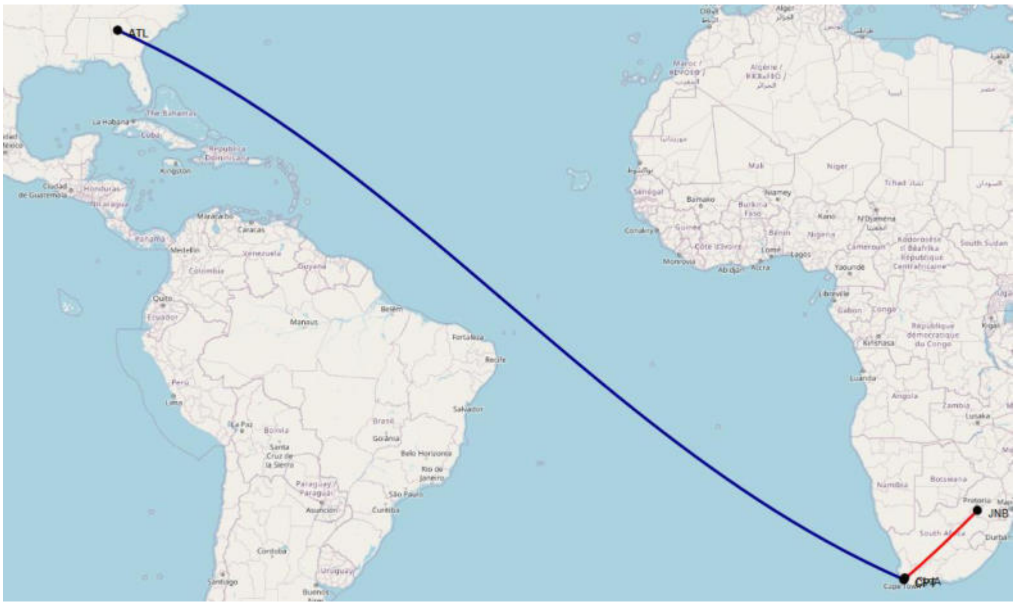

Figure 3 – Route ATL – CTP, JNB and CWA as diversion airports

4 Assumptions

- PLMS version: Pacelab Mission Suite release 7.2.0.8155
- Reclearance: no reclearance was considered
- Takeoff and Landing performance: Low speed performance was not calculated. The assumption is that there are no Takeoff/landing weight limitations.
- Fuel policy: JAR 3%, as detailed in Figure 4.
- Route distance: Great Circle Distance
- Cruise speed: LRC (Long Range Cruise speed)
- Cruise Altitude: Step cruise/Optimum altitude
- Fuel density: 0.803 kg/l
- En route wind and temperatures:
  - Cruise segment:
    - Statistical wind and temperature (PCWindTemp)
    - Period: annual
    - Reliability: 95%
  - Other segments:
    - Temperature: ISA
    - Wind = 70% of cruise wind

JAR 3%

EN-ROUTE

ENGINE START: 2 min
TAXI: 9 min
TAKEOFF AND CLIMB TO 1,500 FT AGL, distance not credited
CLIMB TO OPTIMUM ALTITUDE: Main Speed Schedule defined in Aircraft
STEP CRUISE: Main Speed Schedule defined in Aircraft, No minimum cruise length
DESCENT TO LANDING: Main Speed Schedule defined in Aircraft
APPROACH AND LANDING FROM 1,500 FT AGL: distance not credited
TAXI: 5 min, taken from reserve

DIVERSION (starts after approach)

OVERSHOOT TO 1,500 FT AGL: 80 % T/O-performance
CLIMB TO 35,000 FT: Diversion Speed Schedule defined in Aircraft
STEP CRUISE: Diversion Speed Schedule defined in Aircraft
DESCENT TO LANDING: Diversion Speed Schedule defined in Aircraft
HOLDING AT EXIT ALTITUDE OF PREVIOUS SEGMENT: Diversion Speed Schedule defined in Aircraft, 30 min
APPROACH AND LANDING FROM 1,500 FT AGL: distance not credited

CONTINGENCY fuel

Is defined as Maximum of:
3 % trip fuel
Enroute Holding, 5 min
Trip fuel consists of: TAKEOFF, CLIMB, CRUISE, DESCENT, LANDING
Burnt before diversion

Reserve is defined as the sum of:

Diversion fuel
Contingency fuel

Figure 4 – Fuel policy

5 Results

5.1 Fuel uplift saving

Table 6 – Payload, Total Fuel, and Fuel uplift saving for different Takeoff Weights, CRJ100, DUR

	ISA, no wind				With statistical winds and temps			
Takeoff Weight (kg)	Payload, PLZ div (kg)	Total Fuel, PLZ div (kg)	Total Fuel, CWA div (kg)	Fuel uplift saving (kg)	Payload, PLZ div (kg)	Total Fuel, PLZ div (kg)	Total Fuel, CWA div (kg)	Fuel uplift saving (kg)
15750	-	-	1901	-	-	-	-	-
16000	-	-	1917	-	-	-	2218	-
16250	-	-	1932	-	-	-	2236	-
16500	171	2581	1948	633	-	-	2255	-
16750	399	2603	1965	638	120	2883	2273	610
17000	627	2625	1982	644	345	2907	2292	615
17250	855	2648	1999	649	571	2932	2311	620
17500	1083	2670	2016	654	797	2956	2331	625
17750	1310	2693	2033	660	1022	2980	2350	630
18000	1537	2716	2050	666	1247	3006	2370	636
18250	1762	2740	2068	673	1471	3032	2390	642
18500	1987	2765	2086	679	1694	3059	2411	648

Figure 5 – Example of fuel uplift saving table

The fuel uplift saving is the fuel weight that could be converted to payload weight, by considering the diversion to CWA. In the example from Figure 5, for the takeoff weight of 18000 kg, the payload weight is 1537 kg, and the total fuel is 2716 kg, considering PLZ as diversion. With the same takeoff weight, the total fuel is reduced to 2050kg, considering CWA as diversion. This weight reduction of 666 kg in fuel is considered as additional payload, maintaining the takeoff weight constant.

5.3 Summary of results for ISA, no wind

The results for temperature ISA, no wind, from sections 5.1 and 5.2 are summarized in the tables below, following the template from Table 76, and considering the diversion airports according to definitions in section 3.

Additionally, the fuel volume and fuel cost were computed using the following assumptions:

- Fuel density: 0.803 kg/l
- Fuel cost per liter in ZAD: 13.00 ZAD/liter
- Fuel cost per liter in USD: 0.8125 USD/liter

Carbon emissions (CO_2) were calculated with the factor: 3.16 kg of CO_2/kg of fuel (ref. [12]).

Table 76 – Template for the summary of results Tables format/parameters

	Destination Airport
Fuel Uplift Saving	Fuel Weight in kg
Fuel Burn Saving	Fuel Weight in kg Fuel volume in l Fuel cost in ZAD Fuel cost in USD Cabon emissions (CO_2) in kg

5.3.1 CRJ100

Table 77 – Summary of results for the CRJ100

	Johannesburg International (JNB)	Durban (DUR)
Fuel Uplift Saving	634 to 774 kg	633 to 778 kg
Fuel Burn Saving	27 to 49 kg 33 to 62 l 434.35 to 799.83 ZAD 27.15 to 49.99 USD 85 to 156 kg of CO_2	28 to 52 kg 35 to 64 l 461.08 to 837.16 ZAD 28.82 to 52.32 USD 90 to 163 kg of CO_2

5.3.2 ERJ135

Table 78 – Summary of results for the ERJ135

	Bloemfontein (BFN)	Kimberley (KIM)
Fuel Uplift Saving	663 to 751 kg	654 to 751 kg
Fuel Burn Saving	24 to 34 kg 29 to 42 l 383.25 to 550.48 ZAD 23.95 to 34.40 USD 75 to 107 kg of CO_2	22 to 31 kg 27 to 39 l 355.33 to 501.47 ZAD 22.21 to 31.34 USD 69 to 98 kg of CO_2

5.3.3 E190

Table 79 – Summary of results for the E190

	Johannesburg International (JNB)	Port Elizabeth (PLZ)
Fuel Uplift Saving	1279 to 1576 kg	1280 to 1579 kg
Fuel Burn Saving	58 to 101 kg 72 to 125 l 941.71 to 1629.93 ZAD 58.86 to 101.87 USD 184 to 318 kg of CO_2	37 to 58 kg 46 to 72 l 598.98 to 940.10 ZAD 37.44 to 58.76 USD 117 to 183 kg of CO_2
	Bloemfontein (BFN)	Windhoek (WDH)
Fuel Uplift Saving	1283 to 1579 kg	2323 to 2874 kg
Fuel Burn Saving	44 to 74 kg 55 to 92 l 718.13 to 1200.40 ZAD 44.88 to 75.02 USD 140 to 234 kg of CO_2	107 to 173 kg 134 to 215 l 1739.30 to 2799.94 ZAD 108.71 to 175.00 USD 339 to 547 kg of CO_2
	Harare (HRE)	Walvis Bay (WVB)
Fuel Uplift Saving	2333 to 2866 kg	2319 to 2868 kg
Fuel Burn Saving	181 to 324 kg 225 to 403 l 2927.12 to 5244.20 ZAD 182.95 to 327.76 USD 571 to 1024 kg of CO_2	114 to 181 kg 142 to 226 l 1848.80 to 2936.63 ZAD 115.55 to 183.54 USD 361 to 573 kg of CO_2
	Maun (MUB)	Victoria Falls (VFA)
Fuel Uplift Saving	2335 to 2855 kg	2333 to 2873 kg
Fuel Burn Saving	140 to 239 kg 174 to 298 l 2263.01 to 3867.89 ZAD 141.44 to 241.74 USD 442 to 755 kg of CO_2	161 to 282 kg 201 to 351 l 2607.16 to 4565.67 ZAD 162.95 to 285.35 USD 509 to 891 kg of CO_2
	Nairobi (NBO)	
Fuel Uplift Saving	2334 to 2527 kg	
Fuel Burn Saving	356 to 421 kg 444 to 524 l 5765.84 to 6812.37 ZAD 360.36 to 425.77 USD 1125 to 1330 kg of CO_2	

5.3.4 A320-200

Table 80 – Summary of results for the A320-200

	Johannesburg International (JNB)	Durban (DUR)
Fuel Uplift Saving	1777 to 2122 kg	1774 to 2117 kg
Fuel Burn Saving	72 to 126 kg 89 to 158 l 1157.92 to 2047.86 ZAD 72.37 to 127.99 USD 226 to 400 kg of CO_2	77 to 133 kg 95 to 166 l 1241.42 to 2161.19 ZAD 77.59 to 135.07 USD 242 to 422 kg of CO_2

5.3.5 B737-800

Table 81 – Summary of results for the B737-800

	Johannesburg International (JNB)	Johannesburg Lanseria (HLA)
Fuel Uplift Saving	1781 to 2098 kg	1781 to 2098 kg
Fuel Burn Saving	74 to 117 kg 92 to 146 l 1196.43 to 1900.13 ZAD 74.78 to 118.76 USD 234 to 371 kg of CO_2	74 to 118 kg 93 to 147 l 1204.40 to 1906.89 ZAD 75.27 to 119.18 USD 235 to 372 kg of CO_2
	Durban (DUR)	**Port Elizabeth (PLZ)**
Fuel Uplift Saving	1778 to 2094 kg	1812 to 2115 kg
Fuel Burn Saving	79 to 124 kg 98 to 154 l 1273.12 to 2001.25 ZAD 79.57 to 125.08 USD 249 to 391 kg of CO_2	46 to 65 kg 57 to 81 l 741.43 to 1052.26 ZAD 46.34 to 65.77 USD 145 to 205 kg of CO_2
	Bloemfontein (BFN)	**East London (ELS)**
Fuel Uplift Saving	1800 to 2099 kg	1800 to 2100 kg
Fuel Burn Saving	56 to 84 kg 69 to 105 l 902.88 to 1361.36 ZAD 56.43 to 85.08 USD 176 to 266 kg of CO_2	57 to 84 kg 70 to 105 l 916.40 to 1359.08 ZAD 57.27 to 84.94 USD 179 to 265 kg of CO_2
	Windhoek (WDH)	**Nairobi (NBO)**
Fuel Uplift Saving	3148 to 3775 kg	3236 to 3805 kg
Fuel Burn Saving	133 to 201 kg 166 to 250 l 2152.81 to 3250.10 ZAD 134.55 to 203.13 USD 420 to 634 kg of CO_2	451 to 697 kg 561 to 868 l 7298.25 to 11282.38 ZAD 456.14 to 705.15 USD 1425 to 2202 kg of CO_2
	Addis Ababa (ADD)	
Fuel Uplift Saving	3140 to 3423 kg	
Fuel Burn Saving	602 to 700 kg 750 to 872 l 9743.57 to 11337.58 ZAD 608.97 to 708.60 USD 1902 to 2213 kg of CO_2	

5.3.6 B787-9

Table 82 – Summary of results for the B787-9

	Addis Ababa (ADD)	London (LHR)
Fuel Uplift Saving	5868 to 7235 kg	5868 to 7272 kg
Fuel Burn Saving	759 to 1034 kg 945 to 1288 l 12283.66 to 16745.94 ZAD 767.73 to 1046.62 USD 2398 to 3269 kg of CO_2	1620 to 2094 kg 2017 to 2608 l 26221.24 to 33905.22 ZAD 1638.83 to 2119.08 USD 5118 to 6618 kg of CO_2
	Amsterdam (AMS)	**Frankfurt (FRA)**
Fuel Uplift Saving	5868 to 7287 kg	5860 to 7276 kg
Fuel Burn Saving	1621 to 2096 kg 2019 to 2610 l 26240.97 to 33932.95 ZAD 1640.06 to 2120.81 USD 5122 to 6623 kg of CO_2	1560 to 2063 kg 1942 to 2570 l 25249.48 to 33404.26 ZAD 1578.09 to 2087.77 USD 4928 to 6520 kg of CO_2
	Istanbul (IST)	**Atlanta (ATL)**
Fuel Uplift Saving	5848 to 7250 kg	5862 to 6723 kg
Fuel Burn Saving	1312 to 1798 kg 1633 to 2239 l 21235.35 to 29102.53 ZAD 1327.21 to 1818.91 USD 4145 to 5681 kg of CO_2	2318 to 2720 kg 2886 to 3387 l 37522.46 to 44034.30 ZAD 2345.15 to 2752.14 USD 7324 to 8595 kg of CO_2

5.3.7 B77W

Table 83 – Summary of results for the B77W

	Addis Ababa (ADD)	London (LHR)
Fuel Uplift Saving	8220 to 10341 kg	8323 to 10314 kg
Fuel Burn Saving	1082 to 1709 kg 1347 to 2128 l 17512.31 to 27661.72 ZAD 1094.52 to 1728.86 USD 3418 to 5399 kg of CO_2	2280 to 3569 kg 2839 to 4445 l 36903.67 to 57784.44 ZAD 2306.48 to 3611.53 USD 7203 to 11279 kg of CO_2
	Amsterdam (AMS)	**Dubai (DXB)**
Fuel Uplift Saving	8322 to 10312 kg	8242 to 10297 kg
Fuel Burn Saving	2281 to 3572 kg 2841 to 4448 l 36931.22 to 57823.74 ZAD 2308.20 to 3613.98 USD 7209 to 11287 kg of CO_2	1830 to 2696 kg 2279 to 3357 l 29629.56 to 43640.20 ZAD 1851.85 to 2727.51 USD 5783 to 8518 kg of CO_2
	Doha (DOH)	**Atlanta (ATL)**
Fuel Uplift Saving	8283 to 10297 kg	8302 to 9706 kg
Fuel Burn Saving	1770 to 2619 kg 2204 to 3261 l 28648.41 to 42394.99 ZAD 1790.53 to 2649.69 USD 5592 to 8275 kg of CO_2	3747 to 4613 kg 4667 to 5744 l 60666.11 to 74676.52 ZAD 3791.63 to 4667.28 USD 11841 to 14576 kg of CO_2

5.4 Summary of results for statistical winds and temperatures

The results for statistical winds and temperatures, from sections 5.1 and 5.2 are summarized in the tables below, considering the diversion airports according to definitions in section 3.
As mentioned in section 4, the statistical winds and temperatures were determined assuming the annual basis and a reliability of 95%. This means that the historical winds and temperatures are more favorable than the winds used in this project, in 95% of the cases in an annual basis.

For the E190 flying from Nairobi (NBO) and for the B737-800 flying from Addis Ababa (ADD), the fuel burn savings are expressed in terms of a single value instead of a range of values. The reason is that for these cases the comparison between the two missions could only be achieved for a single value of payload due to the size of the payload weight step adopted (please refer to Table 52 and Table 63, respectively). In both cases, the increase in payload is not possible due to the maximum fuel capacity limit.

5.4.1 CRJ100

Table 84 – Summary of results for the CRJ100

	Johannesburg International (JNB)	Durban (DUR)
Fuel Uplift Saving	612 to 753 kg	610 to 750 kg
Fuel Burn Saving	30 to 58 kg 37 to 72 l 487.43 to 931.64 ZAD 30.46 to 58.23 USD 95 to 182 kg of CO_2	33 to 62 kg 41 to 77 l 530.46 to 1001.92 ZAD 33.15 to 62.62 USD 104 to 196 kg of CO_2

5.4.2 ERJ135

Table 85 – Summary of results for the ERJ135

	Bloemfontein (BFN)	Kimberley (KIM)
Fuel Uplift Saving	634 to 728 kg	637 to 726 kg
Fuel Burn Saving	25 to 39 kg 31 to 48 l 397.85 to 629.56 ZAD 24.87 to 39.35 USD 78 to 123 kg of CO_2	23 to 35 kg 28 to 44 l 366.21 to 565.58 ZAD 22.89 to 35.35 USD 71 to 110 kg of CO_2

5.4.3 E190

Table 86 – Summary of results for the E190

	Johannesburg International (JNB)	Port Elizabeth (PLZ)
Fuel Uplift Saving	1240 to 1536 kg	1245 to 1537 kg
Fuel Burn Saving	64 to 123 kg 80 to 153 l 1034.99 to 1987.62 ZAD 64.69 to 124.23 USD 202 to 388 kg of CO_2	40 to 69 kg 50 to 86 l 653.48 to 1114.61 ZAD 40.84 to 69.66 USD 128 to 218 kg of CO_2
	Bloemfontein (BFN)	**Windhoek (WDH)**
Fuel Uplift Saving	1234 to 1535 kg	2330 to 2862 kg
Fuel Burn Saving	49 to 89 kg 61 to 111 l 786.60 to 1438.10 ZAD 49.16 to 89.88 USD 154 to 281 kg of CO_2	112 to 190 kg 140 to 236 l 1816.15 to 3073.54 ZAD 113.51 to 192.10 USD 354 to 600 kg of CO_2
	Harare (HRE)	**Walvis Bay (WVB)**
Fuel Uplift Saving	2319 to 2873 kg	2329 to 2861 kg
Fuel Burn Saving	204 to 387 kg 254 to 482 l 3304.26 to 6265.35 ZAD 206.52 to 391.58 USD 645 to 1223 kg of CO_2	117 to 193 kg 146 to 241 l 1896.75 to 3132.62 ZAD 118.55 to 195.79 USD 370 to 611 kg of CO_2
	Maun (MUB)	**Victoria Falls (VFA)**
Fuel Uplift Saving	2316 to 2371 kg	2316 to 2371 kg
Fuel Burn Saving	152 to 281 kg 189 to 350 l 2456.93 to 4549.89 ZAD 153.56 to 284.37 USD 480 to 888 kg of CO_2	177 to 333 kg 220 to 415 l 2864.51 to 5394.52 ZAD 179.03 to 337.16 USD 559 to 1053 kg of CO_2
	Nairobi (NBO)	
Fuel Uplift Saving	2316 to 2371 kg	
Fuel Burn Saving	393 kg 490 l 6365.49 ZAD 397.84 USD 1242 kg of CO_2	

5.4.4 A320-200

Table 87 – Summary of results for the A320-200

	Johannesburg International (JNB)	Durban (DUR)
Fuel Uplift Saving	1722 to 2068 kg	1737 to 2072 kg
Fuel Burn Saving	80 to 153 kg 100 to 190 l 1294.09 to 2469.50 ZAD 80.88 to 154.34 USD 253 to 482 kg of CO_2	87 to 167 kg 109 to 208 l 1412.32 to 2704.08 ZAD 88.27 to 169.01 USD 276 to 528 kg of CO_2

5.4.5 B737-800

Table 88 – Summary of results for the B737-800

	Johannesburg International (JNB)	Johannesburg Lanseria (HLA)
Fuel Uplift Saving	1719 to 2042 kg	1719 to 2043 kg
Fuel Burn Saving	81 to 144 kg 101 to 179 l 1316.05 to 2327.03 ZAD 82.25 to 145.44 USD 257 to 454 kg of CO_2	82 to 137 kg 102 to 170 l 1320.54 to 2216.10 ZAD 82.53 to 138.51 USD 258 to 433 kg of CO_2
	Durban (DUR)	**Port Elizabeth (PLZ)**
Fuel Uplift Saving	1713 to 2035 kg	1753 to 2042 kg
Fuel Burn Saving	88 to 157 kg 109 to 195 l 1420.73 to 2535.75 ZAD 88.80 to 158.48 USD 277 to 495 kg of CO_2	50 to 75 kg 63 to 94 l 813.23 to 1216.23 ZAD 50.83 to 76.01 USD 159 to 237 kg of CO_2
	Bloemfontein (BFN)	**East London (ELS)**
Fuel Uplift Saving	1740 to 2048 kg	1739 to 2046 kg
Fuel Burn Saving	61 to 97 kg 76 to 121 l 991.71 to 1573.62 ZAD 61.98 to 98.35 USD 194 to 307 kg of CO_2	63 to 99 kg 78 to 123 l 1017.71 to 1601.96 ZAD 63.61 to 100.12 USD 199 to 313 kg of CO_2
	Windhoek (WDH)	**Nairobi (NBO)**
Fuel Uplift Saving	3138 to 3810 kg	3195 to 3797 kg
Fuel Burn Saving	139 to 213 kg 173 to 266 l 2254.19 to 3453.19 ZAD 140.89 to 215.82 USD 440 to 674 kg of CO_2	496 to 727 kg 618 to 905 l 8031.80 to 11763.16 ZAD 501.99 to 735.20 USD 1568 to 2296 kg of CO_2
	Addis Ababa (ADD)	
Fuel Uplift Saving	3136 to 3238 kg	
Fuel Burn Saving	650 kg 810 l 10529.48 ZAD 658.09 USD 2055 kg of CO_2	

5.4.6 B787-9

Table 89 – Summary of results for the B787-9

	Addis Ababa (ADD)	London (LHR)
Fuel Uplift Saving	5873 to 7270 kg	5825 to 7265 kg
Fuel Burn Saving	849 to 1100 kg 1057 to 1370 l 13742.54 to 17807.18 ZAD 858.91 to 1112.95 USD 2682 to 3476 kg of CO_2	1719 to 2149 kg 2141 to 2676 l 27832.13 to 34786.59 ZAD 1739.51 to 2174.16 USD 5433 to 6790 kg of CO_2
	Amsterdam (AMS)	**Frankfurt (FRA)**
Fuel Uplift Saving	5867 to 7259 kg	5858 to 7316 kg
Fuel Burn Saving	1725 to 2149 kg 2148 to 2676 l 27924.65 to 34788.64 ZAD 1745.29 to 2174.29 USD 5451 to 6790 kg of CO_2	1660 to 2106 kg 2067 to 2623 l 26866.48 to 34095.72 ZAD 1679.15 to 2130.98 USD 5244 to 6655 kg of CO_2
	Istanbul (IST)	**Atlanta (ATL)**
Fuel Uplift Saving	5829 to 7310 kg	5847 to 6759 kg
Fuel Burn Saving	1468 to 1902 kg 1828 to 2368 l 23759.96 to 30788.38 ZAD 1485.00 to 1924.27 USD 4638 to 6010 kg of CO_2	2373 to 2875 kg 2955 to 3580 l 38417.30 to 46543.51 ZAD 2401.08 to 2908.97 USD 7499 to 9085 kg of CO_2

5.4.7 B77W

Table 90 – Summary of results for the B77W

	Addis Ababa (ADD)	London (LHR)
Fuel Uplift Saving	8412 to 10364 kg	8243 to 10367 kg
Fuel Burn Saving	1175 to 2244 kg 1463 to 2794 l 19020.38 to 36325.10 ZAD 1188.77 to 2270.32 USD 3713 to 7090 kg of CO_2	2411 to 3679 kg 3003 to 4582 l 39034.04 to 59560.59 ZAD 2439.63 to 3722.54 USD 7619 to 11626 kg of CO_2
	Amsterdam (AMS)	Dubai (DXB)
Fuel Uplift Saving	8236 to 10358 kg	8376 to 10364 kg
Fuel Burn Saving	2420 to 3676 kg 3013 to 4578 l 39170.04 to 59514.74 ZAD 2448.13 to 3719.67 USD 7646 to 11617 kg of CO_2	1984 to 4217 kg 2470 to 5252 l 32114.30 to 68273.53 ZAD 2007.14 to 4267.10 USD 6268 to 13326 kg of CO_2
	Doha (DOH)	Atlanta (ATL)
Fuel Uplift Saving	8425 to 10376 kg	8327 to 9762 kg
Fuel Burn Saving	1917 to 4046 kg 2388 to 5038 l 31038.57 to 65495.73 ZAD 1939.91 to 4093.48 USD 6058 to 12784 kg of CO_2	3943 to 4907 kg 4910 to 6111 l 63826.98 to 79446.83 ZAD 3989.19 to 4965.43 USD 12458 to 15507 kg of CO_2

6 Conclusion

The individual route results generated by Pacelab Mission Suite (using projects [10] and [11]), for several takeoff weights (reference [8]) and for several payloads (reference [9]), were post-processed. In this step Excel was used to compare the difference in fuel, payload/takeoff weight between two scenarios: the original diversion (PLZ or JNB) and the CWA as diversion.
The fuel uplift saving weights reach the order of 600 kg to 10 tons (for the CRJ100 and for the B77W, respectively).
The fuel burn saving weights reach the order of 30 kg to 3 tons (for the CRJ100 and for the B77W, respectively).
These weight reductions are possible because the distance from the destination airport CPT to the CWA airport (14 NM) is lower than the distance to PLZ (491 NM) or JNB (686 NM). Such reduction in diversion distance results in less fuel weight being allocated to the reserve.