Federal Ministry
of Transport, Building
and Urban Development

ICAO State Action Plan on Emissions Reduction

- Germany-

Transport Mobility Housing Urban and Rural Areas Transport Mobility Housing Urban and Rural Areas **www.bmvbs.de** Transport Mobility Housing Urban and Rural Areas Transport Mobility Housing Urban and Rural Areas Transport

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INTRODUCTION 4

Current state of aviation in the Federal Republic of Germany 6

Structure of the aviation sector and its contribution to CO2 emissions 6

General Transport Data 8

Geographical characteristics 17

SECTION 1- Supra-national actions, including those led by the EU 17

1. Aircraft related Technology Development 17

2. Alternative Fuels 20

3. Improved Air Traffic Management and Infrastructure Use 23

4. Economic / market-based measures 26

5. Support to voluntary actions: ACI Airport Carbon Accreditation 28

SECTION 2- National Measures in Federal Republic of Germany 30

1. Aircraft related Technology Development 30

2. Alternative Fuels 34

3. Improved Air Traffic Management and Infrastructure Use 35

4. Economic / market-based measures 41

5. Support to voluntary actions: ACI Airport Carbon Accreditation 41

Annex 41

INTRODUCTION

a) The Federal Republic of Germany is a Member of European Union and of the European Civil Aviation Conference (ECAC). ECAC is an intergovernmental organisation covering the widest grouping of Member States1 of any European organisation dealing with civil aviation. It is currently composed of 44 Member States, and was created in 1955.

b) The ECAC States share the view that environmental concerns represent a potential constraint on the future development of the international aviation sector, and together they fully support ICAO's ongoing efforts to address the full range of these concerns, including the key strategic challenge posed by climate change, for the sustainable development of international air transport.

c) The Federal Republic of Germany, like all of ECAC's forty-four States, is fully committed to and involved in the fight against climate change, and works towards a resource-efficient, competitive and sustainable multimodal transport system.

d) The Federal Republic of Germany recognises the value of each State preparing and submitting to ICAO a State Action Plan on emission reductions, as an important step towards the achievement of the global collective goals agreed at the 37th Session of the ICAO Assembly in 2010. ICAO Assembly Resolution A37-19 also encourages states to submit an annual reporting on international aviation CO_2 emissions. This is considered by Europe to be an important task, but one which is different in nature and purpose from the Action Plans, which are strategic in their nature. For that reason, the reporting to ICAO on international aviation CO_2 emissions referred to at paragraph 9 of ICAO Resolution A37/19 is not part of this Action Plan, nor of those submitted by other Member States of ECAC. This information will be provided to ICAO separately. However an overview of the CO_2 emissions of aviation of Germany in the past years based on the IPCC guidelines is attached in Annex 2.

e) In this context, it is the intention that all ECAC States to submit to ICAO an Action Plan2, regardless of whether or not the 1% de mimimis threshold is met, thus going beyond the agreement of ICAO Assembly Resolution A/37-19. This is the Action Plan of the Federal Republic of Germany.

f) The Federal Republic of Germany shares the view of all ECAC States that a comprehensive approach to reducing aviation emissions is necessary, and that this should include:

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1 Albania, Armenia, Austria, Azerbaijan, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, The former Yugoslav Republic of Macedonia, Turkey, Ukraine, and the United Kingdom

i. emission reductions at source, including European support to CAEP work;

ii. research and development on emission reduction technologies, including public-private partnerships;

iii. the development and deployment of sustainable alternative low-carbon fuels, including research and operational initiatives undertaken jointly with stakeholders;

iv. the optimisation and improvement of Air Traffic Management and infrastructure use within Europe, in particular through the Single European Sky ATM Research (SESAR), and also beyond European borders, through the Atlantic Initiative for the Reduction of Emissions (AIRE) in cooperation with the US FAA;

v. market-based measures, such as open emission trading schemes (ETS) which allow the sector to continue to grow in a sustainable and efficient manner, recognising that the measures at (i) to (iv) above cannot, even in aggregate, deliver in time the emission reductions necessary to meet the global goals. This growth becomes possible through the purchase under an ETS of CO_2 allowances from other sectors of the economy, where abatement costs are lower than within the aviation sector.

g) In Europe, many of the actions which are undertaken within the framework of this comprehensive approach are in practice taken at a supranational level, most of them led by the EU. They are reported in Section 1 of this Action Plan, where the Federal Republic of Germany involvement in them is described, as well as that of stakeholders.

h) In the Federal Republic of Germany a number of actions are undertaken at the national level, including by stakeholders, in addition to those of a supranational nature. These national actions are reported in Section 2 of this Plan.

i) In relation to actions which are taken at a supranational level, it is important to note that:

i. The extent of participation will vary from one state to another, reflecting the priorities and circumstances of each state (economic situation, size of its aviation market, historical and institutional context, such as EU/non EU). The ECAC States are thus involved to different degrees and on different timelines in the delivery of these common actions. When an additional state joins a collective action, also at a later stage, this broadens the effect of the measure, thus increasing the European contribution to meeting the global goals.

ii. Nonetheless, acting together, the ECAC States have undertaken to reduce the region's emissions through a comprehensive approach which uses each of the pillars of that approach. Some of the component measures, although implemented by some but not all of ECAC's 44 States, nonetheless yield emission reduction benefits across the whole of the region (thus for example research, ETS).

Current state of aviation in the Federal Republic of Germany

National Framework with regard to Climate change

In the framework of EU effort sharing under the Kyoto Protocol, Germany has committed itself to cutting its emissions of climate-damaging gases by a total of 21% in the period 2008 to 2012 compared with 1990.

In addition, Germany has pledged to reduce its GHG emissions by even 40% by 2020 compared with 1990, irrespective of the necessary efforts by other states.

Structure of the aviation sector and its contribution to CO2 emissions

An overview of the CO_2 emissions of aviation of Germany in the past years based on the IPCC guidelines is attached below and in Annex 2. It is planned, that the Annexes will be updated on a regular basis. The CO_2 emissions from civil aircraft in Germany in the area of international aviation have grown about 25% in the last 10 years..

CO_2 emissions (kt) of aviation of Germany in the past years based on the IPCC guidelines

Year	domestic flights	international flights	total flights
2000	2.325,47	19.528,96	21.854,43
2001	2.194,41	19.101,49	21.295,90
2002	2.109,91	19.001,11	21.111,02
2003	2.074,55	19.357,35	21.431,90
2004	2.041,10	21.170,05	23.211,15
2005	2.148,78	23.088,08	25.236,86
2006	2.273,09	24.235,61	26.508,69
2007	2.264,99	25.207,35	27.472,34
2008	2.258,42	25.502,60	27.761,02
2009	2.114,43	24.829,41	26.943,84
2010	1.989,61	24.550,31	26.539,92

Source: Umweltbundesamt

Aircraft Fleet in the Federal Republic of Germany

Categories	2003	2004	2005	2006	2007	2008	2009	2010
A Aircraft over 20 t	653	619	651	663	702	734	757	772
B Aircraft 14 to 20 t	54	55	54	56	51	45	43	40
C Aircraft 5.7 to 14 t	179	172	176	181	200	224	231	228
E Single-engine aircraft below 2 t	6.658	6.670	6.682	6.704	6.705	6.738	6.752	6.801
F Single-engine aircraft 2 to 5.7 t	97	94	93	102	120	126	144	153
G Multi-engined aircraft below 2 t	205	199	212	224	230	232	241	242
I Multi-engined aircraft 2 to 5.7 t	452	440	417	417	417	436	445	444
H Rotorcraft (helicopters)	725	720	721	729	731	739	780	811
K Powered gliders	2.533	2.584	2.664	2.766	2.824	2.948	3.022	3.081
L. Airships	6	6	4	4	4	4	3	4
O Balloons	1.362	1.351	1.305	1.278	1.264	1.286	1.261	1.260
Gliders	7.686	7.703	7.728	7.741	7.769	7.815	7.891	7.867
Aircraft in total	**20.610**	**20.613**	**20.707**	**20.865**	**21.017**	**21.327**	**21.570**	**21.703**

Source: http://www.lba.de/DE/Oeffentlichkeitsarbeit/Statistiken

Number of airlines with active operating licence

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Number of airlines	145	133	120	119	153	170	171	163	165	170

Source: http://www.lba.de/DE/Oeffentlichkeitsarbeit/Statistiken

Statistics enterprises for development, production and maintenance

	2006	2007	2008	2009	2010
Number of the national development enterprises approved by LBA	10	15	23	24	24
Number of approved production enterprises	144	150	149	151	151
Number of approved CAMOs in airlines	168	169	197	203	203
Number of other CAMOs	-	-	47	136	136
Number of approved maintenance enterprises (LTB, part-145, M/F enterprises)	436	430	501	593	593
Number of maintenance enterprises in non-EU countries managed on behalf of EASA	20	18	16	17	17
Number of production enterprises in non-EU countries managed on behalf of EASA	-	-	1	2	2

Source : http://www.lba.de/DE/Oeffentlichkeitsarbeit/Statistiken

General Transport Data

General table

Scope of verification		2008	2009	2010	2011		
					Aug.	Sept.	Okt.
Güterverkehr / Goods Transport		Transport quantity (in 1000 t)					
	Rail transport[1)]	371 298	312 087	355 715	31 069	32 187	…
	Road transport[2)]	3 077 845	2 768 694	2 734 098	…	…	…
	Aviation	3 621	3 398	4 164	353	369	…
	Pipelines: crude oil[3)]	91 069	88 405	88 842	7 645	7 295	7 846
	Maritime transport[5)]	316 651	259 445	272 868	24 703	…	…
	Inland waterway transport	245 674	203 868	229 607	19 669	…	…

		Domestic transport performance (in million tkm)					
	Rail transport[1)]	115 652	95 834	107 317	9 168	9 653	…
	Road transport[2)4)]	341 551	307 575	313 097	…	…	…
	Pipelines: crude oil[3)]	15 670	15 950	16 259	1 439	1 317	1 295
	Inland waterway transport	64 057	55 497	62 278	5 188	…	…
Personenverkehr / Passenger transport		Passengers carried (in millions)					
	Aviation	166	159	167	17	17	…
	By bus and rail (from 2004)						
	→ Scheduled short-distance transport	10 431	10 555	10 572	2 674 [6)]	…	…
	→ Scheduled long-distance transport	126	125	128	32 [6)]	…	…
	Occasional services	83	83	X	X	X	X

1) By wagon load services / *Full wagonloads. Corrected annual data.*

2) Source: Bundesamt für Güterverkehr, Köln; Kraftfahrt-Bundesamt, Flensburg; only domestic lorries.

3) Source: Bundesamt für Wirtschaft und Ausfuhrkontrolle, Eschborn.

4) *Including tkm abroad.*
/ Since reporting year 2000 incl maritime transshipment of inland ports.

6) 2. 6) 2nd quarter of 2011.

Source:
http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Content/Publikationen/Fachveroeffentlichungen/Verkehr

Air freight and air mail by main traffic relations

Year/month	total (in tons)	Of which					
		Domestic transport	International transport			Uninterrupted through transport
			Total	Export	Import	
2001	2 292 371	170 637	2 097 250	1 119 511	977 739	24 484
2002	2 401 015	161 260	2 199 767	1 163 598	1 036 169	39 988
2003[1)]	2 481 239	134 246	2 308 858	1 193 854	1 115 004	38 135
2004[1)]	2 814 438	122 070	2 662 988	1 356 869	1 306 119	29 380
2005[1)]	3 036 210	103 694	2 902 086	1 454 877	1 447 209	30 430
2006[1)]	3 298 987	105 162	3 163 772	1 597 845	1 565 927	30 053
2007	3 468 745	106 066	3 312 247	1 692 211	1 620 036	50 432
2008[1)]	3 621 163	129 483	3 439 051	1 730 225	1 708 826	52 629
2009	3 398 161	109 637	3 231 545	1 643 898	1 587 647	56 979
2010	4 163 716	105 492	3 993 120	2 062 600	1 930 520	65 104
2010						
Sept.	363 978	9 534	347 580	179 874	167 706	6 864
Oct.	391 255	9 521	375 825	193 422	182 403	5 909
Nov.	381 752	9 725	367 436	190 343	177 093	4 591
Dec.	357 312	8 764	343 178	177 952	165 226	5 370
2011[2)]						
Jan.	337 868	9 069	317 586	167 098	150 488	11 213
Febr.	337 598	9 092	316 379	171 325	145 054	12 127
March	408 234	11 020	384 685	204 009	180 676	12 529
Apr.	378 681	9 603	356 266	186 710	169 556	12 812
May	391 468	10 224	368 099	195 613	172 486	13 145
June	368 961	9 222	346 274	183 253	163 021	13 465
July	381 933	9 858	358 276	193 190	165 086	13 799

Aug.	352 751	9 458	329 875	176 076	153 799	13 418
Sept.	368 957	10 133	346 709	183 299	163 410	12 115
Jan. – Sept.	3 326 451	87 679	3 124 149	1 660 573	1 463 576	114 623

Transhipment of air freight and mail on selected airports

Year/month	Total (in tons)	Of which					
		Frankfurt	Köln/Bonn	Leipzig	München	Hahn	Düsseldorf
2001	2 184 899	1 466 455	439 518	7 335	123 249	...	51 354
2002	2 274 629	1 491 080	493 337	7 784	144 951	...	45 405
2003[1)]	2 359 346	1 519 602	517 578	9 298	141 100	36 485	47 610
2004[1)]	2 712 218	1 712 800	611 525	5 528	171 142	66 070	55 865
2005[1)]	2 949 730	1 853 383	640 114	11 425	203 045	100 943	56 331
2006[1)]	3 222 623	2 021 762	685 454	26 812	224 423	113 180	59 222
2007	3 372 774	2 068 032	703 734	86 078	250 767	109 443	57 634
2008[1)]	3 697 848	2 104 348	574 123	430 234	264 933	122 131	70 166
2009	3 450 785	1 882 663	549 026	508 792	234 341	105 060	65 108
2010	4 206 962	2 271 843	639 284	637 757	289 878	164 825	87 123
2010							
Sept.	366 664	188 988	59 319	58 141	26 326	14 461	8 867
Oct.	395 100	209 915	61 524	61 287	28 032	16 083	7 944
Nov.	386 891	203 127	60 455	59 412	27 211	19 657	7 000
Dec.	360 852	183 195	59 329	60 391	25 178	16 946	6 008
2011[2)]							
Jan.	335 363	173 500	53 874	54 814	22 758	14 770	5 913
Febr.	334 284	173 254	52 063	54 090	22 733	15 888	6 222
March	405 848	206 350	64 393	65 417	28 280	22 769	7 336
Apr.	375 335	191 169	59 133	60 032	27 289	20 722	6 959
May	388 267	191 821	69 776	63 164	27 067	18 724	7 551
June	364 554	183 557	61 260	59 727	24 583	19 026	6 708

July	378 074	192 324	59 760	63 077	25 504	20 077	7 135
Aug.	349 371	175 685	58 157	58 881	23 196	16 915	7 063
Sept.	367 005	180 206	62 024	65 041	25 039	18 391	6 573
Jan. – Sept.	3 298 101	1 667 866	540 440	544 243	226 449	167 282	61 460

Passengers at selected airports according to main traffic relations (destination)

Year/month	Total (in thousands)	Of which				
		Domestic transport	International transport			Uninterrupted through traffic
			Total	Export	Import	
2001	117 804	20 311	97 241	48 574	48 667	253
2002	113 974	19 763	93 981	47 075	46 906	230
2003[1)]	120 796	20 693	99 943	50 077	49 866	161
2004[1)]	135 848	21 090	114 465	57 271	57 194	293
2005[1)]	146 190	21 776	124 076	62 079	61 997	338
2006[1)]	154 484	22 646	131 322	65 655	65 667	516
2007	164 150	24 079	139 466	69 658	69 808	606
2008[1)]	166 291	24 724	140 912	70 383	70 529	655
2009	158 855	23 598	134 422	67 207	67 215	834
2010	166 803	24 021	141 966	71 015	70 951	816
2010						
Sept.	16 817	2 326	14 423	7 077	7 346	67
Oct.	16 692	2 319	14 318	6 990	7 328	55
Nov.	12 708	2 206	10 452	5 125	5 327	50
Dec.	11 292	1 757	9 473	4 792	4 680	63

2011						
Jan.	11 162	1 767	9 305	4 550	4 755	90
Febr.	10 773	1 832	8 864	4 472	4 392	77
March	13 249	2 120	11 056	5 515	5 541	73
Apr.	14 289	1 966	12 255	6 187	6 068	69
May	16 002	2 267	13 626	6 849	6 777	109
June	16 345	2 005	14 228	7 159	7 069	112
July	17 816	2 032	15 677	8 121	7 556	107
Aug.	17 283	1 841	15 340	7 616	7 724	101
Sept.	17 406	2 274	15 048	7 341	7 706	85
Jan. – Sept.	134 325	18 104	115 398	57 810	57 588	823

Departing and arriving passengers at selected airports

Year/month	(in thousands)	Of which					
		Frankfurt	München	Düsseldorf	Berlin (Tegel)	Hamburg	Köln/Bonn
2001	138 310	48 197	23 414	15 294	9 834	9 371	5 631
2002	134 962	48 081	22 879	14 589	9 800	8 790	5 291
2003[1)]	141 324	48 025	23 955	14 125	11 027	9 366	7 675
2004[1)]	156 653	50 703	26 603	15 093	10 976	9 765	8 252
2005[1)]	167 628	51 791	28 451	15 393	11 475	10 575	9 387
2006[1)]	176 614	52 404	30 609	16 511	11 769	11 875	9 813
2007	187 625	53 856	33 816	17 782	13 331	12 690	10 404
2008[1)]	190 362	53 189	34 402	18 104	14 454	12 782	10 298
2009	181 618	50 574	32 561	17 726	14 133	12 179	9 697

2010	190 010	52 646	34 519	18 910	14 966	12 884	9 787
2010							
Sept.	19 076	5 061	3 465	1 960	1 516	1 280	1 036
Oct.	18 957	4 993	3 379	1 979	1 526	1 320	989
Nov.	14 865	4 108	2 836	1 489	1 295	1 045	679
Dec.	12 986	3 758	2 502	1 220	1 066	892	597
2011							
Jan.	12 841	3 850	2 549	1 234	1 054	849	560
Febr.	12 528	3 564	2 491	1 237	1 120	885	534
March	15 297	4 312	2 955	1 530	1 313	1 081	689
Apr.	16 187	4 630	3 077	1 568	1 366	1 109	736
May	18 161	5 025	3 401	1 906	1 556	1 234	922
June	18 242	5 074	3 376	1 843	1 514	1 191	916
July	19 743	5 540	3 615	2 051	1 584	1 303	1 006
Aug.	19 026	5 339	3 406	1 970	1 482	1 200	995
Sept.	19 597	5 291	3 556	2 067	1 655	1 322	1 023
Jan. – Sept.	151 622	42 625	28 426	15 407	12 644	10 176	7 381

Year/month	Stuttgart	Berlin (Schöne-feld)	Hannover	Nürnberg	Hahn	Nieder-rhein	Bremen
2001	7 522	1 782	5 032	3 164	430	-	1 796
2002	7 096	1 580	4 584	3 111	1 444	-	1 651
2003[1)]	7 418	1 648	4 905	3 213	2 332	-	1 601
2004[1)]	8 651	3 294	5 123	3 549	2 738	-	1 637
2005[1)]	9 248	5 003	5 535	3 883	2 998	584	1 710

2006[1)]	10 021	6 013	5 609	4 001	3 509	583	1 678
2007	10 271	6 306	5 587	4 230	3 953	846	2 219
2008[1)]	9 877	6 616	5 570	4 230	3 885	1 519	2 477
2009	8 879	6 768	4 907	3 929	3 738	2 390	2 435
2010	9 138	7 255	4 996	4 020	3 454	2 882	2 657
2010							
Sept.	994	695	534	373	316	288	261
Oct.	932	724	549	339	353	297	281
Nov.	681	567	368	377	223	203	202
Dec.	576	542	306	313	208	187	177
2011							
Jan.	528	489	301	286	183	168	161
Febr.	526	466	293	294	171	169	164
March	656	566	390	367	227	209	209
Apr.	729	591	434	356	253	213	213
May	880	604	497	311	254	219	230
June	956	631	485	335	279	222	226
July	980	684	555	337	304	252	251
Aug.	1 019	655	525	365	304	257	237
Sept.	1 021	667	571	373	272	226	248
Jan. – Sept.	7 294	5 353	4 050	3 023	2 247	1 934	1 940

Source:
http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Content/Publikationen/Fachveroeffentlichungen/Verkehr

Geographical characteristics

Germany is a federal republic in Europe and a Member State of the European Union. It covers an area of 357,021 km^2 and is the Member State with the biggest population (81,8 Million inhabitants) of the European Union. It is the fourth largest economy in the world.

In the passenger aviation area Frankfurt/Main is the biggest hub, followed by Munich, Düsseldorf and Berlin. With regard to cargo flights, Frankfurt, Köln/Bonn and Leipzig are the biggest hubs.

Due to the size of Germany, the aviation sector is much diversified; therefore many passenger and cargo airlines are operating from within Germany. Passengers are able to transfer quickly at the German hubs, and practically every destination in the world can be easily accessed for cargo.

In the framework of the aviation administration the Federal Government transferred functions and responsibilities to the federal states, the Laender, for example the licencing of airfields. Furthermore, the Laender play an important role as the authorities and owners of civil airports

SECTION 1- Supra-national actions, including those led by the EU

1. AIRCRAFT-RELATED TECHNOLOGY DEVELOPMENT

Aircraft emissions standards

European states fully support the ongoing work in ICAO's Committee on Aviation Environmental Protection (CAEP) to develop an aircraft CO_2 standard. Assembly Resolution A37-19 requests the Council to develop a global CO_2 standard for aircraft aiming for 2013. It is recognised that this is an ambitious timeframe for the development of a completely new ICAO standard. Europe is contributing to this task notably through the European Aviation Safety Agency providing the co-rapporteurship of the CO_2 task group within CAEP's Working Group 3.

In the event that a standard, comprising certification requirement and regulatory level, is adopted in 2013, it is likely to have an applicability date set some years in the future. The contribution that such a standard will make towards the global aspirational goals will of course depend on the regulatory level that is set, but it seems unlikely that an aircraft CO_2 standard could have any significant effect on the fuel efficiency of the global in-service fleet until well after 2020.

Research and development

Clean Sky is an EU **Joint Technology Initiative** (JTI) that aims to develop and mature breakthrough "clean technologies" for air transport. By accelerating their deployment, the JTI will contribute to Europe's strategic environmental and social priorities, and simultaneously promote competitiveness and sustainable economic growth.

Joint Technology Initiatives are specific large-scale EU research projects created by the European Commission within the 7th Framework Programme (FP7) in order to allow the achievement of ambitious and complex research goals. Set up as a Public Private Partnership between the European

Commission and the European aeronautical industry, Clean Sky will pull together the research and technology resources of the European Union in a coherent, 7-year, €1.6bn programme, and contribute significantly to the ’greening’ of aviation.

The Clean Sky goal is to identify, develop and validate the key technologies necessary to achieve major steps towards the Advisory Council for Aeronautics Research in Europe (ACARE) environmental goals for 2020 when compared to 2000 levels:

- Fuel consumption and carbon dioxide (CO_2) emissions reduced by 50%
- Nitrous oxides (NO_X) emissions reduced by 80%
- Perceived external noise reduction of 50%
- Improved environmental impact of the lifecycle of aircraft and related products.

Three complementary instruments are used by Clean Sky in meeting these goals:

Technologies.

These are selected, developed and monitored in terms of maturity, or “technology readiness level” (TRL). A detailed list of more than one hundred key technologies has been set. The technologies developed by Clean Sky will cover all major segments of commercial aircraft.

Concept Aircraft.

These are design studies dedicated to integrating technologies into a viable conceptual configuration, and assessing their potential and relevance. They cover a broad range of aircraft: business jets, regional and large commercial aircraft, as well as rotorcraft. They have been grouped and categorised in order to represent the major future aircraft families. Clean Sky’s environmental results will be measured and reported upon principally by Concept Aircraft.

Demonstration Programmes.

Some technologies can be assessed during their development phase, but many key technologies need to be validated at an integrated vehicle or system level via dedicated demonstrators. These demonstrators pull together several technologies at a larger “system” or aircraft level. Airframe, Engine and Systems technologies are monitored through in-flight or large scale ground demonstrations. The aim is to validate the feasibility of these technologies in relevant (in-flight or operating) conditions. Their performance can then be predicted in areas such as mechanical or in-flight behaviour. This in turn will help determine the true potential of the technologies and enable a realistic environmental assessment. Demonstrations enable technologies to reach a higher level of maturity (or TRL: technology readiness level), which is the “raison d’être” of Clean Sky.

The environmental objectives of the programme are determined by evaluating the performance of concept aircraft in the global air transport system (when compared to 2000 level technology and to a "business as usual" evolution of technology). The ranges of environmental improvements result from the sum of technologies which are expected to reach TRL5-6 within the programme timeframe.

While not all of these technologies will be developed directly through the Clean Sky programme, it is neither feasible nor relevant at this stage to isolate the benefits derived purely from Clean Sky technologies, as Clean Sky will achieve a significant synergy effect in European Aeronautics Research by maturing closely linked technologies to a materially higher TRL through demonstration and integration.

Clean Sky activities are performed within six "**Integrated Technology Demonstrators**" (ITDs) and a "**Technology Evaluator**".

The three vehicle-based ITDs will develop, deliver and integrate technologies into concrete aircraft configurations. The two "transversal" ITDs are focused on propulsion and systems, and will deliver technologies, which will be integrated in various aircraft configurations by the vehicle ITDs. A further ITD will focus specifically on the life cycle assessment and 'eco-design' philosophy.

Smart Fixed Wing Aircraft (SFWA) – co-led by Airbus and SAAB - will deliver innovative wing technologies together with new aircraft configurations, covering large aircraft and business jets. Key enabling technologies from the transversal ITDs, for instance Contra Rotating Open Rotor, will be integrated into the demonstration programmes and concept aircraft.

Green Regional Aircraft (GRA) – co-led by Alenia and EADS CASA - will develop new technologies for the reduction of noise and emissions, in particular advanced low-weight & high performance structures, incorporation of all-electric systems, bleed-less engine architecture, low noise/high efficiency aerodynamics, and finally environmentally optimised mission and trajectory management.

Green Rotorcraft (GRC) – co-led by Agusta Westland and Eurocopter - will deliver innovative rotor blade technologies for reduction in rotor noise and power consumption, technologies for lower airframe drag, environmentally friendly flight paths, the integration of diesel engine technology, and advanced electrical systems for elimination of hydraulic fluids and for improved fuel consumption.

Sustainable and Green Engines (SAGE) - co-led by Rolls-Royce and Safran - will design and build five engine demonstrators to integrate technologies for low fuel consumption, whilst reducing noise levels and nitrous oxides. The 'Open Rotor' is the target of two demonstrators. The others address geared turbofan technology, low pressure stages of a three-shaft engine and a new turboshaft engine for helicopters.

Systems for Green Operations (SGO) - co-led by Liebherr and Thales - will focus on all electrical aircraft equipment and system architectures, thermal management, capabilities for environmentally-friendly trajectories and missions, and improved ground operations to give any aircraft the capability to fully exploit the benefits of the "Single European Sky".

Eco-Design - co-led by Dassault and Fraunhofer Gesellschaft - will support the ITDs with environmental impact analysis of the product life-cycle. Eco-Design will focus on environmentally-friendly design and production, withdrawal, and recycling of aircraft, by optimal use of raw materials and energies, thus improving the environmental impact of the entire aircraft life-cycle.

Complementing these six ITDs, the **Technology Evaluator (TE)** is a dedicated evaluation platform cross-positioned within the Clean Sky project structure. The TE is co-led by DLR and Thales, and includes the major European aeronautical research organisations. It will assess the environmental impact of the technologies developed by the ITDs and integrated into the Concept Aircraft. By doing this, the TE will enable Clean Sky to measure and report the level of success in achieving the environmental objectives, and in contributing towards the ACARE environmental goals. Besides a mission level analysis (aircraft level), the positive impact of the Clean Sky technologies will be shown at a relevant hub airport environment and across the global air transport system.

The first assessment by the Technology Evaluator on the way to meeting Clean Sky's environmental objectives is planned for the end of 2011. The ranges of potential performance improvement (reduction in CO_2, NO_X and Noise) will be narrowed or evolved during the life of the programme based on the results from the key technologies developed and validated through the demonstrations performed.

Clean Sky is a 'living' programme: each year, Annual Implementation Plans are produced and agreed, and research priorities are (re-)calibrated based on results achieved. The best approach to progressing the technologies is pursued. The Clean Sky JU uses regular Calls for Proposals to engage with the wider aeronautical industry, research organisations and universities in order to bring the best talent on board and enable broad collaborative participation. A very significant share of the Clean Sky research programme is already being taken on by Europe's aerospace related SMEs, and by September 2011 nine Calls for Proposals will have been completed, demonstrating the JU's commitment to involving all competent organisations in the European aeronautics research arena. In June 2011, a major and exciting milestone was reached with the 400th partner joining the Clean Sky programme.

2. ALTERNATIVE FUELS

European Advanced Biofuels Flightpath

In February 2009, the European Commission's Directorate General for Energy and Transport initiated the SWAFEA (Sustainable Ways for Alternative Fuels and Energy for Aviation) study to investigate the feasibility and the impact of the use of alternative fuels in aviation. The goal was to provide the European Commission with information and decision elements to support its future air transport policy, in the framework of the European commitment to promote renewable energy for the mitigation of climate change, security of supply and also to contribute to Europe's competitiveness and economic growth.

The study team involved 20 European and international organisations, representing all players in alternative aviation fuels: aircraft and engine manufacturing, air transport, oil industry, research and consulting organisations covering a large spectrum of expertise in the fields of fuel, combustion, environment as well as agriculture.

The SWAFEA final report was published in July 2011[3]. It provides a comprehensive analysis on the prospects for alternative fuels in aviation, including an integrated analysis of technical feasibility, environmental sustainability (based on the sustainability criteria of the EU Directive on renewable

3 http://www.swafea.eu/LinkClick.aspx?fileticket=llISmYPFNxY%3D&tabid=38

energy[4]) and economic aspects. It includes a number of recommendations on the steps that should be taken to promote the take-up of sustainable biofuels for aviation in Europe.

In March 2011, the European Commission published a White Paper on transport[5]. In the context of an overall goal of achieving a reduction of at least 60% in greenhouse gas emissions from transport by 2050 with respect to 1990, the White Paper established a goal of low-carbon sustainable fuels in aviation reaching 40% by 2050.

As a first step towards delivering this goal, in June the European Commission, in close coordination with Airbus, leading European airlines (Lufthansa, Air France/KLM, & British Airways) and key European biofuel producers (Choren Industries, Neste Oil, Biomass Technology Group and UOP), launched the European Advanced Biofuels Flightpath. This industry-wide initiative aims to speed up the commercialisation of aviation biofuels in Europe, with the objective of achieving the commercialisation of sustainably produced paraffinic biofuels in the aviation sector by reaching a 2 million tons consumption by 2020.

This initiative is a shared and voluntary commitment by its members to support and promote the production, storage and distribution of sustainably produced drop-in biofuels for use in aviation. It also targets establishing appropriate financial mechanisms to support the construction of industrial "first of a kind" advanced biofuel production plants. The Biofuels Flight path is explained in a technical paper, which sets out in more detail the challenges and required actions[6].

More specifically, the initiative focuses on the following:

1. Facilitate the development of standards for drop-in biofuels and their certification for use in commercial aircraft;

2. Work together with the full supply chain to further develop worldwide accepted sustainability certification frameworks

3. Agree on biofuel take-off arrangements over a defined period of time and at a reasonable cost;

4. Promote appropriate public and private actions to ensure the market uptake of paraffinic biofuels by the aviation sector;

5. Establish financing structures to facilitate the realisation of 2G biofuel projects;

6. Accelerate targeted research and innovation for advanced biofuel technologies, and especially algae.

4 Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

5 Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, COM(2011) 144 final

6 http://ec.europa.eu/energy/technology/initiatives/doc/20110622_biofuels_flight_path_technical_paper.pdf

Take concrete actions to inform the European citizen of the benefits of replacing kerosene by certified sustainable biofuels.

The following "Flight Path" provides an overview about the objectives, tasks, and milestones of the initiative.

Time horizons	Action	Aim/Result
Short-term (next 0-3 years)	Announcement of action at International Paris Air Show	To mobilise all stakeholders including Member States.
	High level workshop with financial institutions to address funding mechanisms.	To agree on a "Biofuel in Aviation Fund".
	> 1,000 tons of Fisher-Tropsch biofuel become available.	Verification of Fisher-Tropsch product quality. Significant volumes of synthetic biofuel become available for flight testing.
	Production of aviation class biofuels in the hydrotreated vegetable oil (HVO) plants from sustainable feedstock	Regular testing and eventually few regular flights with HVO biofuels from sustainable feedstock.
	Secure public and private financial and legislative mechanisms for industrial second generation biofuel plants.	To provide the financial means for investing in first of a kind plants and to permit use of aviation biofuel at economically acceptable conditions.
	Biofuel purchase agreement signed between aviation sector and biofuel producers.	To ensure a market for aviation biofuel production and facilitate investment in industrial 2G plants.
	Start construction of the first series of 2G plants.	Plants are operational by 2015-16.
	Identification of refineries & blenders which will take part in the first phase of the action.	Mobilise fuel suppliers and logistics along the supply chain.
Mid-term (4-7 years)	2000 tons of algal oils are becoming available.	First quantities of algal oils are used to produce aviation fuels.
	Supply of 1.0 M tons of hydrotreated sustainable oils and 0.2 tons of synthetic aviation biofuels in the aviation market.	1.2 M tons of biofuels are blended with kerosene.
	Start construction of the second series of 2G plants including algal biofuels and pyrolytic oils from residues.	Operational by 2020.
Long-term (up to 2020)	Supply of an additional 0.8 M tons of aviation biofuels based on synthetic biofuels, pyrolytic oils and algal biofuels.	2.0 M tons of biofuels are blended with kerosene.
	Further supply of biofuels for aviation, biofuels are used in most EU airports.	Commercialisation of aviation biofuels is achieved.

3. IMPROVED AIR TRAFFIC MANAGEMENT AND INFRASTRUCTURE USE

The EU's Single European Sky initiative and SESAR

The EU's Single European Sky initiative was originally launched by the European Commission in 1999. Its fundamental aim is to reform the architecture of European air traffic control to meet future capacity and safety needs. Its main principles are to reduce fragmentation in European air traffic management, between states, between civil and military, and between systems; to introduce new technology; and to establish a new regulatory framework built on closer synergy between the EU and Eurocontrol.

The first package of EU Single European Sky legislation was adopted by the Council and European Parliament in 2004. This was followed in 2009 by the Single European Sky II package of measures, which comprises five main pillars: performance, safety, technology, airport capacity and the human factor. The aim is to improve the performance of air navigation services by reducing the cost of flights, while improving the capacity and better preserving the environment, all having regard to the overriding safety objectives.

Reducing fragmentation in European air traffic management is expected to result in significant efficiency and environmental improvements. A core starting point is the reduction of the current surplus length of flights in Europe, estimated on average to be almost 50 km. The defragmentation of European airspace with new possibilities for more direct routing, and efforts to define a true pan European network of routes and to implement flexible use of airspace are expected to result in emission reductions of 2% per year.

SESAR

SESAR (Single European Sky ATM Research) is the technological component of the Single European Sky (SES). It is a €2.1bn Joint Undertaking, funded equally by the EU, Eurocontrol and industry (€700m EU, €700m Eurocontrol, €700m industry). Fifteen companies are members of the SESAR JU: AENA, Airbus, Alenia Aeronautica, the DFS, the DSNA, ENAV, Frequentis, Honeywell, INDRA, NATMIG, NATS (En Route) Limited, NORACON, SEAC, SELEX Sistemi Integrati and Thales. The SESAR SJU includes an additional thirteen associate partners including non-European companies with different profiles and expertise.

SESAR aims to help create a "paradigm shift" by putting performance-based operations at the core of air traffic management's objectives, and will be supported by state-of-the-art and innovative technology capable of ensuring the safety, sustainability and fluidity of air transport worldwide over the next 30 years. It is composed of three phases:

- The Definition phase (2004-2008) delivered the ATM master plan defining the content, the development and deployment plans of the next generation of ATM systems. This definition phase was led by Eurocontrol, and co-funded by the European Commission under the Trans European Network-Transport programme and executed by a large consortium of all air transport stakeholders.

- The Development phase (2008-2013) will produce the required new generation of technological systems, components and operational procedures as defined in the SESAR ATM Master Plan and Work Programme.

- The Deployment phase (2014-2020) will see the large scale production and implementation of the new air traffic management infrastructure, composed of fully harmonised and interoperable components guaranteeing high performance air transport activities in Europe.

Implementation of SESAR in general will facilitate the following:

- Moving from airspace to trajectory based operations, so that each aircraft achieves its agreed route and time of arrival and air and ground systems share a common system view.

- Collaborative planning so that all parties involved in flight management from departure gate to arrival gate can strategically and tactically plan their business activities based on the performance the system will deliver.

- An information rich ATM environment where partners share information through system wide information management.

- A globally agreed 4D trajectory definition and exchange format at the core of the ATM system where time is the 4th dimension providing a synchronised "time" reference for all partners.

- Airspace users and aircraft fully integrated as essential constituents and nodes of the ATM system.

- Dynamic airspace management and integrated co-ordination between civil and military authorities optimising the available airspace.

- Network planning focused on the arrival time as opposed to today's departure based system with Airport airside and turn-around fully integrated into ATM.

- New Communication, Navigation & Surveillance (CNS) technologies providing for more accurate airborne navigation and spacing between aircraft to maximise airspace and airport efficiency, improve communication and surveillance.

- Central role for the human widely supported by automation and advanced tools ensuring safe working without undue pressure.

Within the SESAR programme most of the almost 300 projects include environmental aspects of aviation. They concern aircraft noise management and mitigation, aircraft fuel use and emissions management etc. throughout all of SESAR's 16 work packages. The Joint Undertaking's role is to establish environmental sustainability as an integral aspect of broader ATM development and operating processes.

SESAR aims at reducing the environmental impact per flight by 10% without compromising on safety but with clear capacity and cost efficiency targets in mind. More specifically, in addressing environmental issues, SESAR will:

1. Achieve emission improvements through the optimisation of air traffic management services. The SESAR target for 2020 is to enable 10% fuel savings per flight as a result of ATM improvements alone, leading to a 10% reduction of CO_2 emissions per flight;

2. Improve the management of noise emissions and their impacts through better flight paths, or optimised climb and descent solutions;

3. Improve the role of ATM in enforcing local environmental rules by ensuring that flight operations fully comply with aircraft type restrictions, night movement bans, noise routes, noise quotas, etc.;

4. Improve the role of ATM in developing environmental rules by assessing the ecological impact of ATM constraints, and, following this assessment, adopting the best alternative solutions from a European sustainability perspective.

5. Accompany the development of new procedures and targets with an effective regulatory framework in close cooperation with the European Commission;

6. Implement more effective two-way community relations and communications capabilities at local and regional levels including a commonly agreed environmental strategy and vision.

By 2012 SESAR is expected to deliver fuel burn reductions of approximately 2% (compared with a baseline 2010), to demonstrate environmental benefits on city pairs connecting 8 European airports, and to have airspace users signing up to the SESAR business case (including the environment case) for time-based operations.

Operational improvements: AIRE

The Atlantic Interoperability Initiative to Reduce Emissions (AIRE) is a programme designed to improve energy efficiency and lower engine emissions and aircraft noise in cooperation with the US FAA. The SESAR JU is responsible for its management from a European perspective.

Under this initiative ATM stakeholders work collaboratively to perform integrated flight trials and demonstrations validating solutions for the reduction of CO_2 emissions for surface, terminal and oceanic operations to substantially accelerate the pace of change.

AIRE has demonstrated in 2009, with 1,152 trials performed, that significant savings can be achieved using existing technology. CO_2 savings per flight ranged from 90kg to 1250kg and the accumulated savings during trials were equivalent to 400 tons of CO_2. Another positive aspect is the human dimension - the AIRE projects boost crew and controller motivation to pioneer new ways of working together focusing on environmental aspects, and enabled cooperative decision-making towards a common goal.

The strategy is to produce constant step-based improvements, to be implemented by each partner in order to contribute to reaching the common objective. In 2010 demand for projects has more than doubled and a high transition rate from R&D to day-to-day operations, estimated at 80%, from AIRE 2009 projects was observed (expected to further increase with time). Everyone sees the “AIRE way of working together” as an absolute win-win to implement change before the implementation of more technology intensive ATM advancements expected for the period 2013 onward. A concrete example of the progress achieved is that, due to AIRE, both FAA and NAV Portugal offer lateral optimisation over the transatlantic routes to any user upon request. In July 2010, the SESAR JU launched a new call for tender and had an excellent response - 18 projects were selected involving 40 airlines, airport, air navigation service providers and industry partners. More than 5,000 trials are expected to take place.

4. ECONOMIC / MARKET-BASED MEASURES

The EU Emissions Trading System

The EU Emissions Trading System (EU ETS) is a cornerstone of the European Union's policy to combat climate change and its key tool for reducing industrial greenhouse gas emissions cost-effectively. Being the first and biggest international scheme for the trading of greenhouse gas emission allowances, the EU ETS currently covers some 11,000 power stations and industrial plants in 30 countries.

Launched in 2005, the EU ETS works on the "cap and trade" principle. This means there is a "cap", or limit, on the total amount of certain greenhouse gases that can be emitted by the factories, power plants and other installations in the system. Within this cap, companies receive emission allowances which they can sell to or buy from one another as needed. The limit on the total number of allowances available provides certainty that the environmental objective is achieved and ensures that the allowances have a market value.

At the end of each year each company must surrender enough allowances to cover all its emissions, otherwise heavy fines are imposed. If a company reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another company that is short of allowances. The flexibility that trading brings ensures that emissions are cut where it costs least to do so. The number of allowances is reduced over time so that total emissions fall.

The EU ETS now operates in 30 countries (the 27 EU Member States plus Iceland, Liechtenstein and Norway). It currently covers CO_2 emissions from installations such as power stations, combustion plants, oil refineries and iron and steel works, as well as factories making cement, glass, lime, bricks, ceramics, pulp, paper and board. Between them, the installations currently in the scheme account for almost half of the EU's CO_2 emissions and 40% of its total greenhouse gas emissions.

The EU ETS will be further expanded to the petrochemicals, ammonia and aluminium industries and to additional gases (PFCs and N_2O) in 2013, when the third trading period starts. At the same time a series of important changes to the way the EU ETS works will take effect in order to strengthen the system.

The legislation to include aviation in the EU ETS was adopted in November 2008, and entered into force as Directive 2008/101/EC of the European Parliament and of the Council on 2 February 2009. The proposal to include aviation in the EU ETS, made by the European Commission in December 2006, was accompanied by a detailed impact assessment.

Under the EU ETS, the emissions cap is increased to accommodate the inclusion of aviation. This addition to the cap establishes the total quantity of allowances to be allocated to aircraft operators.

This quantity is defined as a percentage of historical aviation emissions, which is defined as the mean average of the annual emissions in the calendar years 2004, 2005 and 2006 from aircraft performing an aviation activity falling within the scope of the legislation. In July 2011, it was decided that the historical aviation emissions are set at 221,420,279 tonnes of CO_2.

The additional cap to be added to the EU ETS in 2012, the first year of operation for aviation, will be set at 97% of the historical aviation emissions. For the period from 2013 to 2020 inclusive the additional cap will be set at 95% of the historical aviation emissions.

Aircraft operators flying to and from airports in 30 European states from 2012 will be required to surrender allowances in respect of their CO_2 emissions on an annual basis. The large majority of allowances will be allocated to individual aircraft operators free of charge, based on their respective aviation output (rather than emissions) in 2010, thus rewarding operators that have already invested in cleaner aircraft. In 2012, 85% of the total quantity of the additional allowances (or "cap") will be allocated free of charge according to this benchmarking methodology, while in the 2013-2020 trading period 82% of the additional allowances will be allocated free of charge in this way. In the 2013-2020 trading period, an additional 3% of the total additional allowances for aviation will be set aside for allocation free of charge via the special reserve, to new entrants and fast-growing airlines. The remaining 15% of allowances will be allocated each year by auction.

Aircraft operators that choose to emit more than their free allocation of allowances will be able to source allowances from other participants in the ETS (including those outside the aviation sector), from intermediaries who trade allowances, from Member States via auctions, or they can use specific quantities of international credits from emissions reduction projects in third countries (e.g. CDM credits and ERUs).

The system also includes a de minimis provision under which commercial aircraft operators with a low level of aviation activity in Europe are excluded from its scope. This is likely to mean that many aircraft operators from developing countries will be unaffected by the scheme and, indeed, over 90 ICAO states have no commercial aircraft operators included in the scope of the EU ETS.

The EU legislation foresees that, where a third country takes measures of its own to reduce the climate change impact of flights departing from its airports, the EU will consider options available in order to provide for optimal interaction between the EU scheme and that country's measures. In such a case, flights arriving from the third country could be excluded from the scope of the EU scheme. The EU therefore encourages other countries to adopt measures of their own and is ready to engage in bilateral discussions with any country that has done so.

The legislation also makes it clear that if there is agreement on global measures, the EU shall consider whether amendments to this Directive as it applies to aircraft operators are necessary.

Anticipated change in fuel consumption and/or CO_2 emissions

The environmental outcome of an emissions trading system is pre-determined through the setting of an emissions cap. In the case of the EU ETS, an addition to the overall cap is established for aviation emissions. However, aircraft operators are also able to use allowances allocated to other sectors to cover their emissions. It is therefore possible (indeed highly likely given traffic growth forecasts) that the absolute level of CO_2 emissions from aviation will exceed the number of allowances allocated to aviation. However, any aviation emissions will necessarily be offset by CO_2 emissions reductions elsewhere, either in other sectors within the EU that are subject to the EU ETS, or through emissions reduction projects in third countries. The “net” aviation emissions will however be the same as the number of allowances allocated to aviation under the EU ETS.

In terms of contribution towards the ICAO global goals, the states implementing the EU ETS will together deliver, in “net” terms, a 3% reduction below the 2005 level of aviation CO_2 emissions in 2012, and a 5% reduction below the 2005 level of aviation CO_2 emissions in the period 2013-2020.

Other emissions reduction measures taken, either at supra-national level in Europe or, by any of the 30 individual states implementing the EU ETS, will of course make their own contribution towards the ICAO global goals. Such measures are likely to moderate the anticipated growth in aviation emissions in Europe and therefore reduce the extent to which the absolute level of CO_2 emissions from aviation will exceed the number of allowances allocated to aviation. However, assuming that absolute aviation emissions will nonetheless in future exceed the additional aviation cap, the aggregate contribution towards the global goals is likely to remain that which is determined by the EU ETS cap.

Expected co-benefits

The EU ETS covers both international and domestic aviation and does not distinguish between them. It is not therefore possible to identify how the “net” emissions reductions it delivers are apportioned between international and domestic aviation.

5. SUPPORT TO VOLUNTARY ACTIONS: ACI AIRPORT CARBON ACCREDITATION

Airport Carbon Accreditation is a certification programme for carbon management at airports, based on carbon mapping and management standard specifically designed for the airport industry. It was launched in 2009 by ACI EUROPE, the trade association for European airports.

This industry-driven initiative was officially endorsed by Eurocontrol and the European Civil Aviation Conference (ECAC). It is also officially supported by the United Nations Environmental Programme (UNEP). The programme is overseen by an independent Advisory Board. ACI EUROPE is looking at expanding the geographical scope of the programme through the other ACI regions. Discussions are currently under way with ACI Asia Pacific for a possible extension of the programme to the Asia Pacific region.

Airport Carbon Accreditation is a four-step programme, from carbon mapping to carbon neutrality. The four steps of certification are: Level 1 “Mapping”, Level 2 “Reduction”, Level 3 “Optimisation”, and Level 3+ “Carbon Neutrality”. One of its essential requirements is the verification by external and independent auditors of the data provided by airports. Aggregated data are included in the *Airport Carbon Accreditation* Annual Report thus ensuring transparent and accurate carbon reporting. At level 2 of the programme and above (Reduction, Optimisation and Carbon Neutrality), airport operators are required to demonstrate CO2 reduction associated with the activities they control.

IIn June 2011, 2 years after the launch of the programme, 43 airports were accredited, representing 43% of European passenger traffic. ACI/Europe's objective for the end of the 3rd year of the programme's operation is to cover airports representing 50% of European passenger traffic. Programme's implementation is twofold: on top of recruiting new participants, individual airports should progress along the 4 levels of the programme.

Anticipated benefits:

The administrator of the programme has been collecting CO2 data from participating airports over the past two years. This has allowed the absolute CO2 reduction from the participation in the programme to be quantified.

	2009 – 2011	2010 – 2011
Total aggregate scope 1 & 2 reduction (t CO2)	51 657	54 565
Total aggregate scope 3 reduction (t CO2)	359 733	675 124

<table>
<tr><th rowspan="2">Variable</th><th colspan="2">Year 1</th><th colspan="2">Year 2</th></tr>
<tr><th>Emissions</th><th>Number of airports</th><th>Emissions</th><th>Number of airports</th></tr>
<tr><td>Aggregate carbon footprint for 'year 0'[7] for all emissions under airports' direct control (all airports)</td><td>803 050 tonnes CO2</td><td rowspan="2">17</td><td>2 275 469 tonnes CO2</td><td rowspan="2">43</td></tr>
<tr><td>Carbon footprint per passenger</td><td>2.6 kg CO2</td><td>3.73 kg CO2</td></tr>
<tr><td>Aggregate reduction in emissions from sources under airports' direct control (level 2 and above)[8]</td><td>51 657 tonnes CO2</td><td rowspan="2">9</td><td>51 819 tonnes CO2</td><td rowspan="2">19</td></tr>
<tr><td>Carbon footprint reduction per passenger</td><td>0.351 kg CO2</td><td>0.11 kg CO2</td></tr>
<tr><td>Total carbon footprint for 'year 0' for emissions sources which an airport may guide or influence (level 3 and above)</td><td>2 397 622 tonnes CO2</td><td rowspan="2">6</td><td>6 643 266 tonnes CO2</td><td rowspan="2">13</td></tr>
<tr><td>Aggregate reductions from emissions sources which an airport may guide or influence</td><td>359 733 tonnes CO2</td><td>675 124 tonnes CO2</td></tr>
<tr><td>Total emissions offset (level 3+)</td><td>13 129 tonnes CO2</td><td>4</td><td>85 602 tonnes CO2</td><td>8</td></tr>
</table>

7 'Year 0' refers to the 12 month period for which an individual airport's carbon footprint refers to, which according to the Airport Carbon Accreditation requirements must have been within 12 months of the application date.

8 This figure includes increases in emissions at airports that have used a relative emissions benchmark in order to demonstrate a reduction.

Its main immediate environmental co-benefit is the improvement of local air quality.

Costs for design, development and implementation of *Airport Carbon Accreditation* have been borne by ACI EUROPE. *Airport Carbon Accreditation* is a non-for-profit initiative, with participation fees set at a level aimed at allowing for the recovery of the aforementioned costs.

The scope of *Airport Carbon Accreditation,* i.e. emissions that an airport operator can control, guide and influence, implies that aircraft emissions in the LTO cycle are also covered. Thus, airlines can benefit from the gains made by more efficient airport operations to see a decrease in their emissions during the LTO cycle. This is coherent with the objectives pursued with the inclusion of aviation in the EU ETS as of 1 January 2012 (Directive 2008/101/EC) and can support the efforts of airlines to reduce these emissions.

SECTION 2- National Measures in Federal Republic of Germany

National Framework with regard to Climate change

In the framework of EU effort sharing under the Kyoto Protocol, Germany has committed itself to cutting its emissions of climate-damaging gases by a total of 21% in the period 2008 to 2012 compared with 1990.

In addition, Germany has pledged to reduce its GHG emissions by even 40% by 2020 compared with 1990, irrespective of the necessary efforts by other states.

1. Aircraft related Technology Development

The aviation industry enterprises in Germany and Europe are oriented in research, technology and innovation towards targets which have been coordinated Europe-wide. They were formulated for the first time in the strategy paper “Vision 2020” and were last updated in “Flight path 2050”.

The aviation industry enterprises in Germany are at the top of and in cooperation with European and global supply chains. The gains in efficiency of newly available aircraft stem from the overall and partial system architecture and from the synergy of many innovations in technical detail along the supply chain. Investments into research, technology and innovation with the aim of improving the ecological balance of the aviation product for the enterprises at the same time mean investments into their own competitiveness, since ecological benefit in aviation in most cases also entails economic benefits for the aircraft operator.

A quantification of the contributions to ecological efficiency of the systems and components from Germany to global reduction targets is not possible because of the large numbers of influence factors, for example the individual success of the technologies in the market and the fleet policy of the airlines.**National aviation research programme**

Objective of the aid

In principle the purpose of the promotional measures is to improve the technological basis and the economic and technical situation of the aviation industry and of air transport. Strengthening the innovative power and the competencies in research, development and production at the economic site Germany is the main aim. In this way the aviation industry is to be enabled in the framework of effective network structures to achieve the targets laid down in the ACARE VISION 2010. The long term aim is to achieve a sustainable and economical air transport system. The innovative power of the German aviation industry is essentially based on a research network which is continuously consolidated and growing. The collaboration of the universities, the relevant research centres and the specialised small and medium-sized enterprises is of central importance here. With the help of this network the aviation industry at the economic site Germany has succeeded in recent years to defend and extend its position in promising development and production programmes in international competition. This success is clearly reflected in the positive developments of the number of jobs and the turnover in the civil aviation industry.

The entry into the market of new international competitors, especially in the sector of regional and short-distance aircraft (150 seaters), opens up new possibilities of participating in aircraft programmes for the German aviation industry. This, however, requires increased efforts of the industry in research and development in order to continue to be competitive at international level with innovative high technologies. In the medium term these technologies maintain and expand the added value shares in Germany.

Further growth in global aviation is only possible if innovative and internationally competitive technologies can be offered which allow a further optimisation of civil aircraft. The focus is placed especially on improvements and increases in efficiency in the research and technology fields listed under number 2. This also includes aspects of an efficient and resource-saving manufacture and production of sustainable technologies. According to market forecasts, regional and short-distance aircraft will form the largest market segment also in the future. Technological progress brought to bear on these products at an early time therefore has the biggest impact on the reduction of harmful climate gas emissions.

At the same time this largest market segment offers the possibility of maintaining and expanding added value shares in the cell, the systems and engines for German economic sites if competitive and mature technologies and manufacturing strategies are available in time. For the purpose of this provision for the future it is indispensable to continue to advance research and development of high technologies in civil aviation also in the future. The Federal Government, therefore, is pursuing the aim of offering enterprises at the industrial site Germany internationally comparable framework conditions and thus a fair chance of acquiring technologically demanding work shares, of creating a high degree of added value and through this creating jobs in Germany in a sustainable manner. This objective is an essential component of the national action plan “High-tech Strategy 2020 for Germany”.

Subject of the funding

Research and technology projects

The research promotion is based on the goals of ACARE (Advisory Council for Aeronautic Research in Europe) Vision 2020 and it will be oriented towards the challenges which can be recognised today.

Production, maintenance and repair

The important thing is to introduce the high competency of the aviation industry at the site Germany in the area of innovative production procedures, processes und machines into the international market for production, maintenance and repair. This is also the basis from which it is planned to develop flexible and customer-oriented value-creation processes with the further development of this competency it will be possible to cover all phases of the life cycle, from development through production to maintenance and repair including modification and retrofitting, at national level. This takes account of the increased importance of this sector. To further increase the sustainability of the entire value-creation chain particularly subjects of innovative, environment-friendly and resource-saving manufacturing and production procedures and processes are promoted. The further reduction of the weight of (printed) structures, particularly through innovative construction methods and material selection is a current research subject.

Environmentally compatible air transport

The social challenges regarding the environment require a sustainable restriction of negative external effects of air transport. In order to achieve the goals of ACARE Vision 2020 for an environmentally compatible air transport innovative technologies for the reduction of noise and harmful pollutants are necessary. Active and passive technological measures at propulsion systems and in the field of flight physics are applied in an effort to reduce external noise by 50%. In particular the noise burden in the neighbourhood of airports is to be reduced. Endeavours are also made to achieve a further reduction of fuel consumption and thereby of the CO2 emissions into the atmosphere by approximately 50% and also of nitrogen oxides by 80% compared to the ICAO limit value CAEP 2. Up-to-date propulsion concepts and aero-dynamic systems in the low-speed area as well as measures to reduce the flow resistance during cruise are to make special contributions to this goal.

Increase of the transport performance, infrastructure and processes in civil aviation have to be coordinated and integrated in a way which achieves the expected increase of the transport performance in a safe, reliable and highly flexible manner while at the same time reducing the aircraft accident rate by 80%, in accordance with the objective set by ACARE in the European framework. This requires measures in the areas flight guidance, all-weather capability and automation.

Efficient aircraft

More stringent emission constraints and performance requirements demand a continuous evolutionary and revolutionary development of modern aircraft. In order to achieve a decrease in environmental pollution efficient aviation systems have to be developed which reduce the consumption and operational costs of individual aircraft and of fleet operation. Research is focused on efforts to further reduce energy consumption and to optimise use and provision of energy for consumers. And increasing efficiency of existing and new systems in aircraft, especially through the reduction of weight and in the production of energy (e.g. fuel cells), as well as the inclusion and integration of these factors into the overall system are also subjects of technology issues which need to be resolved.

Integrated technology projects

In addition to the technology fields mentioned individual technologies which are known in principle, but still isolated, should be optimised and validated in a more comprehensive system context. Apart from individual technologies the system context also includes procedures for their production and manufacturing concepts at the level of the overall system. The aim is to examine, in addition to technologies in the system context, also the related manufacturing concepts as to their industrial applicability. The issue is to focus integrated technology projects on the provision of technologies for the next generation of wide-body aircraft for short and medium distances. Projects in the framework of the integrated technology projects are to concern the following areas:

– Configuration and integration at the level of the entire aircraft

- progressive fuselage construction methods and fuselage manufacturing concepts

– energy efficient systems

– modular concepts for cabins and cabin assembly

– environmentally sound and efficient propulsion concepts

The aim is to improve the capabilities for the development of complex aircraft and sub-systems which especially includes the multi-disciplinary optimisation of the entire aircraft. The projects should, if possible, be controlled by the system leaders.

Ecologically efficient flying

The long-term goal of research in the field of civil aviation is the further implementation of a sustainable air transport system. Some aspects of this are: a zero-emission aircraft regarding pollutant emissions and noise, and efficient flight guidance structures for more capacity and safety in aviation. A further technological foundation and protection of such a sustainable air transport system requires the academic research of technologies with an application period from 2030 to 2050. To achieve the aim of a zero-emission aviation system it is necessary to examine fundamentally new solutions and technologies. For this purpose a number of different individual technologies have to be optimised for new overall concepts. In the framework of the funding line “Ecologically efficient flying”

The Federal Ministry of Economics and Technology promotes joint initiatives of science and industry for aviation in the years 2030 and after. Basic research projects in this context can be applied for in the funding programmes of the German Research Foundation (DFG). In view of the very long product cycles and life cycles in aviation and the connected early orientation required, the research of promising technologies is necessary already now. Especially subjects concerning the further reduction of the so-called “environmental footprint” of aviation and of aircraft are funded. Special attention in this context is given to projects with great environmental potential and recognisable potential for implementation. Promoted are subjects across the whole range of the aviation system and of civil aircraft. The precondition for the funding is that it is not the evolution of a technology which, in principle, is known, but rather of new innovative technologies and incentives.

The energetic optimisation of individual components of the system, taking account of the impact on the overall system, allows well-founded starting points. Especially the better use of residual and waste energy, (nano)materials, propulsion concepts with alternative thermo-dynamic processes, innovative aero-dynamic solutions, effective flight guidance systems as well as ecologically acceptable concepts for “post oil” energy sources offer very promising potentials. Depending on the objective of the projects they can be submitted either in the aviation research programme (LuFo) or to DFG. The potential funding is effected according to the regulations in force either of LuFo or of DFG. The selection by the funding donor should comply with the primary character of the research project and the funding instrument.

The technology developments expected in the framework of the programme have to take up the challenges and fields of action mentioned in a holistic approach according to the concept of a demand-oriented air transport system. The primary aim is to serve the growing demand for air transport capacity in a way which takes account in equal measure of the social and economic as well as the ecological requirements of the society.

2. Alternative Fuels

In 2011 25 organizations came together in Germany to form an association called aireg – Aviation Initiative for Renewable Energy in Germany e.V. – strives to gain an all-encompassing perspective on the field of aviation biofuels. aireg believes that biomass production, conversion and distribution have to be optimized in order to achieve a sufficient supply of biofuel at fair prices within a reasonable time. Following that objective aireg is bringing together companies and organizations from biomass producers to airlines, from aircraft manufacturers to airports and from universities to consulting firms. This broad spectrum will enable aireg to connect know-how across the entire value chain and to act as a catalyst for sector-wide progress at the same time.

As a nonprofit organization aireg`s membership is open to all parties willing to contribute to furthering the common cause of establishing sustainable ways to introduce aviation biofuels. In order to assure a global approach t aireg is inviting companies and organizations from around the globe to join the effort. aireg’s comprehensive approach is further emphasized by the set-up of five working groups that are shedding light on the specific aspects of how to implement aviation biofuels on a large scale.

1. Starting with topics concerning the “Provision of Feedstock”, aireg experts are comparing different types of crops regarding their respective benefits, detecting adequate regions for mass-production and assessing the sustainability for all options of feedstock provision.

2. With the assumption that Jet A-1 will remain the standard aviation fuel and drop-in synthetic fuels are the way to usher in a new era, an aireg team is working on “Technologies of Fuel Production”. Critical issues are to ensure the quality of biofuels, to identify the most efficient conversion process and to establish a roadmap for extensive distribution.

3. With its working group "Fuel Utilization" aireg aims to verify that aviation biofuels will not require adaptation of fleet or infrastructure. We are also looking into assessing the future demand in Germany and beyond in order to determine the feasibility of current emission reduction goals.

4. The "Quality and Certification" working group will ensure that the largely self-regulated standardization is providing for sufficient transfer of know-how to new market participants. Also, this group will be concerning itself with assuring standard compliance of biofuels and assisting during certification of new aviation biofuels.

5. On top of all that rests the question of "Sustainability", the objective of the fifth working group. This group will be contributing to implement and further develop sustainability criteria along the value-creation chain. By doing so, it will be able to evaluate different incentive systems for emission reduction and to identify research requirements and needs for political action.

3. Improved Air Traffic Management and Infrastructure Use

3.1 Essential projects for airspace optimisation in the framework of FABEC

In the course of the FABEC airspace optimisation several projects have the objective of increasing capacity and at the same time establish more direct or shorten the flight paths. In all these projects DFS is active in a leading function or in the framework of the project management.

An additional component of this route optimisation is the reduction or flexibilisation of military exercise areas which up to now were not or only insufficiently available for civil aviation.

For some of these air space optimisation projects simulations were carried out or sometimes concluded in the planning phase already. First calculations were made on the basis of these simulations in order to determine potential positive CO_2 effects.

The preliminary results of these calculations are shown as follows. They give an impression of the environmental relevance of the described air space optimisation projects. The real effects can be determined after implementation by means of environmental impact assessments.

The aim of the "Implementation Project Luxembourg" is to optimise the airspace in the border area of Germany, France, Luxembourg and Belgium. Here the optimisation work is focused on the reduction and flexibilisation of the military exercise areas, their use across borders and the extension and shortening of the flight paths.

(1) Implementation Project West

The aim of the "Implementation Project West" is to optimise the airspace in the border area of England, France and Belgium. Here the optimisation work is focused on the reduction and flexibilisation of the military exercise areas, their use across borders and the extension and shortening of the flight paths.

<u>Leadership:</u> Belgocontrol

Results: Not yet known.

(2) Implementation Project Central West /CBA Land

The aim of the "Implementation Project Central West/Cross-Border Area Land" is to optimise the airspace in the border area of Germany, Belgium, the Netherlands and in the direction of Scandinavia. Here the optimisation work is focused on the reduction and flexibilisation of the military exercise areas, their use across borders and the extension and shortening of the flight paths.

Leadership: LVNL/RNLAF (Netherlands Air Force)

Results: Not yet known.

(3) Implementation Project Lux

The aim of the "Implementation Project Lux" is to optimise the airspace in the border area of Germany, France, Luxembourg and Belgium. Here the optimisation work is focused on the reduction and flexibilisation of the military exercise areas, their use across borders and the extension and shortening of the flight paths.

Leadership: German Air Navigation Services (DFS)

Results: Not yet known.

(4) Implementation Project South East

The aim of the "Implementation Project South East" is to optimise the airspace in the border area of Germany, France and Switzerland. Here the optimisation work is focused on the reduction and flexibilisation of the military exercise areas, their use across borders and the extension and shortening of the flight paths.

Leadership: Skyguide

Results: Not yet known.

(5) FRA (Free Route Airspace)

Free Route Airspace is an airspace concept in which the airspace user can basically plan a free route between a defined entry point and a defined exit point. The flights themselves will be given clearances by ATC and/or controlled.

Leadership: DFS (Free Route Airspace Karlsruhe); DSNA (Free Route Airspace Maastricht)

Results: For the FABEC FRA Projects, for which a stepwise implementation is foreseen, three periods were evaluated : 2013, 2016 and 2019. The full implementation, dependent on SESAR deployment, was not taken into account due to a high degree of uncertain results. On the baseline of a SAAM simulation, based on current route network as it was during the reference period (end of June 2011 – begin of July 2011) and an average aircraft used in the FABEC airspace, the estimated results were as following :

- 2013/Potential Savings: 54733 NMs/Week; 130 flying hours/week; 49818 Tons of CO2/Year
- 2016 Potential Savings: 132341 NMs/Week; 315 flying hours/week; 120292 Tons of CO2/Year
- 2019 Potential Savings: 208206 NMs/Week; 495 flying hours/week; 189250 Tons of CO2/Year

These estimated results show an expected positive environmental effect for the FABEC FRA implementation.

(6) XMAN/AMAN

The system XMAN is the cross-border version of the AMAN (Arrival Manager) which is already in operation. It serves the flow optimisation and approach pre-sorting in a cross-border region with a distance of up to 200 nautical miles. A main instrument of XMAN is speed control which can delay a flight by way of optimised approach control up to a maximum of 10 minutes.

Leadership: DFS

Results: First trials in Australia and New Zealand with comparable systems resulted in fuel savings of 50 to 100 kg per flight.

3.2 Successive introduction of CDA*-procedures (Continuous Descent Approach) at German civil airports.

** Also known as CDO Continuous Descent Operations (corresponds to the CDA procedure)*

The Continuous Descent Approach (CDA) is an approach procedure where the aircraft is sinking with minimum engine power (ideally idling) and as much as possible avoids horizontal flight phases. This saves fuel, reduces CO 2 emissions and in some areas noise reduction

may be expected. What amount of kerosene can be saved depends primarily on the flight level where the constant descent is initiated.

Leadership: DFS Deutsche Flugsicherung GmbH

Partner/stakeholders: Airlines, airports, airport noise commission, Federal Supervisory Authority for Air Navigation Services (BAF), Federal Ministry of Transport, Building and Urban Development

Timetable:

Airport	Time of application	Introduction of CDA
Frankfurt/Main	23:00-05:00 h	„Night Transition" since 2005, segmented RNAV GPS in trial operation since 2010
Hamburg-Fuhlsbüttel		Planned for the end of 2012
Hannover-Langenhagen	23:00-06:00 h	Introduced in 2010
Köln/Bonn	23:00-07:00 h	Introduced in 2009
Leipzig-Halle	23:00-06:00 h	Introduced in 2010
München	23:00-06:00 h	Introduced in 2010
Braunschweig		Planned for the end of 2012

3.3 Introduction of A-CDM (Airport Collaborative Decision Making) at German Airports

A new procedure is to make the turnaround process of aircraft at the airports smoother: The planners hope to achieve in this way among other things shorter operating times of the engines and a reduction of the waiting times at the runway, but mainly a better feasibility of planning the operational processes.

The core idea of the concept is the introduction of a “Target Off-Block Time” (TOBT) for every flight, that is a target time for the moment when the aircraft has finished its handling on the ground. This target time is laid down by the airline which reports it to the system. The TOBT automatically generates a latest point in time for the start of the engines, the so-called Target Start-up Approval Time (TSAT) which is transparent for all the parties concerned – airlines, airport operators, air traffic control, ground handling and CFMU. If formerly it was an ad-hoc decision of the controller as to which aircraft he cleared at what time, this is now defined as early as forty minutes before the planned end of the handling. This can avoid congestion at the runway and unnecessary engine operating times (CO2 emissions).

Essential results based on Munich Airport

- It has been possible to shorten the waiting times at the runways by one minute on average to approximately 3.4 minutes.

- For more than 50% of the flights it was possible to reduce the delay in take-off compared to the delay in arrival or to compensate it completely.

- Improvement of the comparison airport slot (SOBT) und ATC flight plan (EOBT)

- Improvement of the process of the allocation of positions in case of overlap of positions.

- In all cases the values of the target times (CTOT) achieved a better quality than the Estimated Take-off Time (ETOT) based only on ATC flight plan data.

On 7 June 2007 the trial operation “Airport CDM at Munich Airport” was transferred into regular operation and thus implemented as standard procedure at the first airport in Europe. The project partners FMG Munich Airport GmbH and DFS Deutsche Flugsicherung GmbH are responsible for the execution of the project.

Leadership: DFS Deutsche Flugsicherung GmbH, FMG Flughafen München GmbH

Partner/stakeholder: All airlines, Ground Handling agents, Eurocontrol (CFMU)

In Februar 2011 the trial operation “Airport CDM at Frankfurt Airport” was transferred into regular operation and thus implemented as standard procedure at the Second CDM airport in Germany and the forth in Europe. The project partners Fraport AG and DFS Deutsche Flugsicherung GmbH were responsible for the execution of the project.

Leadership: DFS Deutsche Flugsicherung GmbH, Fraport AG

Partner/stakeholder: All airlines, Ground Handling agents, Eurocontrol (CFMU)

In January 2010 an initative on harmonisation of Airport CDM in Germany was established. A Letter of Intend is signed by DFS and the Airport operation companies, FMG Munich, Fraport Frankfurt, FBB Berlin, FDG Düsseldorf, FSG Stuttgart, FHG Hamburg. The objectives of this Initiative are:

• Exchange of information and best practices between the different German CDM airports (regardless if fully implemented or project)

• To achieve a common understanding of Airport CDM in Germany and represent this understanding to the European Airport CDM process

• In the interest of the customers (AO) it is necessary to harmonize the use and consequences of several aspects of the Airport CDM process

Next Airport CDM regular implementations are planned for the new Berlin airport in June 2012, followed by Düsseldorf in January 2013, Stuttgart December 2013 and Hamburg in 2014.

3.5 Infrastructure Use

The reduction of the CO_2 emissions at the airport locations requires detailed knowledge on the sources of the emissions and the amount of emissions. On the basis of a systematic approach it is then possible to design, judge and implement measures. The airports organised in the airport association ADV have come to an understanding on the following steps for the way towards a comprehensive protection against climate change:

1. Drawing up of a climate inventory

2. Planning and implementation of measures

3. Monitoring of the reduction of emissions

The priority of measures depends on the following principles:

Avoidance: emissions should not be generated in the first place;

Reduction: measures which lead to a situation where an operation generates the fewest emissions possible;

Compensation: measures which compensate for unavoidable emissions at other places.

The aim is to continue to sustainably reduce the specific emissions. The airports are not beginning only now to do this. Numerous projects in the past show that the saving of energy has always been part of the environmental strategy of the airports. And through certification according to ISO or EMAS, too, the airports professed their responsibility at an early stage already. With a number of measures the airports have implemented solutions for climate protection issues. Examples which can be mentioned here are the energy supply through block-type heat and power plants, photovoltaics installations, district heat from biogas as well as the optimised air conditioning of the terminals. In addition the use of alternative fuels on the apron is stepped up and investments are made in efficient lighting. Other projects at airports are planned and will be implemented in the next few years.

4. Economic / market-based measures

One of the measures adopted by the German Government to implement is the introduction of an aviation tax (ATT). The different modes of transport are liable to an energy tax. The aviation fuel is exempted from taxation. The ATT intends to create an environmental benefit. In order to reflect the growing CO_2 emissions with the distance the ATT differentiates three bands.

From 1 January 2011, all flights departing from Germany are subject to the aviation tax. The amount of tax to be paid depends on the distance to the final destination. Flights to a destination up to 2,500km away will incur a tax of eight euros per passenger. The amount increases to 25 euros for distances of up to 6,000km and 45 euros for distances beyond this. The distance taken into account is that for the entire journey as booked. For flights involving a transfer or short stopover, this means that the tax only becomes chargeable on the initial departure. If the journey is broken up by a longer stopover (of 12 or 24 hours), however, the tax becomes payable again.

In principle, the tax is levied on all departing flights operated by commercial airlines. However, there are exceptions. Passengers under two years of age are exempt from the tax. Flights conducted exclusively for sovereign, military or medical purposes are also exempted. Similarly, there will be exceptions for island residents flying to and from islands that cannot be reached by land.

5. Support to voluntary actions: ACI Airport Carbon Accreditation

The list of accredited airports:

- Hamburg (level 2)
- Frankfurt (level 2)
- Munich (level 3)
- Düsseldorf (level 1)

Annex

1. RTK of the air operators registered in Germany based on ICAO definitions

2. CO_2 emissions of aviation of Germany in the past years based on the IPCC guidelines -

3. Best Practice examples

Annex 1

RTK of the air operators registered in Germany based on ICAO definitions

Year	International_RTK	Total_RTK
2000	24197127000	25094996000
2001	23370186000	24218969000
2002	23378067000	24216911000
2003	23489865000	24331815000
2004	26511833000	27338250000
2005	26608296000	27487064000
2006	28228449000	29115844000
2007	28969266000	30008772000
2008	29089749000	30143928000
2009	26229613000	27210385000

Source: ICAO APER website

Annex 2

CO_2 emissions (kt) of aviation of Germany in the past years based on the IPCC guidelines

Year	domestic flights	international flights	total flights
2000	2.325,47	19.528,96	21.854,43
2001	2.194,41	19.101,49	21.295,90
2002	2.109,91	19.001,11	21.111,02
2003	2.074,55	19.357,35	21.431,90
2004	2.041,10	21.170,05	23.211,15
2005	2.148,78	23.088,08	25.236,86
2006	2.273,09	24.235,61	26.508,69
2007	2.264,99	25.207,35	27.472,34
2008	2.258,42	25.502,60	27.761,02
2009	2.114,43	24.829,41	26.943,84
2010	1.989,61	24.550,31	26.539,92

Source: Umweltbundesamt

Annex 3: Best Practice Examples
Measures to mitigate CO_2 Emissions

In order to facilitate the compilation of a comprehensive German Action Plan contributing to ICAO´s Action Plan on Emissions Reduction, aireg and the German Aviation Association (BDL) are providing the following outline of measures to the Federal Ministry of Transport, Building and Urban Development. This is to summarize the major national existing and intended actions towards a large-scale introduction of alternative fuels in aviation.

We are convinced that whereas improvements in technology, air traffic management and operations will lead to a sizable emissions reduction, the industry`s ambitious goals* will only be met with a significant contribution of alternative fuels. Therefore we are emphasizing that regulatory and public financial support for alternative fuels has to be a top priority. Adequate support will enable achieving the potential benefits described in the measures below:

* ACARE Vision for 2020, ACARE Flightpath 2050, IATA Global Approach to Reducing Aviation Emissions

Category A:

Alternative Aviation Fuel Measures in Germany
that are ongoing or whose financing will be secured
in the short to medium term

Title	**aireg – Aviation Initiative for Renewable Energy in Germany e.V.**
Description	organizational
Category	Alternative Fuels
Measure	• Consortium of stakeholders comprising the entire biofuel value creation chain • Creating a permanent forum for scientific cooperation as a basis for strategic and operational projects
Action	• Development and continuous updating of a strategic timeline for large-scale deployment of alternative fuels • Working groups as aggregator and initiator of research • Creating political and public awareness in order to gain necessary support
Start Date	June 8th, 2011
Date of full implementation	since September 19th, 2011
Economic Cost in €	approx. 150.000,- p.a. fix. provided by member organizations
Assistance needed	variable costs according to project scope to be provided by external public or private institutions
List of stakeholders involved (to date)	• Air Berlin PLC & Co. Luftverkehrs KG • Bauhaus Luftfahrt e.V. • Boeing International Corporation • Booz & Company Inc. • Condor Flugdienst GmbH • Deutsche Energie-Agentur GmbH (dena) • Deutsche Lufthansa AG • Deutsche Post AG • Deutsches BiomasseForschungsZentrum gGmbH • Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) • EADS Deutschland GmbH • Flughafen München GmbH • Forschungszentrum Jülich GmbH • Fraunhofer-Institut für Bauphysik • ISCC System GmbH • Jatro AG • JatroSolutions GmbH • Leuphana Universität Lüneburg • MTU Aero Engines GmbH • Phytolutions GmbH • Rolls-Royce Deutschland Ltd & Co KG • TU Hamburg-Harburg – Inst. f. Umweltt. &Energiewirt. • TUIfly GmbH • Verbio Vereinigte BioEnergie AG
Contact for this measure	Lukas Rohleder Political & Public Affairs, aireg e.V. Georgenstrasse 25, 10117 Berlin, Germany Phone: +49 30 700 118515 Fax: +49 30 700 118520 Mail: lukas.rohleder@aireg.de, Web: www.aireg.de

Title	**Leuphana University –** **Platform for Sustainable Aviation Fuels**
Description	scientific
Category	Alternative Fuels
Measure	Evaluation of sustainable feedstock production systems for aviation biofuels
Action	• Improving existing concepts and creating new solutions to produce plant oil feedstocks in a sustainable way, including entrepreneurial implementation • Improving production models of annual oil crops such as Camelina sativa, including field trials in Europe • Evaluation and improvement of production models for oil bearing perennials in tropical and sub-tropical climatic zones • 2011: Global market study on oil bearing trees covering Jatropha, Moringa and Pongamia: the study covers aspects such as size and growth path of plantations, oil production today and forecasts to 2020, agronomy issues, business models, economics and finance, as well as the sustainability of the industry in terms of carbon reduction, biodiversity conservation or social impacts
Start Date	February 2011
Date of full implementation	2011 through 2014
Economic Cost in €	2.7 mio. funding provided by the European Union
Assistance needed in €	Implementation of pilot projects/ field trials will require approx. another 0.7 mio.
List of stakeholders involved	• Leuphana University Lüneburg • Yale University • University of South Australia • Inocas GmbH • Deutsche Lufthansa AG
Contact for this measure	Thilo Zelt Innovations-Inkubator Lüneburg Kompetenztandem Biokerosin Scharnhorststraße 1 21335 Lüneburg Tel.: +49 (0)4131.677-2087 Mob: +49 (0)171.954-8788 Mail: zelt@inkubator.leuphana.de

Title	**Forschungszentrum Jülich –** **ALAERO – Aviation Fuel from Algae**
Description	scientific
Category	Alternative Fuels
Measure	Evaluation and demonstration of aviation fuel from algae
Action	• Phase I: set-up of 3-4 pilot facilities for algae production and conversion into fuel, selection and breeding of algae, assessment of different production factors like lighting, procurement of heat and CO2, etc., fuel production tests for characterization • Phase II: demonstrator using most promising feedstock and conversion process as derived from Phase I, production of 20t of biojet/ month
Start Date	2012
Date of full implementation	Phase I: 2012-2013; Phase II: 2013-2016
Economic Cost in €	30-50 Mio.
Assistance needed	Public financial R&D support, provision of infrastructure
List of stakeholders involved	• Forschungszentrum Jülich • Helmholtz-Gemeinschaft • EADS • et al.
Contact for this measure	Dr. Andreas Müller Forschungszentrum Jülich GmbH IBG-2: Plant Sciences 52425 Jülich Tel.: +49 2461 61 3528 Fax: +49 2461 61 2492 Mail: a.mueller@fz-juelich.de Web: www.fz-juelich.de

Title	**JatroSolutions - jatropha plantation/ desert cultivation**
Description	market-based
Category	Alternative Fuels
Measure	Cultivation of desert land with a jatropha plantation using pretreated sewage water
Action	• investment in land (500 ha) and irrigation system • cultivation with jatropha plants • yield of 2.4 to 4.0 tonnes of seed per year and hectare • CDM registration and emission certification
Start Date	as soon as financing is secured, estimated in Q1/2012
Date of full implementation	Peak yield to be reached from 2016
Economic Cost in €	Investment cost 1.5 Mio.
Assistance needed	Long-term financial commitment, profitability projected after 15 years
List of stakeholders involved	• JatroSolutions GmbH • Biofuel Egypt Ltd. • Luxor Regional Government
Contact for this measure	Prof. Dr. Klaus Becker Managing Director JatroSolutions GmbH Wollgrasweg 49 70599 Stuttgart-Hohenheim Tel.: +49-711-451 017 420 Fax: +49-711-451 017 421 Mail: office@jatrosolutions.com Web: www.jatrosolutions.com

Title	**Lufthansa - BurnFAIR**
Description	operational
Category	Alternative Fuels
Measure	Commercial flights using biofuel
Action	• Lufthansa Airbus A321 flying between Hamburg and Frankfurt on 50% biofuel in one of its engines for 6 months • Biofuel is converted from sustainably cultivated feedstock • Assessment of feasibility and potential impact on engines
Start Date	July 15th, 2011
Economic Cost in €	Total investment: 6.6 Mio., 2.5 Mio. granted by the Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology)
List of stakeholders involved	• Deutsche Lufthansa AG • Deutsches Zentrum für Luft- und Raumfahrt (DLR) • Technical University Hamburg-Harburg • Technical University Munich • Bauhaus Luftfahrt • EADS Innovation Works • MTU Aero Engines • Deutsches Biomasse Forschungszentrum (DBFZ)
Contact for this measure	Joachim Buse Vice President Aviation Biofuel Deutsche Lufthansa AG Lufthansa Aviation Center Airportring 60546 Frankfurt/Main Germany Tel.:+49 69 696 82000 Fax: +49 69 696 98 35413 Mail: Joachim.buse@dlh.de Web: biofuel.lufthansa.com

Title	**DLR Airbus Fuel cell powered nose wheel**
Description	technological
Category	Alternative Fuels
Measure	Implementation of an electrically powered wheel drive for aircrafts
Action	• Design of a fuel cell powered APU as an emission free power source • Design of an electric nose wheel or main wheel drive
Start Date	Fuel cell based APU: Q1 2012; wheel drive: Q1 2013
Date of full implementation	Fuel cell based APU: 2020; wheel drive: 2020
Economic Cost in €	Fuel cell based APU: 15 million; wheel drive: 7 million
Assistance needed	Public financial R&D support needed for fuel cell based APU (5 million) and wheel drive (2 million)
List of stakeholders involved	• DLR • Airbus • Diehl • Magnetmotor • Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology)
Contact for this measure	Dr.-Ing. Josef Kallo German Aerospace Center (DLR) Institute of Technical Thermodynamics, Electrochemical Energy Technology Pfaffenwaldring 38-40 70569 Stuttgart Tel.:+49 711 6862-672 Fax:+49 711 6862-747 Web: www.dlr.de/tt

Title	**Alternative and renewable fuels for international air traffic**
Description	Scientific
Category	Alternative Fuels
Measure	Evaluation of alternative fuel CO2-emission reduction potential including life cycle emissions
Action	• Identification and life cycle assessment of feasible alternative fuels and production pathways. • Modeling of alternative fuels and analysis of engine performance and emissions. • Investigations on flight mission level and ATS level. • Scenario like prediction of future air traffic and alternative fuels deployment
Start Date	2011
Date of full implementation	2013
Economic Cost in €	135.650 € funding by Bundesministerium für Verkehr, Bau und Stadtentwicklung (Federal Ministry of Transport, Building and Urban Development)
List of stakeholders involved	Deutsches Zentrum für Luft- und Raumfahrt e.V.
Contact for this measure	Dr. Andreas Döpelheuer Deutsches Zentrum für Luft- und Raumfahrt e.V. Linder Hoehe 51147 Köln Tel.:+49-2203-601-2281 Fax.: +49-2203-64395 Mail: Andreas.Doepelheuer@dlr.de

Title	**Bauhaus Luftfahrt – Strategic Prioritization**
Description	scientific
Category	Alternative Fuels
Measure	Assessment and prioritization of alternative fuel options and their respective production pathways
Action	• Assessment based on fuel readiness level, drop-in capability, production costs, substitution potential, well-to-wake greenhouse gas emissions and habitat requirements • Utilization of a metric to translate fuel information into a characteristic score • Weighting of criteria by a scenario-dependent factor to allow context-specific assessments
Start Date	at request
Economic Cost in €	depending on project scale
List of stakeholders involved	• Bauhaus Luftfahrt
Contact for this measure	Dr. Arne Roth Bauhaus Luftfahrt e.V. Lyonel-Feininger-Str. 28 80807 München Tel.: +49-89-307 4849 46 Fax: +49-89-307 4849 20 Mail: arne.roth@bauhaus-luftfahrt.net Web: www.bauhaus-luftfahrt.net

Title	**Bauhaus Luftfahrt – QuaNaBioL**
Description	scientific
Category	Alternative Fuels
Measure	Quality assurance and sustainability for the provision of biological aviation fuels
Action	• Along the entire logistic chain, analyze quality and sustainability criteria for biological aviation fuels • design an incentive compatible market structure for drop-in biofuels
Start Date	2012
Date of full implementation	2013
Economic Cost in €	Total investment: 450 000 €, 400 000 € granted by the Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology), and 50 000 € by Deutsche Lufthansa AG
List of stakeholders involved	• Fraunhofer Institut UMSICHT • TU Berlin • Bauhaus Luftfahrt e.V.
Contact for this measure	Dr. Christoph Jeßberger Bauhaus Luftfahrt e.V. Lyonel-Feininger-Str. 28 80807 München Tel.: +49-89-307 4849 29 Fax: +49-89-307 4849 20 Mail: christoph.jessberger@bauhaus-luftfahrt.net Web: www.bauhaus-luftfahrt.net

Category B:

Measures that are in the stage of early development or available when financing is secured and bear a significant long-term potential of emissions reduction

Title	**Bauhaus Luftfahrt – Solar drop-in fuels**
Description	scientific
Category	Alternative Fuels
Measure	Investigate and assess different pathways to solar drop-in fuels
Action	• development of provision pathways of solar fuels produced from syngas which is derived electrochemically, photochemically or thermochemically and converted via FT-synthesis to liquid hydrocarbons • special emphasis is put on thermochemical solar fuels which have a unique potential of all three key aspects: suitability, sustainability and scalability
Start Date	2011
Date of full implementation	2012
Economic Cost in €	Supported by public R&D funding, depending on project scale
Assistance needed	Financial support according to project scope, access to experimental infrastructure
List of stakeholders involved	• Bauhaus Luftfahrt e.V. • Cooperations and additional partners are to be determined on project period
Contact for this measure	Dr. Holger Kuhn Bauhaus Luftfahrt e.V. Lyonel-Feininger-Str. 28 80807 München Tel.: +49-89-307 4849 23 Fax: +49-89-307 4849 20 Mail: holger.kuhn@bauhaus-luftfahrt.net Web: www.bauhaus-luftfahrt.net

Title	**Bauhaus Luftfahrt – Electric flying**
Description	scientific
Category	Alternative Energy Carriers
Measure	Assessment of feasibility perspectives, scaling properties and limits of fully or hybrid electric motive power systems
Action	• Identification of physical limits and perspectives • Evaluation of key technologies, progress and requirements • Analysis of scaling properties of key technologies and requirements • Analysis of performance characteristics of hybrid motive power system architectures
Start Date	2009
Date of full implementation	2010
Economic Cost in €	Supported by public R&D funding, depending on project scale
Assistance needed	Financial support according to project scope, access to experimental data
List of stakeholders involved	• Bauhaus Luftfahrt e.V.
Contact for this measure	Dr. Holger Kuhn Bauhaus Luftfahrt e.V. Lyonel-Feininger-Str. 28 80807 München Tel.: +49-89-307 4849 23 Fax: +49-89-307 4849 20 Mail: holger.kuhn@bauhaus-luftfahrt.net Web: www.bauhaus-luftfahrt.net

Title	**Fraunhofer Institute for Building Physics** **Life Cycle Engineering**
Description	scientific
Category	Alternative Fuels
Measure	Evaluation of various types of alternative fuel – holistic life cycle analysis
Action	• Sustainability analysis for production, conversion and usage of alternative fuel • Investigation of aspects such as global warming potential (GWP), acidification potential (AP), eutrophication potential (EP), Photochemical Ozone Creation Potential (POCP), Primary Energy Demand (PED) and Impact Categories like land use change, water and biodiversity
Start Date	at request
Economic Cost in €	depending on project scale
List of stakeholders involved	• Fraunhofer Institute for Building Physics • University of Stuttgart
Contact for this measure	Robert Ilg University of Stuttgart Chair of Building Physics Life Cycle Engineering Hauptstraße 113 70771 Echterdingen Tel.: +49-711-489 999 22 Fax: +49-711-489 999 11 Mail: Robert.ilg@lbp.uni-stuttgart.de Web: www.lbp-gabi.de

Title	**TU Hamburg-Harburg –** **Identification and Evaluation of Biofuel Pathways**
Description	scientific
Category	Alternative Fuels
Measure	Identification and Evaluation of different pathways of biofuel provision
Action	• Identifying most promising provision pathways of Alternative Aviation Fuel • Evaluation of technical, economical and ecological criteria • Focusing on HEFA-, BtL- and GtL-based options • Holistic analysis of provision pathways for different points in time (2010, 2015, 2020, 2030) based on costs and GHG-emissions
Start Date	at request, potentially Q1 2012
Date of full implementation	Depending on project scale
Economic Cost in €	Several 10k€ for external consultants
Assistance needed in €	Assistance of industry partners, reporting by plant engineers
List of stakeholders involved	• Hamburg University of Technology (TUHH) - Institute of Environmental Technology and Energy Economics (IUE) • VERBIO AG
Contact for this measure	Prof. Dr. Martin Kaltschmitt Hamburg University of Technology (TUHH) Institute of Environmental Technology and Energy Economics (IUE) Eissendorfer Str. 40 D-21073 Hamburg Tel.: ++49 / (0)40 / 42 878 - 3008 Mobil: ++49 / (0)173 / 942 7778 Fax: ++49 / (0)40 / 42 878 – 2315 kaltschmitt@tu-harburg.de

Category C:

Measures of Airlines and Airports in Germany

1. Lufthansa fleet renewal programme

Title	Lufthansa fleet renewal programme
Description	Technological improvement
Category	Aircraft-related Technology Development
Measure	Purchase of new aircraft
Action	Lufthansa fleet renewal programme: By 2018, a total of 168 fuel efficient aircrafts will be flying with the fleet. The latest newcomer is the Boeing 747-8 Intercontinental, which entered into service at Lufthansa in June 2012. The new aircraft is 15 per cent more fuel-efficient than the Boeing 747-400 predecessor model.
Start Date	2012
Date of full implementation	2018
Economic Cost	list price of € 17 billion
List of Stakeholders involved	Boeing, Airbus

Incremental improvements / benefits for each measure

YEAR	2012 - 2018
Improvement in Total Fuels (%)	15 % to 20 % more fuel-efficient than predecessor model
Improvement in Total CO_2 Emissions (%)	15 % to 20 % more CO_2-efficient than predecessor model
Anticipated co-benefits	New »low-noise« aircrafts

Point of contact for this measure

Deutsche Lufthansa AG, www.lufthansa.com
Dr. Christoph Franz, Chairman of the Executive Board and CEO

2. Retrofit of airberlin's Boeing B73N fleet with Blended Winglets

Title	Retrofit of airberlin's Boeing B73N fleet with Blended Winglets
Description	Technological/Aerodynamic improvement
Category	Aircraft-related Technology Development
Measure	Retrofitting and upgrade improvements on existing aircraft
Action	• The wing tips of the B737(-700/-800) fleet were retrofitted with Blended Wings • This measure increases the aspect ratio of the wing, thus reducing lift-induced drag and increasing performance
Start Date	2002
Date of full implementation	2012
Economic Cost	Moderate investment volume (678,000 €)
List of Stakeholders involved	• airberlin • airberlin Technik • Boeing

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (litres)	337,500 l/Plane p.a.
Improvement in Total Fuels (%)	3 %/Flight
Improvement in Total CO_2 Emissions (kg)	850,000 kg/Plane p.a.
Improvement in Total CO_2 Emissions (%)	3 %/Flight
Anticipated co-benefits	• Better climb performance • Noise reduction by about 6.5 %

Point of contact for this measure

Air Berlin PLC & Co. Luftverkehrs KG, www.airberlin.com
Hermann Lindner, Director External Affairs, hlindner@airberlin.com

3. Reduction of Aircraft Weight

Title	Reduction of Aircraft Weight
Description	Technological improvement
Category	Aircraft-related Technology Development
Measure	Retrofitting and upgrade improvements on existing aircraft
Action	• New Continental Cabin Europe Despite an increased amount of seats, the layout change of the new continental cabin Europe entails weight savings on 175 aircraft of Lufthansa‘s continental fleet of 330 kg. • Implementation Light Weight Containers LD3 After successfully testing 1,000 light weight LD3 containers, the implementation of ACS Aerobox and DoKaSch containers is prepared. A sum of 16 kg weight can be saved per utilized container. • LSG Light Weight Trolley Interkont LSG is about to introduce lighter trolleys on the flights of Lufthansa and its regional carriers. Weight is reduced by 10 kg per full size trolley and by 6.5 kg per half size trolley. A testing phase has been completed successfully in 2010. The introduction of light weight trolleys on the intercontinental fleet starts with the introduction of the summer flight plan 2011. • Omission towing loop A340-300 By omitting the towing loop at the nose gear of A340-300 aircraft, 9 kg of weight can be saved per aircraft. • Omission Fuel Expansion Tanks A340-300 of the series ST4 from MSN 135 to MSN contain two expansion tanks which are situated above the centre tanks. They are not required in Lufthansa‘s flight operations. By omitting the fuel expansion tanks, 230 kg of weight can be saved per aircraft. • Reduction of Paper Maps on Board As a consequence of the introduction of the electronic flight bag EFB, the amount of paper maps on board can be reduced. Thus, weight savings of 10 kg per airplane can be realised.
Start Date	2008
Date of full implementation	-

Economic Cost	Moderate investment volume
List of Stakeholders involved	These measures, as described by Lufthansa, are also implemented by: • Air Berlin PLC & Co. Luftverkehrs KG • Augsburg Airways GmbH • Condor Flugdienst GmbH • Lufthansa Konzern (inkl. LX, OS, BD, SN)

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (litres)	Improvement depends on type of aircraft, the weight and the distance: • e.g. on a flight from Berlin to Tenerife (5 h) with a Boeing 737 with 100 kg less weight, fuel savings are 14 litres • 1 kg less weight on e.g. all aircrafts of Lufthansa Passage saves 25 t fuel per year

Point of contact for this measure

Bundesverband der Deutschen Luftverkehrswirtschaft (BDL) - German Aviation Association
www.bdl.aero
Uta Maria Pfeiffer, Head of Sustainability, uta-maria.pfeiffer@bdl.aero

4. Use of deep geothermal energy at Hannover Airport

Title	Use of deep geothermal energy at Hannover Airport
Description	Technological Improvement
Category	Alternative Fuels at Airports
Measure	Operations with alternative fuels
Action	• Examination of potentials for deep geothermal energy for heating and power supply of Hannover Airport • Implementation and use of water cycles in depths of 3500 m - 5000 m • Temperatures in these regions are between 130 °C and 180 °C • Depending on various factors like depth and temperature, this technology could not only be used to heat 100 % of the airport facilities but to produce enough electrical energy for about 30 - 50 % of the airport's demand
Start Date	2010
Date of full implementation	2020
Economic Cost	High investment volume (30 - 50 Mio.)
List of Stakeholders involved	• Hannover Airport • TD2 • TUIfly • Federal State of Lower Saxony • City of Hannover • Fraport • Government

Point of contact for this measure

Hannover Airport, www.hannover-airport.de
Carsten Skwirblies, Head of Technical Services, c.skwirblies@hannover-airport.de

5. Use of photovoltaic systems at airports for power generation

Title	Use of photovoltaic systems at airports for power generation
Description	Technological
Category	Alternative Fuels at Airports
Measure	Operations with alternative fuels
Action	• Düsseldorf International Airport is installing a new photovoltaic system • It is supposed to generate about 2 Mio. kilowatt hours of energy p.a. • One of the biggest photovoltaic systems in North Rhine-Westphalia • It is the only facility located within the security area of an international airport in Germany • About 8.400 modules, the size of six football fields
Start Date	October of 2011
Date of full implementation	December of 2011
Economic Cost	Moderate investment volume
List of Stakeholders involved	• Flughafen Düsseldorf GmbH

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total CO_2 Emissions (kg)	1,000,000 kg p.a.

Point of contact for this measure

Flughafen Düsseldorf GmbH, www.duesseldorf-international.de
Veronika Bappert, Head of Neighbourhood Dialogue and Immission Protection, bappert@dus-int.de

6. Introduction of Continuous Descent Approach/Operation at Cologne Bonn Airport

Title	Introduction of Continuous Descent Approach/Operation at Cologne Bonn Airport
Description	Operational Improvement
Category	Improved Air Traffic Management and Infrastructure Use
Measure	More efficient ATM planning
Action	• Introduction of CDA/CDO at night from 10 p.m. - 6 a.m. (from august 2011: 10 p.m. - 8 a.m.) • During CDA/CDO an aircraft's engine is in idle, therefore producing little thrust and reducing noise levels and emissions
Start Date	January of 2009
Date of full implementation	Already implemented
Economic Cost	Low investment volume
List of Stakeholders involved	• Cologne Bonn Airport in cooperation with UPS • DFS • Various airlines • Noise Commission of Cologne Bonn Airport

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (litres)	137.5 l/Approach
Improvement in Total CO_2 Emissions (kg)	5,205,000 kg p.a. 347 kg/Approach
Anticipated co-benefits	2 - 6 dB(A) reduction of noise levels on approach

Point of contact for this measure

Flughafen Köln/Bonn GmbH, www.koeln-bonn-airport.de
Martin Partsch, Head of Aircraft Noise Measurement Station, martin.partsch@koeln-bonn-airport.de

7. Decreasing acceleration altitude

Title	Decreasing acceleration altitude
Description	Operational Improvement
Category	Improved Air Traffic and Infrastructure Use
Measure	More efficient ATM planning
Action	• Where possible, Acceleration Altitude is reduced by about 500 ft • Changing the required engine power from take-off to climb reduces fuel consumption and noise levels • The wings are exposed to the influence of strong drag for a shorter period of time. Thus, early acceleration helps to save kerosene • Thrust reduction increases the lifespan of engines
Start Date	2011
Date of full implementation	Already implemented
Economic Cost	Low investment volume
List of Stakeholders involved	• airberlin, Flight Operations • Lufthansa

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (litres)	12.5 l/Flight
Improvement in Total CO_2 Emissions (kg)	31.5 kg/Flight
Anticipated co-benefits	• Lower noise levels • Increased lifespan of engines

Point of contact for this measure

Air Berlin PLC & Co. Luftverkehrs KG, www.airberlin.com
Hermann Lindner, Director External Affairs, hlindner@airberlin.com

Deutsche Lufthansa AG, www.lufthansa.com
Dr. Karlheinz Haag, Head of Environmental Issues, karlheinz.haag@dlh.de

8. Intelligent air-conditioning at Cologne Bonn Airport

Title	Intelligent air-conditioning at Cologne Bonn Airport
Description	Technological Improvement
Category	Improved Air Traffic and Infrastructure Use
Measure	More efficient terminal operations
Action	• Less consumption of warm and cold air for air-conditioning of Cologne Bonn's Cargo Centre Terminal 2 as well as Terminal 1 with the new "Bauer System"
Start Date	2009
Date of full implementation	End of 2012
Economic Cost	Moderate investment volume (2 Mio. €)
List of Stakeholders involved	• Cologne Bonn Airport

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (%)	30 % less energy consumption
Improvement in Total CO_2 Emissions (kg)	2,000,000 kg p.a.

Additional information

www.baopt.de

Point of contact for this measure

Flughafen Köln/Bonn GmbH, www.koeln-bonn-airport.de
Martin Partsch, Head of Aircraft Noise Measurement Station, martin.partsch@koeln-bonn-airport.de

9. Increased use of aircraft tugs/TaxiBot

Title	Increased use of aircraft tugs/TaxiBot
Description	Technological and operational
Category	Improved Air Traffic Management and Infrastructure Use
Measure	More efficient ground operations
Action	• TaxiBot is the name of a new type of aircraft tug • Without any kind of modification needed to the aircraft itself, the pilot is able to control the tug completely • The nose wheel of the aircraft is attached to a moving disc on top of the tug • This way, the pilot can control the tug with the cockpit controls as if the aircraft was moving freely • Cleverly thought out sensors, speed controls and GPS simplify the steering of the aircraft for the pilots
Start Date	Still in test phase, first trial runs in December of 2010
Date of full implementation	-
Economic Cost	Moderate investment volume
List of Stakeholders involved	• Israel Aerospace Industries (IAI) • TLD • Airbus • Lufthansa Technik- Subsidiary Lufthansa LEOS • Fraport AG

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (litres)	500 l – 700 l/flight (B747)
Improvement in Total Fuels (%)	3 %/flight
Anticipated co-benefits	• No engine noise while taxiing • Aircraft tugs are considerably more quite

Additional information

Source: Fraport, Lufthansa

Point of contact for this measure

Deutsche Lufthansa AG, www.lufthansa.com
Dr. Karlheinz Haag, Head of Environmental Issues, karlheinz.haag@dlh.de

Fraport AG, www.fraport.de
Jörg Kämer, Head of Sustainability Management and Corporate Compliance, j.kaemer@fraport.de

10. Reduction of APU utilization

Title	Reduction of APU utilization
Description	Technological and operational
Category	Improved Air Traffic Management and Infrastructure Use
Measure	Installation of airport infrastructure such as Fixed Electrical Ground Power and Pre-Conditioned Air to allow aircraft APU (Auxiliary Power Unit) switch-off
Action	Methodology: • APU fuel consumption and related emissions average 10 times more costs than alternative ground power options Achievements: • airberlin already reduced the APU utilization by three minutes per turnaround • The target in 2011 is to reduce the average utilization time per flight by further five minutes • A lower APU utilization also results in the reduction of overhaul costs, emissions and noise
Start Date	2010
Date of full implementation	Already implemented
Economic Cost	Moderate investment volume
List of Stakeholders involved	• airberlin

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (litres)	3,625,000 l p.a. 12.5 l/flight
Improvement in Total CO_2 Emissions (kg)	9,100,000 kg p.a.

Point of contact for this measure

Air Berlin PLC & Co. Luftverkehrs KG, www.airberlin.com
Hermann Lindner, Director External Affairs, hlindner@airberlin.com

11. FMS-Feeding of specific A/C drag optimizes descent profile

Title	FMS-Feeding of specific A/C drag optimizes descent profile
Description	Operational, Flight Procedures
Category	Improved Air Traffic Management and Infrastructure Use
Measure	More efficient ATM planning and aircraft capabilities
Action	Methodology: • Exact determination of TOD (Top of Descent: Transition from cruise to descent) due to exact knowledge about drag conditions of the airplane • The higher the aircraft specific drag, the less lateral distance between TOD and destination Achievements: • Optimization of the descent path as exact drag behaviour of airplane is inserted in the MCDU/FMC (Flight Management Computer) and included in flight path calculations • A longer cruise flight leads to lower fuel burn and, in ground vicinity, noise abatement • Applying both the correct idle factor and continuous descent approaches lead to significant fuel savings
Start Date	2008
Date of full implementation	Already implemented
Economic Cost	Low investment volume
List of Stakeholders involved	• airberlin

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (litres)	1,250,000 l p.a. 22.5 l/flight
Improvement in Total CO_2 Emissions (kg)	3,100,000 kg p.a.
Anticipated co-benefits	• Lower noise levels

Point of contact for this measure

Air Berlin PLC & Co. Luftverkehrs KG, www.airberlin.com
Hermann Lindner, Director External Affairs, hlindner@airberlin.com

12. Best practice in ATC

Title	Best practice in ATC
Description	Operational
Category	Improved Air Traffic Management and Infrastructure Use
Measure	More efficient ATM planning and en-route operations
Action	Route Shortings 2010 Eurocontrol • In airspaces controlled by Eurocontrol, route shortings of 4.9 NM per Lufthansa flight could be achieved. This leads to fuel saving of 6,434,000 kg per year Night Time Direct Routings • In the UK airspace, direct routings are possible before 05:30 UTC, which reduces flight times by up to three minutes. This corresponds to fuel savings of up to 500 l per flight. This project results from a cooperation between NATS, Eurocontrol, IAA and the Maastricht centre. Optimization of Flight Planning • Employing more dispatchers allows for more manual calculations and a deeper analysis of flights. Thus, it is possible to further optimize flights with the help of LIDO OC. This leads to a reduction of fuel consumed.
Start Date	2010
Date of full implementation	-
Economic Cost	Low investment volume
List of Stakeholders involved	• Lufthansa

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (litres)	• Different – see above

Point of contact for this measure

Deutsche Lufthansa AG, www.lufthansa.com
Dr. Karlheinz Haag, Head of Environmental Issues, karlheinz.haag@dlh.de

13. Best practice in flight operations

Title	Best practice in flight Operations
Description	Operational
Category	Improved Air Traffic Management and Infrastructure Use
Measure	More efficient ATM planning, ground operations and en-route operations
Action	Blocktime Adjustment PHL-FRA • Flight LH427 from Philadelphia to Frankfurt has been shifted ahead by 45 minutes to avoid long taxiing due to high density of traffic. Situation based Cost Index 0 on LH409 • Flight LH409 EWR-DUS is not permitted to arrive prior to 06:00 AM at DUS. Despite the short flight time it often has to leave the gate in EWR at STD due to infrastructural reasons. • Instead of a remote holding with running engines, pertaining to the prevailing situation it is recommended to conduct the flight with a cost index of 0. This saves 500 l of kerosene per flight at the same variable cost. Optimization OPS MUC (Cont.) • The effect of a general fixation on the standard cost index for all HUB outbound routes (Cont.) is measured. For this purpose, a worst-case test concerning three flight numbers took place during the summer flight plan 2010 in Munich. It could be observed that fixing the cost index did not have significant negative effects. Consequently, the project is introduced in Munich and is now also being analyzed for the hub Frankfurt. Blocktime Adjustments WFP 2010/11 • For the winter period 2010/2011, the block times of six out of the eleven most fuel consuming flights are adjusted to a level which is optimal for the cost index.
Start Date	2010
Date of full implementation	-
Economic Cost	Low investment volume
List of Stakeholders involved	• Lufthansa

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (litres)	• Different – see above

Point of contact for this measure

Deutsche Lufthansa AG, www.lufthansa.com
Dr. Karlheinz Haag, Head of Environmental Issues, karlheinz.haag@dlh.de

14. Use of satellite navigation technology

Title	Use of satellite navigation technology
Description	Operational
Category	Improved Air Traffic Management and Infrastructure Use
Measure	More efficient ATM planning, ground operations and en-route operations
Action	• In a joined research project with airberlin, the German Aerospace Centre (DLR), the German Air Traffic Services (Deutsche Flugsicherungs GmbH DFS) and Fraport AG, new, more efficient and noise reducing approach procedures are being tested • For this, an airberlin Boeing 737-700 aircraft performed several approaches at the DLR research airport Braunschweig-Wolfsburg while noise levels were being measured on the ground • The airberlin-Boeing approached the airport with more steep angles than the usual 3 ° • airberlin is using the new ground supported satellite navigation System GLS (Global Position Landing System) • In contrast to the conventional instrument landing system (ILS) GLS permits even steeper and curved approaches • The satellite navigation allows for noise level reductions and a better cost efficiency • Approaches to geographically unfavourably located airports without ILS or with poor visibility can be performed precisely with GLS • Thus, making holding patterns and the need to divert to alternative airports unnecessary • Flights can be performed with less weather dependency and with more flexibility which leads to more reliability • With all this, GLS can also reduce fuel consumption
Start Date	Test phase, evaluation approaches at Bremen since 2008 and trial runs with scientific evaluation at Braunschweig-Wolfsburg airport in 2010
Date of full implementation	Implementation is dependent on installation of required equipment at airports.
Economic Cost	High investment volume
List of Stakeholders involved	• airberlin • Deutsches Zentrum für Luft- und Raumfahrt (DLR) • Deutsche Flugsicherung GmbH (DFS) • Fraport AG

Incremental improvements / benefits for each measure

YEAR	
Anticipated co-benefits	• Optimised approaches • Holding patterns can be avoided • Noise level reduction • Less fuel consumption • Less weather dependency • Retraining of cockpit crew not necessary

Point of contact for this measure

Air Berlin PLC & Co. Luftverkehrs KG, www.airberlin.com
Hermann Lindner, Director External Affairs, hlindner@airberlin.com

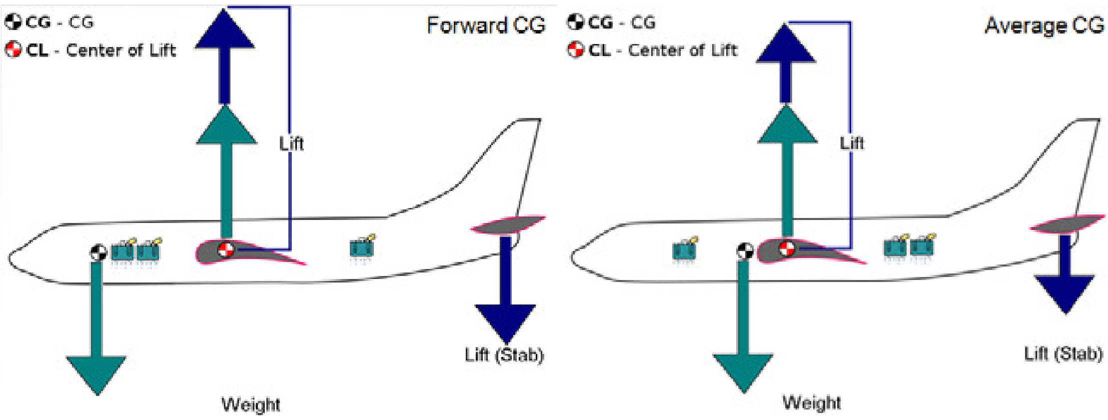
15. Smart seating procedure

Title	Smart seating procedure
Description	Weight & Balance
Category	More efficient operations
Measure	Best practices in operations
Action	Smart seating procedure leads to significant fuel savings Methodology: • At rearward centre of gravity the stabilizer needs to produce less downward lift • That results in a lower lift demand at the wing Achievements: • airberlin anticipates tendency of pax to check in at the front of the aircraft • Therefore, the aimed seat load factor in the middle and backward compartments have been slightly increased • airberlin fuel efficiency management achieves a material annual saving of 7,600 tons of fuel (9,500,000 l) • Changes resulted in a move of pax 1 row backwards
Start Date	2010
Date of full implementation	Already implemented
Economic Cost	Low investment volume
List of Stakeholders involved	• airberlin, Flight Operations

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (litres)	45 l/Flight 7,600 tons of fuel (9,500,000 l) p.a.
Improvement in Total CO_2 Emissions (kg)	23,940,000 kg p.a.

Additional information



Point of contact for this measure

Air Berlin PLC & Co. Luftverkehrs KG, www.airberlin.com
Hermann Lindner, Director External Affairs, hlindner@airberlin.com

16. Dynamic Cost-Index Optimisation and Application

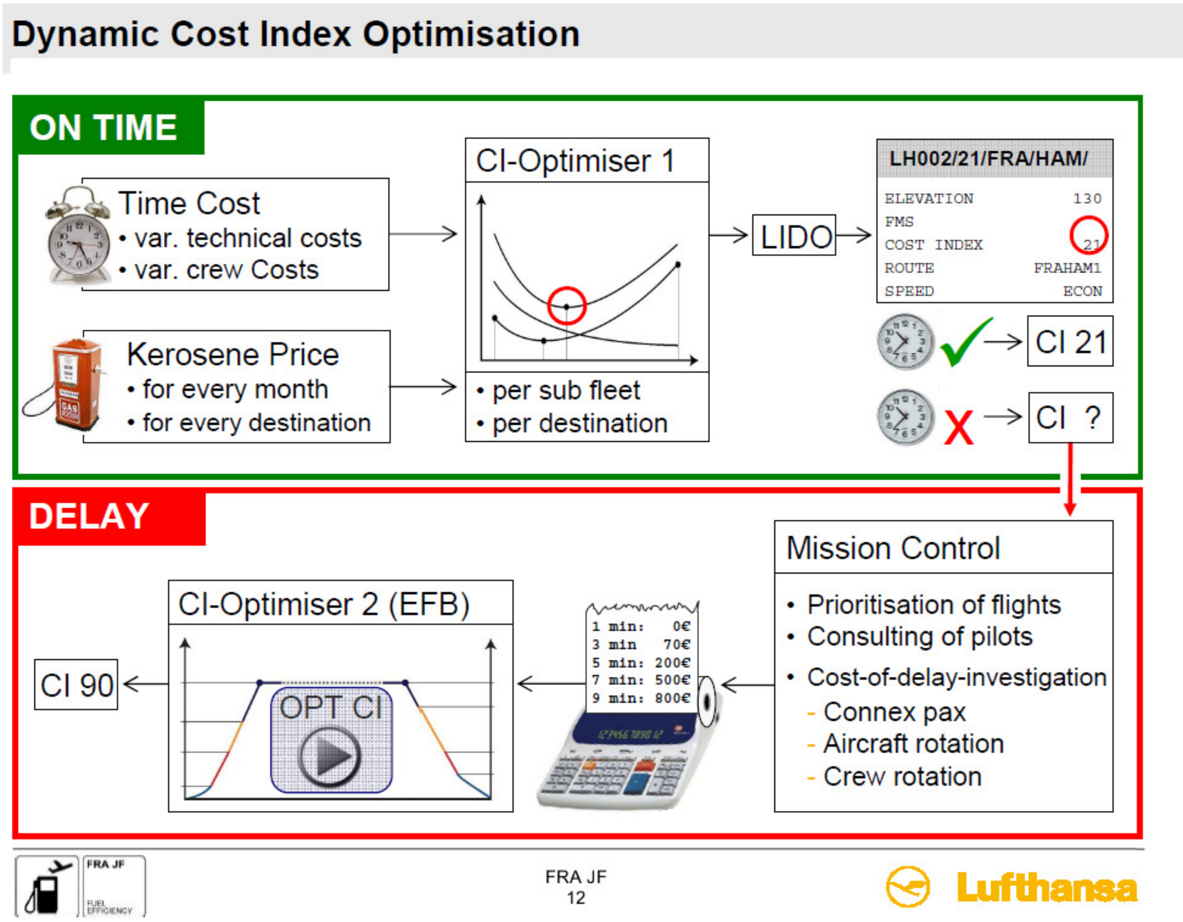
Title	Dynamic Cost-Index Optimisation and Application
Description	Organisational Improvement
Category	More efficient operations
Measure	Best practices in operations
Action	Tactical Cost Index Considering actual daily data concerning weather, traffic and connecting flights, the optimal speed and flight level are calculated for each flight. In order to catch up delays, the flight speed can be changed via the cost index. Connex Info The acceleration of a delayed intercontinental flight only takes place if there are connex passengers on board whose connecting flights are at risk due to a delay. In all other cases, flights are planned to operate at an optimal cost index. In January 2011, a connectivity information has been introduced to help to decide whether or not to increase speed. Optimal CI in the Case of Punctual Flights In the case of punctual flights, the cost index should be optimised. On the A320 fleet, the Standard CI is reduced from 30 to 25. This means, that 18 kg of fuel can be saved per flight. The flight time increases by about one minute.
Start Date	2011
Date of full implementation	-
Economic Cost	Moderate investment volume

List of Stakeholders involved	• Lufthansa CityLine implements a cost index operation for its CRJ and Embraer fleet. • Eurowings plans to introduce cost index operations for its CRJ fleet. As a part of this procedure Eurowings will be switching from Jeppesen to Lido OC. Fuel consumption is expected to decrease by 4 %. • Augsburg Airways plans to introduce cost index operations for its EMJ195 fleet. It operates the same aircraft type with identical engines. • In cooperation with Embraer Flight Operations Support, Air Dolomiti examines the possibility of optimising the flight profiles on its routes. It pursues the goal of finding a flight profile which reduces trip fuel by improving the amount of fuel consumed.

Incremental improvements / benefits for each measure

YEAR	Per year after full implementation
Improvement in Total Fuels (litres)	• Lufthansa CityLine: 7,554 t = 9,442,500 l • Eurowings: 5,000 t = 6,250,000 l • Augsburg Airways: 1,370 t = 1,712,500 l • Air Dolomiti: 1,507 t = 1,883,750 l
Improvement in Total CO_2 Emissions (kg)	• Lufthansa CityLine: 23,795,000 kg • Eurowings: 15,750,000 kg • Augsburg Airways: 4,315,000 kg • Air Dolomiti: 4,747,000 kg

Additional information



Point of contact for this measure

Deutsche Lufthansa AG, www.lufthansa.com
Dr. Karlheinz Haag, Head of Environmental Issues, karlheinz.haag@dlh.de

17. Best Practice in more efficient operations

Title	Best Practice in more efficient operations
Description	Organisational Improvement
Category	More efficient operations
Measure	Best practices in operations
Action	Optimised take-off Reducing the wing-flap settings and thereby decreasing air resistance saves 10 - 15 kg fuel just on take-off. 30 - 50 kg CO_2 are saved per flight by adopting more aerodynamic wing-flap settings at an earlier stage. Cruising speed An optimum cruising speed delivers savings of up to 3 %. Even a slight reduction in the cruising speed - not discernible by passengers – allows to save fuel. The shortest route Flight planning and pilots always work out the shortest route between two geographical points. This allows to reduce fuel consumption on some routes by up to 4 %. The most efficient route Highly sophisticated software is used to determine the most fuel-efficient route. The program uses current data relating to weather and other flying conditions to work out the most efficient route. Flying with a tailwind The positive effect of tailwinds generates fuel savings of up to 3 % for airlines. Less thrust is required when there is a tailwind, and this also produces a marked reduction in fuel consumption when cruising. Perfect landing Satellite navigation allows to optimise the approach procedures, which means that the aircraft can fly in air strata that are aerodynamically more favourable. At the same time it avoids holding patterns and reduces fuel consumption during the descent. Optimum lading Optimised, individual lading allows to reduce fuel consumption as well as saving between 2 and 3 % CO_2.

Action	Down-to-earth actions Using a ground power unit instead of the auxiliary power unit in the tail of the aircraft saves up to 60 kg of fuel. The power units ensure that the aircraft remains supplied with electricity and fresh air when the engines are switched off. Starting the engines Pilots do not start the engines until the aircraft has been pushed back from the air bridge. Waiting for as long as possible before starting the engines reduces CO_2 emissions by up to 100 kg. Systematic switch-off Avoiding unnecessary fuel consumption after landing by switching off the engines as soon as the aircraft has reached the gate. This also minimises the noise level at the airport.
Start Date	Different
Date of full implementation	Different
Economic Cost	Moderate investment volume
List of Stakeholders involved	• Air Berlin PLC & Co. Luftverkehrs KG • Augsburg Airways GmbH • Condor Flugdienst GmbH • Lufthansa Konzern (inkl. LX, OS, BD, SN) • TUIfly GmbH

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (litres)	• Different – see above
Improvement in Total CO_2 Emissions (kg)	• Different – see above

Point of contact for this measure

Bundesverband der Deutschen Luftverkehrswirtschaft (BDL) - German Aviation Association
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18. Improved engine and aircraft wash

Title	Improved engine and aircraft wash
Description	Operational Improvements
Category	More efficient operations
Measure	Optimised aircraft maintenance
Action	<u>New Full-Service Tool "Clear Core"</u> • TUIfly utilizes the new Full-Service Tool "Clear Core", developed by GE Aviation, for its engine wash • The new tool is able to filter the water used for the engine wash, making it reusable for about 100 times • Deposits inside the engine are washed out through this measure, thus increasing efficiency and reducing emissions • 87,500 l fuel/Flight p.a. can be saved, which equals 220,000 kg CO_2 emissions/Flight p.a. <u>Increased wash cycles</u> • Airlines, like airberlin, are washing their engines on a regular basis, thus taking advantage of the benefits of this measure as well • airberlin fuel efficiency management achieved to reduce engine water wash intervals down to 1000 flight cycles on narrowbody aircraft (500 cycles on widebody) • Reducing the engine water wash intervals increases fuel efficiency by up to 0.5 % • As it lowers exhaust gas temperature margin by 15 °C also on-wing-time is extended • airberlin achieves a material annual saving of 4,375,000 l of fuel with a saving of 32.25 l fuel/flight • With the aid of a method developed by Lufthansa Technik, engines can also be washed within shorter parking periods <u>Improved aircraft wash</u> • Besides washing the engines, the aircraft itself is washed routinely and more thoroughly, which increases the aerodynamic quality of the aircraft and reduces fuel consumption by about 2 %
Start Date	2011
Date of full implementation	Already implemented
Economic Cost	Low investment volume, 3000 €/engine wash

List of Stakeholders involved	• TUIfly • GE Aviation • Airberlin • Lufthansa

Incremental improvements / benefits for each measure

YEAR	
Improvement in Total Fuels (%)	Engine wash: 0.5 - 1 % Aircraft wash: 2 %
Improvement in Total CO_2 Emissions (%)	Engine wash: 220,000 kg CO_2 emissions/Flight p.a.
Anticipated co-benefits	• The lifespan of engines is increased • Water consumptions is reduced • Better operational capabilities

Additional information

Source: TUIfly

Point of contact for this measure

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Air Berlin PLC & Co. Luftverkehrs KG, www.airberlin.com
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Deutsche Lufthansa AG, www.lufthansa.com
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19. “Fuel Saving Pilot” with Fuel Coaching Campaign and manual

Title	“Fuel Saving Pilot” with Fuel Coaching Campaign and manual
Description	Organisational and operational
Category	Regulatory measures/Other
Measure	Conference/Workshops
Action	airberlin’s Fuel Coaching Campaign allows its cockpit crew to become a “Fuel Saving Pilot” Three steps: Step 1: Online Course (LMS) • Online course for pilots regarding the topic: the best techniques to save fuel. Step 2: Fuel Coaching • The second step is a coaching flight whereby a specially trained and experienced pilot, presents numerous techniques to save fuel during the flight. Step 3: Certificate and Fuel Voucher • Upon the successful completion of the online course and the coaching flight the pilots will receive a petrol voucher. Besides this, airlines are also distributing manuals to the pilots that contain information about and codes of behaviour for: • When specifically to switch on and off the engines • Ideal cursing speed • Aerodynamic wing flap positions • Calculation of the shortest route
Start Date	2008
Date of full implementation	Repeated annually
Economic Cost	Moderate investment volume
List of Stakeholders involved	• airberlin

Incremental improvements / benefits for each measure

YEAR	
Anticipated co-benefits	• Reduced fuel consumption and therefore less CO_2 emissions

Point of contact for this measure

Air Berlin PLC & Co. Luftverkehrs KG, www.airberlin.com
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20. BDL-Forum »energy efficiency and climate protection in aviation«

Title	BDL-Forum »energy efficiency and climate protection in aviation«
Description	Communicative Improvement
Category	Regulatory measures / Other
Measure	Conferences / workshops
Action	Air transport has many issues that reach far into the society. As part of the BDL-Forum, a new series of the German Aviation Association is ideal for a broad dialogue on their topics. The first event was held in June 2012 in cooperation with the German Energy Agency GmbH (dena) About 120 guests from politics and administration, business and science, but also from environmental organizations, the media and interested public discussed in Berlin.
Start Date	20. June 2012
List of Stakeholders involved	Bundesverband der Deutschen Luftverkehrswirtschaft (BDL) - German Aviation Association Deutsche Energieagentur GmbH (dena) - German Energy Agency GmbH Representatives of • German Parliament • Public authorities • NGOs • Science • Transport associations • Aviation industry

Additional information

Further information: http://www.bdl.aero/de/presse-publikationen/bdl-forum/

Point of contact for this measure

Bundesverband der Deutschen Luftverkehrswirtschaft (BDL) - German Aviation Association
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