Organización de Aviación Civil Internacional

GIACC/4-WP/2
7/5/09

NOTA DE ESTUDIO

**GRUPO SOBRE LA AVIACIÓN INTERNACIONAL
Y EL CAMBIO CLIMÁTICO (GIACC)**

CUARTA REUNIÓN

Montreal, 25 - 27 de mayo de 2009

Cuestión 3 del orden del día: **Informe sobre las medidas y elementos de política elaborados por los grupos de trabajo**

INFORME SOBRE EL AVANCE DEL GRUPO DE TRABAJO PARA LA ELABORACIÓN DE METAS

(Nota presentada por el presidente del Grupo de trabajo)

1. Antecedentes

1.1 Entre las reuniones GIACC/2 Y GIACC/3, el grupo de trabajo (WG) 1 identificó asuntos fundamentales para someterlos a la consideración del GIACC en su tercera reunión. Entre los elementos más importantes, recomendó dos metas de corto plazo para el rendimiento del combustible: 1) una meta de rendimiento del combustible mundial para 2012 (p. ej., XX litros de combustible/100 RTK), y 2) una tasa anual de mejoramiento del rendimiento del combustible de X%/año entre 1990 y 2012. Considerando los datos entregados por la OACI, OAG y la industria, el WG 1 tomó nota de una variación de 1,7%/año a 2,1%/año en el mejoramiento anual del rendimiento del combustible para 2012. La GIACC/3 tomó nota de un acuerdo indicativo respecto de una meta de corto plazo para el rendimiento del combustible con un mejoramiento de 2,0%/año, con la intención de revisar este porcentaje basándose en nueva información.

1.2 El WG 1 reconoció que era, en cierta medida, difícil establecer metas de mediano y largo plazos. Indicó que los plazos, en general, debían coincidir con los de la CMNUCC (es decir 2020 para mediano plazo y 2050 para largo plazo), aunque tomó nota de que un Estado sugería 2025 para mediano plazo. Las deliberaciones para establecer metas de rendimiento del combustible de mediano plazo y de largo plazo se centraron en la dificultad de encontrar datos creíbles en los cuales basar estas metas. Además, algunos opinaron que debían establecerse metas más flexibles, en tanto que otros consideraron que las metas a las que se aspira debían expresarse únicamente en términos de rendimiento del combustible.

1.3 El Grupo de trabajo para la elaboración de metas (WG 4) se creó para continuar y avanzar las iniciativas del WG 1. El WG 4, en sus esfuerzos por elaborar posibles metas de mediano y largo plazos que se someterían al examen del GIACC, debía encargarse, además, de considerar el aporte de la industria a partir de la GIACC/3. Cabría recordar que la industria sugirió que, en comparación con los niveles de 2005, con respecto al rendimiento del combustible podían lograrse mejoras de 15% en 2012 (cerca de 2,1% anual), 29% en 2020 (cerca de 1,9% anual), y 50% para 2050 (cerca de 1,1% anual). Se invitó a la industria a entregar más información al WG 4, pero no lo hizo.

2. Métodos de medición

2.1 Las deliberaciones del grupo relativas a las definiciones de rendimiento del combustible y medición del rendimiento del combustible con ajuste al contenido de carbono (para tener en cuenta los combustibles provenientes de fuentes renovables y las medidas basadas en criterios de mercado) evolucionaron para transformarse en un debate sobre medición.

2.2 Con respecto al **rendimiento del combustible**, el consenso fue general en cuanto a que volumen/RTK, de acuerdo con el WG 1, es una buena medición inicial. Sin embargo, algunos Estados consideraron que era necesario una medición que tuviera en cuenta la intensidad de carbono, para poder determinar el mejoramiento del rendimiento logrado mediante combustibles alternativos sostenibles para la aviación o medidas basadas en criterios de mercado. La medición del rendimiento del combustible sería un componente de una medición más amplia, que se ha denominado "**Medición de intensidad de CO_2 neto**" para los fines de nuestro análisis. Representantes europeos propusieron una fórmula que tendría en cuenta estas novedades.

2.3 El grupo examinó las compensaciones y el grado de precisión con que la fórmula de intensidad de carbono podría reflejar con exactitud reducciones en otros sectores. De manera similar, hubo interés en cuanto al grado en que la fórmula de intensidad de carbono podía tener en cuenta la masa con respecto al volumen de combustible. El grupo tomó nota de que el WG 1 había propuesto dos posibles fórmulas del rendimiento de combustible, que utilizaban masa o volumen. El grupo sugirió que la fórmula del rendimiento del combustible, Volumen/RTK, podría ampliarse para incluir kg/Volumen (densidad del combustible), CO_2 /kg (factor carbono) y reducciones MBM/RTK [reducciones de carbono a partir de medidas basadas en criterios de mercado (MBM)].

$$\text{"Medición de intensidad de } CO_2 \text{ neto"} = \underbrace{\left(\frac{Vol_{\text{combustible}}}{RTK}\right)}_{\text{Medición del rendimiento del combustible}} \cdot \underbrace{\left(\frac{Masa_{\text{combustible}}}{Vol_{\text{combustible}}}\right)}_{\text{Densidad del combustible}} \cdot \underbrace{\left(\frac{Masa_{CO_2}}{Masa_{\text{combustible}}}\right)}_{\text{Factor } CO_2} - \underbrace{\left(\frac{\text{Reducciones MBM}}{RTK}\right)}_{\text{Medidas basadas en criterios de mercado}}$$

2.4 Japón señaló que las metas debían establecerse basándose en Volumen/RTK, en tanto que para los combustibles alternativos sostenibles debían desarrollarse factores de conversión apropiados (véase el párrafo 29 del informe del WG 1), evitándose términos complejos como densidad de combustible.

2.5 Asimismo, se deliberó sobre la noción de establecer cada meta de rendimiento en función de un volumen de combustible fijo de 100 toneladas-kilómetros de pago (*vol/100RTK*) en cada una de las fechas límite de las metas (es decir, 2020/2025 y 2050), como lo sugirió el WG 1 (véase el párrafo 38 de la nota GIACC/3 – WP/2). Esta meta global debería establecerse basándose en las reducciones porcentuales analizadas, en lo que corresponde al sistema de aviación internacional. Si una meta a la que se aspira a escala mundial tiene un valor absoluto, la misma presenta la ventaja de que cuando se considera en el contexto de sistemas de aviación individuales, pueden emprenderse distintas medidas respecto de los distintos sistemas para lograr la meta mundial. Asimismo, un valor absoluto puede servir además para transmitir una meta más concreta y transparente. Japón señaló que si se adopta una meta absoluta de rendimiento del combustible, ésta debería basarse más bien en datos reales que en datos calculados basándose en supuestos.

3. Definiciones

3.1 El grupo consideró la forma de definir crecimiento neutro en carbono y neutralidad en carbono, basándose en una nota presentada por Australia (copia adjunta). El grupo reflexionó sobre el nivel de crecimiento neutro en carbono que el sector de la aviación podía lograr a escala mundial mediante mejoras tecnológicas y operacionales únicamente. Para considerar el caso de que esto no fuera posible, como algunos sugirieron, el grupo examinó el propósito de la nota de definir el logro de crecimiento neutro en carbono y neutralidad en carbono mediante el empleo adicional de compensaciones. En particular, en la nota dice:

> "El crecimiento neutro en carbono ocurre cuando la huella de carbono neto del sector de la aviación no sobrepasa el valor de referencia seleccionado para un año determinado".
>
> "La neutralidad en carbono se logra cuando la huella de carbono neto del sector de la aviación es igual a cero, es decir, cuando la huella de carbono bruto se compensa totalmente. Probablemente, la vía más fácil para alcanzar esta meta sería la adquisición de compensaciones de CO_2, por lo menos, en el futuro previsible. La industria tiene la aspiración de lograr a largo plazo neutralidad en carbono mediante el uso de biocombustibles".

3.2 Aun cuando se reconoció que, para evitar malentendidos, es mejor utilizar "emisiones de CO_2" que "huella de carbono" y se consideró necesario un análisis más profundo al respecto, estos conceptos sirvieron en las deliberaciones ulteriores del grupo.

4. Año de referencia

4.1 La base del debate para la reunión en persona del Grupo de trabajo 4 incluyó respuestas a un conjunto de preguntas de orientación presentadas a cada uno de los participantes (copia adjunta). Con las preguntas se buscaba comprender la forma de pensar de cada Estado con respecto a un posible año de referencia, las posibles metas a las que se aspira respecto del rendimiento del combustible a corto, mediano y largo plazos, y las posibilidades de establecer metas a las que se aspira de manera más ambiciosa.

4.2 En relación con la selección de un año de referencia para mediano plazo y largo plazo, hubo dos sugerencias concretas, 2000 y 2005. Algunos países sugirieron que se establecieran puntos de referencia en el futuro, lo cual inquietó a otros que señalaron que esto podría significar más emisiones. Además, se solicitó información para comprender mejor las circunstancias en cuanto a las emisiones de 2000 en comparación con 2005, a escala mundial y regional (tabla adjunta, proporcionada por la Secretaría de la OACI). El grupo tomó nota además de que los plazos para lograr las metas debían concordar, en general, con los plazos de la CMNUCC.

5. Metas relativas al rendimiento del combustible

5.1 El grupo convino en que todas las metas, comprendidas las metas de rendimiento del combustible, serían mundiales, no obligatorias y aplicables únicamente a la aviación internacional sin responsabilidad ni obligación de medidas atribuibles a un Estado contratante de la OACI en particular. Los Estados pueden decidir dedicarse al logro de estas metas a un ritmo que les permita tener el espacio adecuado para el desarrollo de sus industrias de la aviación, teniendo en cuenta las circunstancias y capacidades nacionales. China recalcó que es crucial que las naciones desarrolladas desempeñen un rol de liderazgo en el logro de estas metas. Asimismo, China y Brasil destacaron la importancia de que los Estados desarrollados ayuden a los Estados en desarrollo para que tengan la capacidad de mejorar el rendimiento del combustible a fin de contribuir con las metas mundiales.

5.2 **Corto plazo** – Teniendo en cuenta las deliberaciones de la GIACC/3 y ante la ausencia de nueva información, el grupo convino en un mejoramiento del 2% para el rendimiento del combustible anual hasta 2012, basándose en las tendencias históricas.

5.3 **Mediano plazo** – Las deliberaciones del grupo se centraron en opciones que abarcaban del 2% al 2,5% anual de mejoramiento desde 2013 hasta 2020 ó 2025. Aunque la mayoría sugirió 2020 como fecha límite para el mediano plazo, Estados Unidos propuso 2025 ya que así hay más tiempo para lograr una meta más ambiciosa, en particular para que los procedimientos y la tecnología ATM tengan un efecto. Se debatió si 2,5% representaba una opción demasiado ambiciosa. Algunos Estados recalcaron que era necesario hacer que la meta de mediano plazo fuera, dentro de lo posible, fácil de alcanzar. Estados Unidos señaló que la estructura que propondría el GIACC era una estructura a la que se aspiraba, por lo que, por definición, debía ir más allá de lo que es posible hoy, ser más ambiciosa, y sentar un precedente que aliente la innovación y la inversión.

5.4 **Largo plazo** – Las opciones abarcan del 2% al 3% de mejoramiento anual desde 2021 ó 2026 hasta 2050. A este respecto, se expresaron inquietudes en cuanto a la certeza de predecir las posibles mejoras en el rendimiento del combustible tan adelante, en el futuro. Un Estado sugirió que una declaración política con posibles escenarios podía representar un enfoque más apropiado. Se debatió si el 3% representaba una opción muy ambiciosa. Estados Unidos ofreció presentar una nota para explicar su apoyo respecto de la meta a la que se aspira del 2,5% al 3% de mejoramiento anual para 2050 (copia adjunta).

6. Metas que indican expectativas más ambiciosas

6.1 Se reconoció que el mejoramiento del rendimiento del combustible por sí solo no va a llevar al sector al crecimiento neutro en carbono a escala mundial y que podrían necesitarse medidas adicionales, además del rendimiento del combustible, en los Estados que así lo decidan. El grupo consideró metas adicionales que indicarían expectativas más ambiciosas. En relación con el plazo mediano, las deliberaciones se centraron en una meta de crecimiento neutro en carbono. En general, se reconoció que la fórmula de intensidad de carbono constituiría una herramienta útil para demostrar el avance hacia esta meta.

6.2 Con respecto al largo plazo, el debate se centró en las reducciones de carbono. Se compartió la propuesta europea de que, en 2050, la aviación debía mantener la misma participación porcentual de las emisiones mundiales que había tenido en 1990. En vista de que se suscitó gran preocupación y como todavía no se han presentado otras propuestas, se requiere un análisis más a fondo en relación con el largo plazo.

6.3 Se consideró la noción de un “conjunto” o gama de metas. Esto sería particularmente útil en cuanto a que se establecería una meta general para todos y algunos países, si pueden, podrían llegar a ejercer liderazgo al respecto. No obstante, algunos expresaron inquietud en cuanto a que los críticos considerarían que al nivel inferior de la gama le correspondería un nivel menor de ambición.

6.4 China introdujo la noción de emisiones per cápita en el contexto de la medición, pero después de un período de deliberaciones, algunos países indicaron que tendría más potencial como umbral para indicar que un país debía dedicarse a lograr metas más ambiciosas. Sin embargo, se plantearon algunas inquietudes; a este respecto, se necesitaría un análisis más a fondo para comprender mejor la idea.

6.5 Tanto Brasil como China sostuvieron que las metas de mediano y largo plazos, aparte del rendimiento del combustible, debían tener en cuenta las negociaciones en curso sobre el clima de la CMNUCC. Sin embargo, otros Estados señalaron que esto complicaría la labor del GIACC para el cumplimiento de su mandato. Se requiere un análisis más a fondo con respecto a las metas más ambiciosas.

7. Asistencia a los países en desarrollo

7.1 El GIACC ha considerado exhaustivamente la idea de que los Estados desarrollados deben ayudar a los Estados en desarrollo con medidas que les permitan contribuir a las metas a las que se aspira mundialmente. El Grupo de trabajo 2 proporcionó una lista de medidas y principios a este respecto. Aunque esto no le corresponde directamente al Grupo de trabajo 4, los participantes siguieron reconociendo que las iniciativas de asistencia entre los Estados y de recurrir a la comunidad de bancos de desarrollo serán fundamentales para la aplicación con éxito de todas las recomendaciones del GIACC.

8. Resumen de metas y plazos posibles

Referencia: 2000 ó 2005

Opciones para las metas relativas al rendimiento del combustible:

	Meta: Mejoramiento del rendimiento	**Fecha(s) límite**	**Comentario**
Corto plazo	Mejoramiento de 2% anual en el rendimiento	2012	Prolongación de las tendencias actuales.
Mediano plazo	2,0%-2,5% anualmente a partir de 2012 (se requiere análisis más a fondo)	2020 ó 2025	Meta ambiciosa. Con un enfoque que considere una gama se reflejará mejor el riesgo de lograr la meta y el nivel de ambición establecido por los Estados para el sistema de la aviación. Algunas inquietudes respecto del logro.
Largo plazo	2,0%-3% anualmente a partir de 2020 ó 2025 (se requiere análisis más a fondo)	2050	Meta altamente ambiciosa. El extremo superior de la gama superaría en cerca del 50% la meta de la industria. Gran incertidumbre con respecto a la tecnología y el nivel de ambición de los Estados. Algunas inquietudes respecto del logro.

Opciones sobre las metas que indican expectativas más ambiciosas: Se requiere análisis más a fondo

	Metas	**Plazo**	**Comentario**
Mediano plazo	Crecimiento neutro en carbono	2020 ó 2025	Meta ambiciosa. Para algunos, es posible únicamente con medidas basadas en criterios de mercado. Debe calcularse con la fórmula de intensidad de carbono neto. Como en el caso de otras metas, metas a las que se aspira y mundiales. Determinados elementos, como el concepto de per cápita, podrían indicar el momento en que un Estado debería esforzarse más para contribuir respecto de una meta. Se requiere análisis más a fondo.
Largo plazo	Reducción: El sector mundial representa el mismo porcentaje de emisiones que en 1990	2050	Propuesta europea. Se expresaron algunas inquietudes. En las deliberaciones se reconoció que las opciones adicionales debían ser objeto de desarrollo y análisis.

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APPENDIX A
English only

GIACC Goals Development Group – WG4

Defining 'Carbon Neutrality'

Summary

In order to assist the Group in its deliberations on carbon neutrality, the paper puts forward draft definitions of the key terms such as 'carbon neutral growth'.

Estimations of the costs associated with applying the suggested definitions to international aviation indicate that:

i) carbon neutral growth, using 1990 as the base year, could be achieved at a cost of about $5/passenger at a CO_2 cost of $20/tonne
ii) carbon neutrality could be achieved at a cost of approximately $10/passenger at a CO_2 cost of $20/tonne.

(Submitted by the Adviser Australia)

1 Introduction

1.1 The terms of reference for the GIACC Goals Development Group require the Group to '*Assess the scope for additional goals and statements to indicate a strong ambition for addressing emissions, including **in the form of carbon neutrality**.*'

1.2 At the present time there appears to be no common understanding on the meaning of the terms *'carbon neutral growth'* and *'carbon neutrality'*. Agreement on the definition of these two terms is clearly a prerequisite for assessing the scope for using these concepts within ICAO.

1.3 In the absence of an agreement on the definition of the terms it has not yet been possible to inject into the GIACC process estimations of the magnitude of the costs of adopting carbon neutrality concepts.

1.4 This paper proposes, for discussion purposes, draft definitions of the terms *'gross carbon footprint'*, *'net carbon footprint'*, *'carbon neutral growth'* and *'carbon neutrality'* and provides estimates of the magnitude of the average costs if carbon neutral concepts, based on these definitions, were adopted as goals for international aviation.

2 Draft Definitions

2.1 Gross Carbon Footprint

2.1.1 In this context **Gross** carbon footprint means the actual CO_2 emissions generated by international aviation in one year.

2.1.2 The magnitude of growth in international aviation's **Gross** carbon footprint is determined essentially by the difference between two factors

- *Growth* – the rate of growth in demand for international aviation
- *Technology* – the rate at which fuel efficiency measures can be adopted by the aviation industry.

2.1.3 Since 1990, Growth has outstripped Technology at a rate of about 3% per year – that is, the **Gross** carbon footprint of international aviation is growing at about 3% per year.

2.2 Net Carbon Footprint

2.2.1 In circumstances where Technology cannot keep pace with Growth, the magnitude of aviation's **Net** carbon footprint can be managed through the purchase of offsets using some form of economic instrument.

2.2.2 The relationship between **Net** and **Gross** carbon footprint can be expressed in the following expression:

Net CO_2 emissions = (**Gross** CO_2 emissions) – (CO_2 emissions purchased through offsets).

2.3 Carbon Neutral Growth

2.3.1 Carbon neutral growth occurs when the **Net** carbon footprint of the aviation industry does not exceed a chosen baseline value in any given year.

2.3.2 In circumstances where Technology is able to match or outstrip Growth, carbon neutral growth is achieved without the purchase of offsets. When growth in demand exceeds gains in efficiency there is a 'CO_2 gap'; in these circumstances carbon neutrality can be achieved by purchasing CO_2 offsets equal in magnitude to the 'CO_2 gap'.

2.3.3 A carbon neutral growth strategy is usually implemented by selecting a baseline year and then ensuring that the net annual emissions do not exceed the baseline during any future year. Based on experience over the past two decades, the industry will generally, but not always, need to purchase CO_2 offsets in order to achieve carbon neutral growth.

2.4 Carbon Neutrality

2.4.1 Carbon neutrality is achieved when the **Net** carbon footprint of the aviation industry equals zero – that is, when the **Gross** carbon footprint is fully offset. The most likely route to this goal would be through the purchase of CO_2 offsets at least for the foreseeable future. An industry ambition is that carbon neutrality be achieved in the long term through the use of biofuels.

2.5 Explanatory Diagram

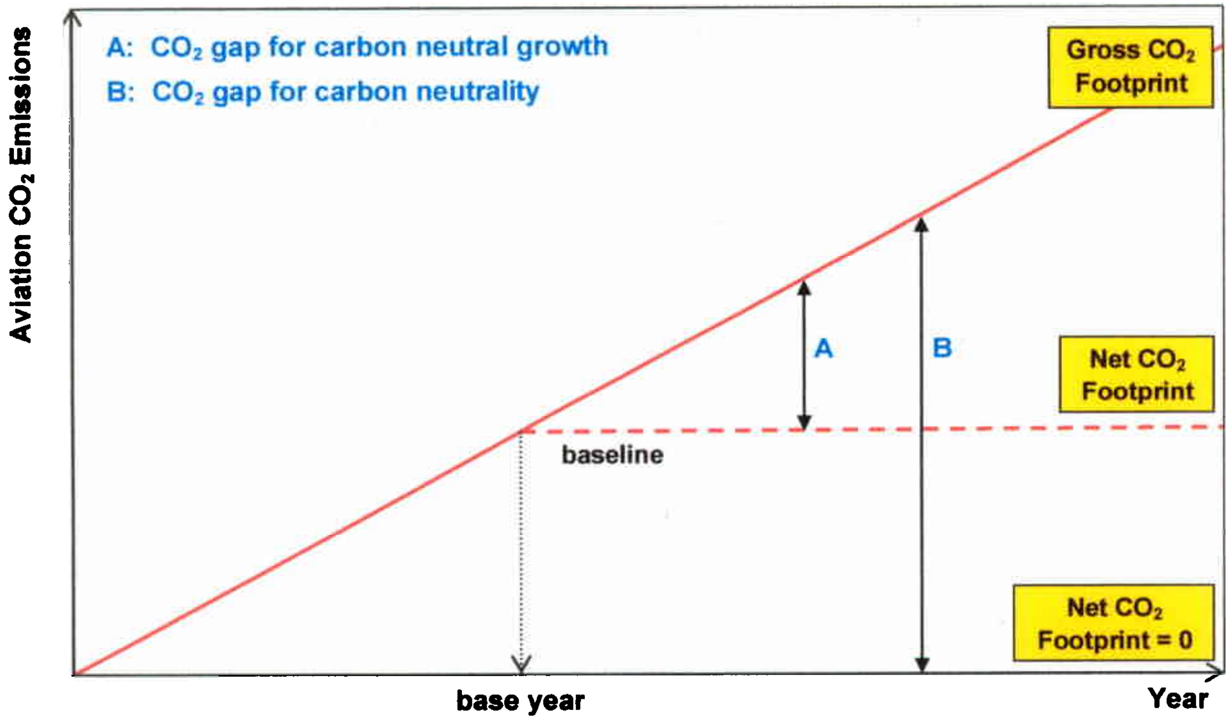
2.5.1 The concepts described in sections 2.1 to 2.4 are illustrated in Figure 1.

3 Implementation Hierarchy

3.1 If a goal incorporating carbon neutral concepts is to be adopted it is fundamental that the following implementation hierarchy underpin the goal:

i) priority be given to minimising the **Gross** carbon footprint of aviation through technology
ii) CO_2 offsets be purchased to bridge any 'CO_2' gap when technology gains fail to keep pace with growth in demand.

Figure 1: Illustration of carbon neutral growth and carbon neutrality



4 Estimation of Costs

4.1 This section provides indicative estimations of system wide costs for *'carbon neutral growth'* and *'carbon neutrality'* for international aviation based on fuel use and passenger data sourced from ICAO.[1] Three scenario costs for carbon ($20, $40 & $100 per tonne of CO_2) are used to show illustrative costs. The costs shown in the graphs are global averages based on $/passenger – on short routes the costs will be less than the average while on long haul routes the costs will be significantly higher. In a similar manner, there may be significant variations in the costs between different global regions.

4.2 Carbon Neutral Growth – 1990 baseline

4.2.1 Figure 2 indicates that if a carbon neutral growth policy were adopted using 1990 as the base year costs would currently be of the order of $5/passenger at a CO_2 cost of $20/tonne. This cost per passenger has remained relatively stable throughout this decade.

4.3 Carbon Neutral Growth – 2000 baseline

4.3.1 Figure 3 indicates that if a carbon neutral growth policy were adopted using 2000 as the base year, costs would currently be of the order of $1/passenger at a CO_2 cost of $20/tonne. It can be seen that for the years 2002 and 2003 carbon neutral growth would have been achieved without the need to purchase any CO_2 offsets.

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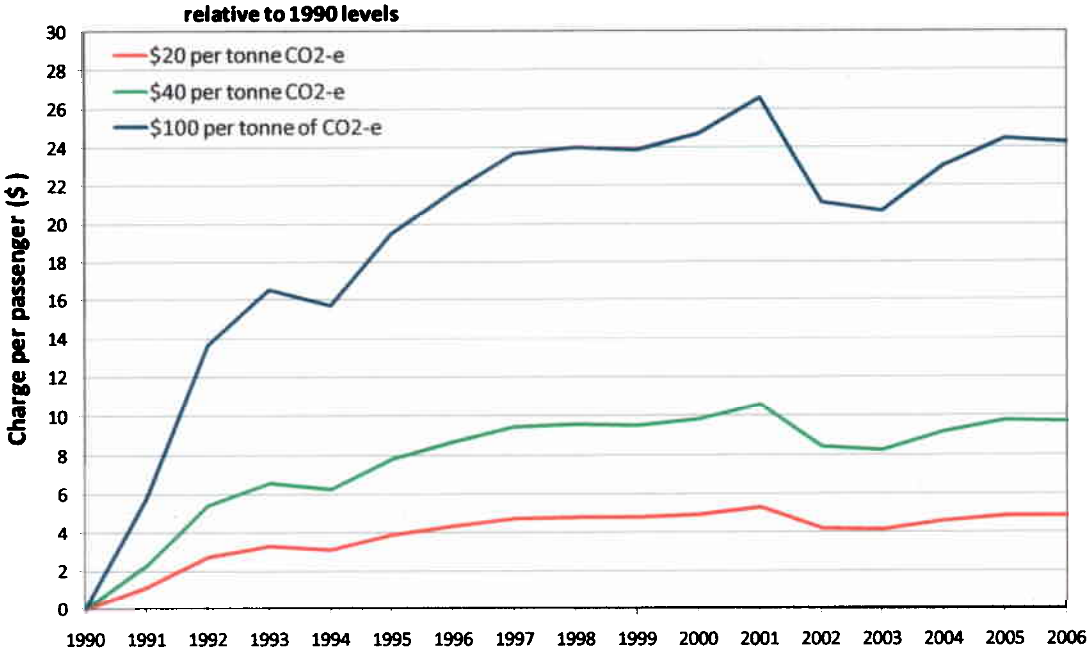
[1] The annual weight of CO_2 emissions has been calculated by multiplying the annual tonnage of aviation fuel used in international aviation by a factor of 3.16. This has been reduced to a per passenger basis using annual global international aviation passenger numbers. The fuel consumption data was provided by ICAO's *Economic Analyses and Databases Section*, Air Transport Bureau, while passenger data is from ICAO's *Annual Report of the Council*, various years (http://www.icao.int/annualreports).

4.4 Carbon Neutrality

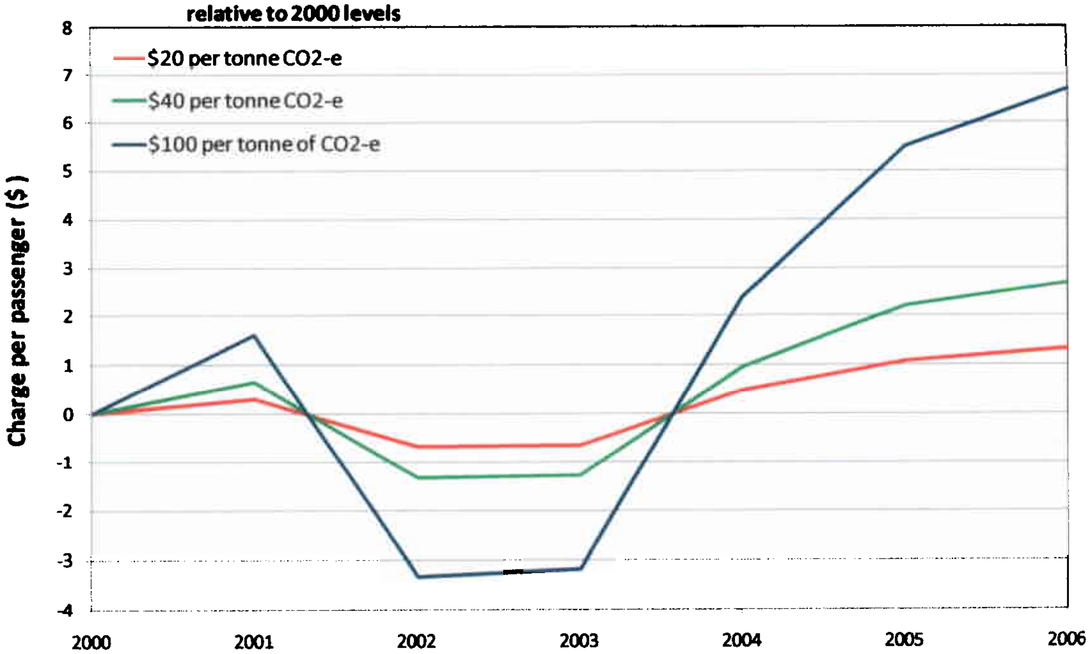
i) 4.4.1 Figure 4 shows the annual costs of achieving carbon neutrality for international aviation since 1990. It can be seen that the magnitude of this cost has been steadily declining as efficiency gains have been achieved. Carbon neutrality could be achieved at a cost of approximately $10/passenger at a CO_2 cost of $20/tonne.

Figure 2: Carbon neutral growth cost per passenger for global international airline scheduled services relative to 1990 levels



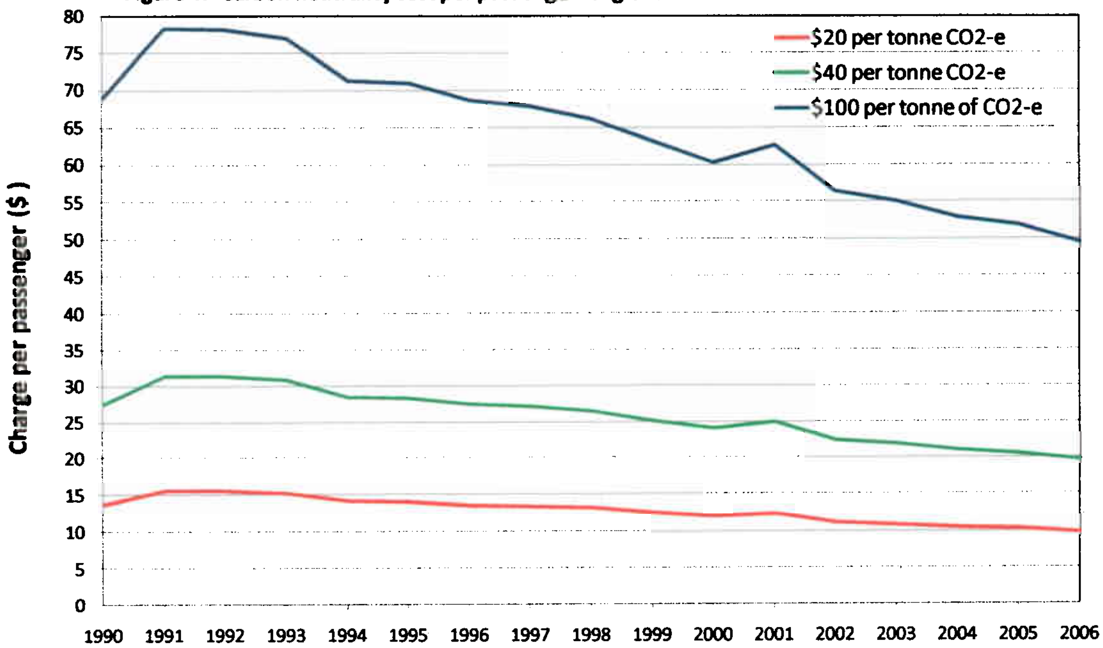
Source: Emissions were calculated using ICAO fuel consumption estimates of global international scheduled services based on OAG data, Economic Analyses and Databases Section, Air Transport Bureau, ICAO. Passenger data is from ICAO, *Annual Report of the Council*, various years (http://www.icao.int/annualreports).

Figure 3: Carbon neutral growth cost per passenger for global international airline scheduled services relative to 2000 levels



Source: Emissions were calculated using ICAO fuel consumption estimates of global international scheduled services based on OAG data, Economic Analyses and Databases Section, Air Transport Bureau, ICAO. Passenger data is from ICAO, *Annual Report of the Council*, various years (http://www.icao.int/annualreports).

Figure 4: Carbon neutrality cost per passenger for global international airline scheduled services



Source: Emissions were calculated using ICAO fuel consumption estimates of global international scheduled services based on OAG data, Economic Analyses and Databases Section, Air Transport Bureau, ICAO. Passenger data is from ICAO, *Annual Report of the Council*, various years (http://www.icao.int/annualreports).

5 Recommendation

5.1 For discussion.

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APPENDIX B
English only

"Guiding Questions" for Working Group 4 – Goals Development
March 25, 2009

Terms of Reference

1. For the short term global aspirational goal for fuel efficiency, review available data to determine whether the 2% per year indicative figure supported at GIACC/3 is the most appropriate.

2. Progress the development of possible medium and long-term global aspirational goals based upon fuel efficiency in consultation with CAEP and on consideration of available data on industry trends and relevant forecasts.

3. Assess the scope to develop a global aspirational goal for carbon neutrality having regard to fuel efficiency trends and time frames. **[Alternative language to be clarified by the Secretariat: Assess the scope for additional goals and statements to indicate a strong ambition for addressing emissions, including in the form of carbon neutrality.]**

4. Review other goals provided by industry and others with respect to level of ambition for addressing emissions from international aviation.

5. Deliver a report to GIACC/4 with options and supporting information.

Definitions

Global aspirational goal: A non-binding goal, applicable only to international aviation, with no responsibility or obligation for action attributable to any individual ICAO Contracting State.[*]

Fuel efficiency metric: Liters (gallons) of fuel consumed / Revenue Ton Kilometers (miles) with provision made to modify in future based on carbon content of fuel. *

Timelines:* Short-term: 2012
Medium-term: No agreement
Long-term: 2050

Carbon neutral: Carbon neutral means that the growth of carbon dioxide from aviation fuel burn will not exceed a base year level regardless of the increase in level of operations.

[*] Terms generally accepted at the GIACC 3 meeting.

Carbon reduction: Carbon reduction means that the growth of carbon dioxide from aviation fuel burn will be less than the base year level regardless of the increase in level of operations.

Guiding Questions

Given the terms of reference, there are a number of key issues on which our group should try to reach agreement. Please bear in mind the progress we made in discussions of a way forward from GIACC/3 on concerns raised by developing nations as you address concerns and rationales. The questions include:

1. Based on information available, is a 2% annual improvement in fuel efficiency an appropriate short-term goal through 2012?

2. Based on your review of CAEP, industry and other information on medium and long-term fuel efficiency gains, would you recommend more ambitious global aspirational goals in the medium and long term than those provided by industry?

3. For a fuel efficiency target for the medium term global aspirational goal, what date and what target rate would you suggest?

4. For a fuel efficiency target for the long-term global aspirational goal, what date and what target rate would you suggest?

5. What scope do you see for achieving carbon neutral growth as a medium term goal? What base year and what target year would you suggest?

6. What scope do you see for achieving carbon neutral growth as a long-term goal? What base year and what target year would you suggest?

7. What scope do you see for achieving carbon reduction growth as a medium term goal? What base year and what target year would you suggest?

8. What scope do you see for achieving carbon reduction growth as a long-term goal? What base year and what target year would you suggest?

9. Under what conditions would you agree to a global aspirational goal other than fuel efficiency?

10. Would you prefer a single point target for medium and long-term aspirational goals or a range?

11. Would you prefer a single baseline year and target year for medium and long-term aspirational goals or a range?

Goals	Efficiency Target	Timeline	Other Target	Timeline	Comment
Short Term					
Medium Term					
Long Term					

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APPENDIX C
English only

Potential Aircraft Fuel Consumption Reduction Aspirational Goals and their Implications to Fuel Consumption Trends

Introduction

Total aviation fuel consumption is a function of the number of aircraft operating in the airspace system, how those aircraft operate, and the fuel consumption technology characteristics of those aircraft and the engines that power them. This paper focuses on understanding potential fuel consumption technology characteristics of future aircraft. Predictions of the numbers of aircraft in the airspace system and how those aircraft will operate are outside the scope of this paper.

To understand the implication of fuel consumption technology characteristics, the paper briefly discusses ICAO and U.S. Government estimates for aviation fuel consumption trends. Fuel consumption can be considered a direct surrogate for CO_2, a primary Greenhouse Gas (GHG) emission for aviation. Any alternative aviation fuels which can act as a 'drop-in' aviation fuel will not significantly impact fuel consumption, though they may lead to GHG reductions when the full life-cycle (including production) is considered.

ICAO goals

The Modelling and Databases Task Force (MODTF) of ICAO's Committee on Aviation Environmental Protection (CAEP) is the group responsible for modeling of various scenarios to capture future trends in aviation noise, air quality emissions, and GHG emissions.

MODTF recently completed an initial analysis of the trends in global aviation fuel consumption. The analysis assumes a growth in the numbers of operations from the baseline year of 2006 out to 2036 based on the consensus forecast of the CAEP's Forecasting and Economics Support Group (FESG). The fuel consumption growth is mitigated to varying degrees by the implementation of various technology improvement scenarios, which are discussed in more detail in Appendix A.

From a starting point of about 191 Megatons of total aviation fuel consumed in 2006, MODTF predicts a range of annual fuel consumption in 2036 from a "non-interference" scenario fuel consumption of about 800 Megatons, to an optimistic technology and operational improvement scenario fuel consumption of about 500 Megatons. Alternative fuels were not considered in the MODTF analysis. The most optimistic scenarios required MODTF to assume technology improvement more ambitious than those recommended by the manufacturing industry. The more aggressive scenarios were recommended by government and research entities as a way of bounding the potential improvements and to provide a sensitivity analysis for policy-makers.

U.S. National fuel consumption reduction technology goals

The U.S. Government, in the National Plan for Aeronautics Research and Development and Related Infrastructure (National Science and Technology Council, December 2007), has adopted fuel consumption reduction goals for new aircraft. This National Plan has articulated these goals as N+1, N+2, and N+3 technology generations. The "N" refers to the baseline generation level of the aircraft. The associated numbers refer to subsequent technology generations. The U.S. National goals are discussed in more detail below. The National Goals also include ambitious targets for reducing aircraft noise and air quality emissions (primarily Oxides of Nitrogen emissions, NOx). There are tradeoffs among the goals, and it may not be possible to achieve all goals simultaneously.

Technology generation N+1

The N+1 technology generation represents the next generation of traditional tube-and-wing civil transport airplanes. The expected entry-into-service (EIS) date for this aircraft is the latter part of the next decade. An example of this aircraft would be a Boeing 737 or Airbus A-320 replacement with a significantly improved propulsion system such as an open rotor (currently under study by General Electric) or a Geared Turbofan (GTF) (currently under development by Pratt & Whitney). These propulsion systems have the potential to significantly improve fuel consumption, but, particularly for the open rotor engine, have challenges with regard to the aircraft's community noise levels. In addition, significant drag reduction on the wing, tail surfaces, and engine nacelles would be required using techniques such as laminar flow control. The goal for aircraft of this generation is to be 33% more fuel efficient than an aircraft with an EIS date of 1998.

Technology generation N+2

The N+2 technology generation envisions a step-change from the traditional tube-and-wing aircraft configuration to a more integrate wing and body architecture, such as to a blended-wing-body (BWB). The expected EIS date for this technology generation is 2025. The airframe layout of such an aircraft is not determined, nor is the propulsion system. To achieve the N+2 goals, an integrated airframe and engine would likely be required, as well as advanced propulsion system concepts, extensive drag reduction techniques (such as laminar flow control), and weight reduction through advanced material and structural systems. Such an aircraft might first be used as a cargo carrier if airlines foresee passenger acceptance as an issue. The goal for aircraft of this generation is to be 40% more fuel efficient than the baseline aircraft with an EIS date of 1998.

Technology generation N+3

The N+3 aircraft are defined as the next generation after N+2. Any airframe layout or propulsion system architecture is conjectural. The EIS date for this aircraft is 2035. The goal for aircraft of this generation is to be 70% more fuel efficient than the baseline 1998 aircraft.

A comparison between the different MODTF scenarios and the National Plan goals is shown in Figure 1 below. The figure does not include MODTF scenarios 1 and 2 since these involve no change in the baseline aircraft technology. Note that the MODTF scenarios are defined out to the year 2036 and last National Plan technology introduction date is 2035; Figure 1 assumes the MODTF trends continue until the year 2050.

In the figure, the U.S. National goals have been shifted from the 1998 baseline to the 2006 baseline of the MODTF goals for consistency. The U.S. National goals are adjusted by a 15% improvement in fuel consumption from 1998 to 2006. With this shift in the goals baseline to 2006, the N+1, N+2, and N+3 fuel efficiency improvements are 24%, 32% and 66%, respectively. In addition to the MODTF and the U.S. National goals in Figure 1, a 2% per annum improvement curve is also shown as a very aggressive goal for improvement in per aircraft fuel consumption, and a 3.5% per annum curve in shown to demonstrate the improvement necessary to meet the N+3 goal.

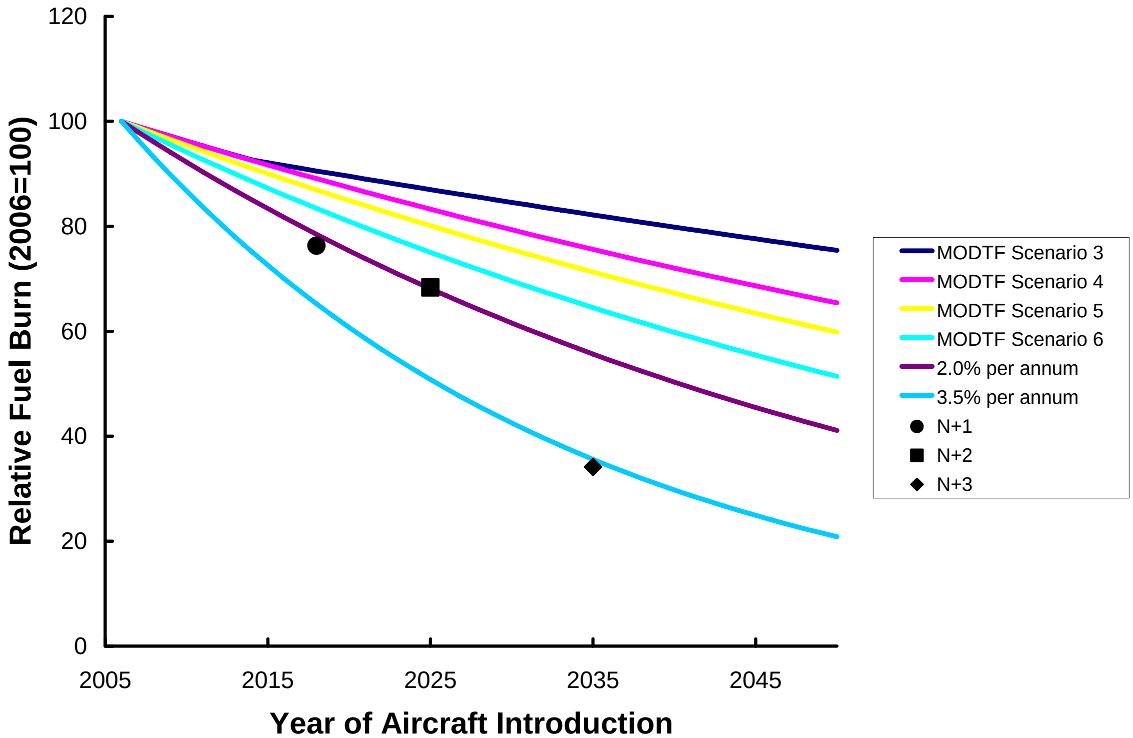

Figure 1, Comparison of Fuel Consumption Goals based on Aircraft Technology Improvements

Summary of MODTF fuel consumption goals analysis

The MODTF scenarios take into account improvements in both aircraft and in the airspace system in which the aircraft operate. The scenarios range from assuming no aircraft fuel consumption reductions and no airspace operational improvements (scenario 1) to assuming significant aircraft fuel consumption reductions combined with operational improvements in given years (scenario 6). The descriptions of the individual scenarios below are taken directly from the MODTF paper.

Scenario 1 (*Current Aircraft/Operations*): This scenario assumes no improvements in aircraft technology beyond those available today and no improvements from Communication, Navigation, and Surveillance systems for Air Traffic Management (CNS/ATM) investment or from planned initiatives, e.g., those planned in NextGen and SESAR (Single European Sky ATM Research).

Scenario 2 (*CAEP7 Baseline*): This scenario includes the CNS/ATM improvements necessary to maintain current ATM efficiency levels, but does not include any technology improvements beyond those available today.

Scenario 3 (*Low Aircraft Technology and Moderate Operational Improvement*): In addition to including the improvements associated with the migration to the latest CNS/ATM initiatives, e.g., those planned in NextGen and SESAR (Scenario 2), this scenario includes fuel consumption improvements of 0.95 percent per annum for all aircraft entering the fleet after 2006 and prior to 2015, and 0.57 percent per annum for all aircraft entering the fleet beginning in 2015 out to 2036. It also includes additional fleet-wide moderate operational improvements of 0.5, 1.4 and 2.3 percent in 2016, 2026 and 2036, respectively.

Scenario 4 (*Moderate Aircraft Technology and Operational Improvement*): In addition to including the improvements associated with the migration to the latest CNS/ATM initiatives, e.g., those planned in NextGen and SESAR (Scenario 2), this scenario includes fuel consumption improvements of 0.96 percent per annum for all aircraft entering the fleet after 2006 out to 2036, and additional fleet-wide moderate operational improvements of 0.5, 1.4 and 2.3 percent by 2016, 2026 and 2036, respectively.

Scenario 5 (*Advanced Technology and Operational Improvement*): In addition to including the improvements associated with the migration to the latest CNS/ATM initiatives, e.g., those planned in NextGen and SESAR (Scenario 2), this scenario includes fuel consumption improvements of 1.16 percent per annum for all aircraft entering the fleet after 2006 out to 2036, and additional fleet-wide advanced operational improvements of 1.0, 1.6 and 3.0 percent by 2016, 2026 and 2036, respectively.

Scenario 6 (*Optimistic Technology and Operational Improvement*): In addition to including the improvements associated with the migration to the latest CNS/ATM initiatives, e.g., those planned in NextGen and SESAR (Scenario 2), this sensitivity study includes an optimistic fuel consumption improvement of 1.5 percent per annum for all aircraft entering the fleet after 2006 out to 2036, and additional fleet-wide optimistic operational improvements of 3.0, 6.0 and 6.0 percent by 2016, 2026 and 2036, respectively. This scenario goes beyond the improvements based on industry-based recommendations.

The table below summarizes the technology and operational improvements of each of the MODTF scenarios. Note that the Operational Improvement percentages are not on a per annum basis, but rather represent steps along the way to an aspirational goal of a 6% improvement in total system efficiency through operational improvements. The highest rate of increase, 3% to 2016, continuing to a total 6% improvement by 2026, is equal to about a 0.3% improvement per annum. Note no assumption is made of any additional improvement between 2026 and 2036.

Table 1, MODTF Technology and Operational Improvement Summary

Scenario	Technology Improvement (per Annum)		Operational Improvement		
	2006-2014	2015-2036	2016	2026	2036
1	None	None	None	None	None
2	None	None	As required	As required	As required
3	0.95%	0.57%	0.5%	1.4%	2.3%
4	0.96%	0.96%	0.5%	1.4%	2.3%
5	1.16%	1.16%	1.0%	1.6%	3.0%
6	1.5%	1.5%	3.0%	6.0%	6.0%

Figure 2 below presents the total aviation system fuel consumption for the various scenarios given above, starting with the 2006 baseline. The FESG forecast growth is implicit in these system totals. The FESG forecast is a function of aircraft operations both within a given region and between regions; because these operations change from year to year, the FESG forecast growth can't be summarized into a single per annum number. However, the general trend for the FESG forecast is approximately 40% growth per decade.

Figure 2 shows the FESG forecast growth in the number of aircraft operating in the global system out-running technology and operational improvements, even in the most optimistic MODTF scenario. Slowing the growth in global fleet fuel consumption would require more aggressive technology and operational improvements than modeled in the MODTF scenarios; such improvements are represented by the U. S. National goals, and could be used by the GIACC as part of the basis for establishing aspirational goals.

Concluding Observations

Combining air traffic management improvements and aircraft technology enhancements one arrives at a forecast of about 1.8% per year improvement in fuel efficiency for the forecast period through 2036. The Group on International Aviation and Climate Change (GIACC) is trying to set "aspirational" global goals for the international aviation sector. The aviation sector might aspire to 2.5 to 3 per cent fuel efficiency improvement annually under a set of assumptions. First, it would require a large commitment of resources by government and industry to accelerate the research and development of both N+2 and N+3 technologies. Second, it would need meaningful investment by both air navigation service providers and airlines to develop and implement operational improvements in air traffic management to produce continued gains after 2026. Finally, it would require very aggressive implementation of new technology into aircraft fleets and the very large investment that this path would involve. It should be clear that reaching such improved fuel efficiency levels would be a substantial stretch. Not only would such goals require much higher levels of investment by governments and industry than currently planned, but there are considerably greater inherent risks in maturing and implementing the technology concepts upon which these ambitious predictions are predicated.

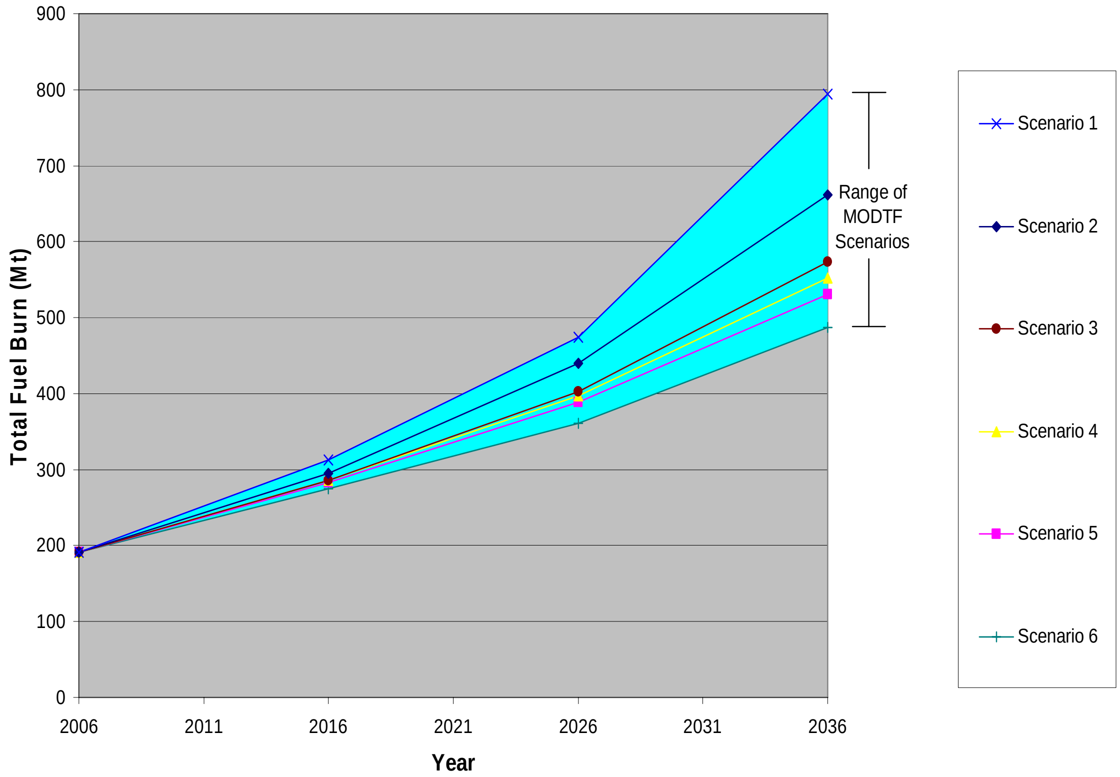

Figure 2, MODTF projections of Global Aviation Fuel Consumption

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Appendix D
English only

Traffic by region of air carrier registration

International schedueld and non-scheduled traffic of scheduled airlines of ICAO Contracting States

Tonne-km performed

Total (thousand)

Region	1990	1995	2000	2005
Africa	4,678,621	5,372,000	7,860,173	9,862,179
Asia/Pacific	37,797,021	63,243,000	87,952,232	105,989,874
Europe	52,841,427	75,347,000	126,400,679	143,710,980
Latin America/Caribbean	7,628,140	10,216,000	12,433,813	13,544,022
Middle East	6,169,230	9,354,000	12,902,501	23,838,934
North America	31,725,006	38,956,000	57,758,282	69,923,638
World	140,839,445	202,488,000	305,307,680	366,869,627

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