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International Civil Aviation Organization

WORKING PAPER

ASSEMBLY — 37TH SESSION

EXECUTIVE COMMITTEE

Agenda Item 17: Environmental protection

FEASIBILITY ASSESSMENT OF THE GOAL OF CARBON-NEUTRAL GROWTH FOR INTERNATIONAL AIR TRANSPORT BY 2020

(Presented by the People's Republic of China)

EXECUTIVE SUMMARY

Based on the predicted CO_2 emissions from global international aviation in 2020, this paper conducted a feasibility assessment of the goal of carbon-neutral growth (CNG) for international aviation by 2020 under different emission reduction scenarios and implementation plans for emission reduction targets. The conclusion indicate that there exists 37.2% gap between the emissions in 2020 and the goal of carbon-neutral growth, which is expected not to undermine the development of international aviation in Member states and attribute obligations to individual states, given the current and measurable potential for emission reduction in global international aviation. In other words, the CNG is so idealistic or aspirational that it cannot be achieved unless measures to restrain growth are taken. In addition, it will be more than difficult to achieve the goal of CNG in global international aviation by 2020 when taking into account the fact that international aviation in different member states are at different stages of maturity and the growth of global international aviation are not developed in a balanced manner. As a result, another viewpoint, based on the responsibility and capacities for emission reduction, is proposed that it will be of more equity and rational than CNG that historical cumulative sum of CO_2 emissions per capita and per capita GDP of each country is taken as the indexes for the ranking and evaluation.

Action: The Assembly is invited to:

a) further explore the feasibility of the goal of carbon-neutral growth by 2020 and the potential for emission reduction from international air transport; discuss and determine to make more feasible medium and long-term targets for emissions reduction in global international aviation by taking cumulative sum of historical CO_2 emissions per capita and per capita GDP of each country as the indexes for the ranking and assessment of global international aviation; and
b) request developed countries to take practical actions expeditiously to intensify the overall capacities of global international aviation in addressing climate change and in particular to provide developing countries with financial, technical and capacity building support.

Strategic Objectives:	This working paper relates to Strategic Objective C, *Environmental Protection - Minimize the adverse effect of global civil aviation on the environment.*
Financial implications:	No additional resources required.
References:	No references.

[1] English and Chinese translation provided by the People's Republic of China.

1. INTRODUCTION

1.1 ICAO should put the development of international air transport as its first priority, bearing in mind the mandate of Article 44 on the aims and objectives of ICAO in the Chicago Convention.

1.2 Since the 36th session of ICAO Assembly, ICAO and its member states have made a lot of active efforts to mitigate climate change. The Council of ICAO successively reviewed and approved the Programme of Action on International Aviation and Climate Change by Group on International Aviation and Climate Change (GIACC) and the Declaration and Recommendations by the High-level Meeting on International Aviation and Climate Change (HLM), then further affirmed the goal of annual fuel efficiency improvement of 2% as ICAO's medium and long-term emission reduction targets.

1.3 Paragraphs 11 and 12 in the Programme agreed by consensus among GIACC indicates that goals of more ambition for the medium term such as carbon neutral growth by 2020 relative to the baseline of 2005 was considered and discussed but no consensus has been reached.

1.4 Paragraph 3 of the HLM Declaration reads, "... ICAO and its Contracting States, with relevant organizations will also keep working together in undertaking further work on medium and long-term goals, including exploring the feasibility of goals of more ambition including carbon-neutral growth and emissions reductions..." . By now, however, no substantial progress has been made.

1.5 The "more ambitious" emission reduction targets do not merely include the two goals of "carbon-neutral growth" and "absolute emissions reduction". Therefore, ICAO should initiate all-round research and systematically present all potential targets, i.e. explore the feasibility of goals with equity at the core as well as based upon differentiated responsibilities and capacities for emission reduction.

2. FEASIBILITY ANALYSIS OF THE GOAL OF GLOBAL CARBON-NEUTRAL GROWTH

2.1 Definition of the goal of carbon-neutral growth

ICAO GIACC defined the goal of carbon-neutral growth (hereinafter as CNG) as "the aviation's net carbon footprint in any given year will remain below the baseline of the selected year". Specifically, the total CO_2 emissions from international air transport in 2020 will remain equal to the emissions in 2005, limiting the total emissions less than 391, 000, 000 tonnes[2].

2.2 The forecast of CO_2 emissions from international air transport under different scenarios

2.2.1 Sources of data

The data based upon for the forecast are from such official data release agencies as World Bank, EU Statistical Office, United States Department of Transportation and National Bureau of Statistics of China. In addition, the annual reports and annals of statistics from aviation authorities like ICAO and Civil Aviation Administration of China (CAAC) are also referred to.

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[2] IEA Report CO_2 Emissions from Fuel Combustion 2009 edition, including total CO_2 emissions from stages of cruise, LTO, holding, etc. in international air transport.

2.2.2 Methodologies

International air transport is kind of volatile sector which is liable to be affected by socio-economic situations as well as emergent events. Consequently emissions from global international aviation see lots of uncertainties due to its close relationship with air traffic capacities and impact from potential technologies to reduce emissions from civil aviation, as illustrated in diagram 1[2]. The diagram also indicates that it is rather difficult and challengeable to forecast the CO_2 emission from global international aviation. The scenario-based forecasting method of TEI@I [3] is hence taken as appropriate to such prediction, which is widely used to predict the trends of GHG emissions, energy consumption and container throughput and has been proved to be a very reliable method for forecast and analysis on practical and complex systems characterized by emergence, instability, non-linearity and uncertainty.

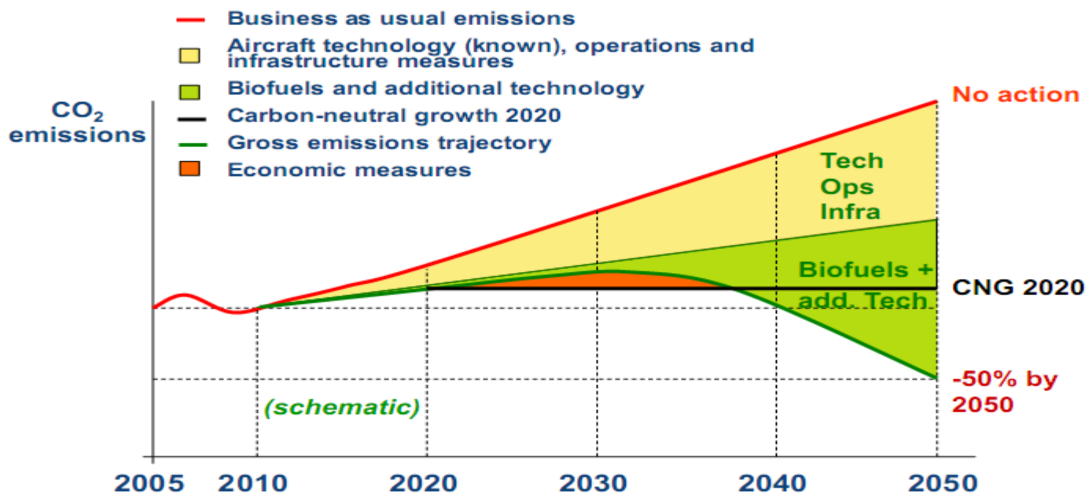

Diagram 1: Uncertainties in reduction of CO_2 emissions from international air transport (Steele, 2010[4])

2.2.3 Scenarios for effects of emissions reduction

CO_2 emissions from international air transport are mainly influenced by the normal growth of Revenue Tonne Kilometres (RTK) and the uncertain effects of various measures for CO_2 emission reduction. TEI@I is taken to predict the normal growth of RTK and the following scenarios are for different effects of emission reduction.

According to the formula for CO_2 emissions from international air transport: CO_2 emissions=fuel efficiency×RTK×emission factor. Thereby the uncertain elements affecting CO_2 emissions from international air transport for the medium term can be classified into two types, i.e. A and B. Type A includes the emissions reduction measures of technology, operation and infrastructure as

[2] quoted from President of ATAG Paul Steel's report Aviation & Climate Change: Industry Perspectives & Policy Implications Post - Copenhagen,2010

[3] TEI@I: firstly put forward by Chinese scholar Shouyang Wang in 2004. It is a new methodology for forcast and analysis of practical and complex system characterzied by emergence, instability, non-linearity and uncertainty. Text mining refers to dealing with the effects that irregular events pose on the forecasted volume through refining the suggestions proposed by experts; Econometric represents econometric models used to forecast the general trend of forecasted volume. Intelligent techniques are used to predict the periodic and complex changing law of forecasted volume; @ represents the integration of the above forecasting processes ; I means the first generation.

[4] The diagram is from Paul Steele's presentation at DGCIG/1 in March 2010 and it also indicates the uncertainties in CO_2 emission reduction from global international aviation.

indicated in Diagram 1, which could achieve the goal of emission reduction by the reduction of fuel burn per unit and RTK. Type B refers to the sustainable alternative fuels which could reduce aviation emissions in a life-cycle way.

Three scenarios are set for the effects by type A:

A1: no emission reduction measures of technology, operation and infrastructure is adopted, that is, a business-as-usual development model(BAU) .

A2: annual improvement of fuel efficiency by 1.5% by taking measures of technology, operation and infrastructure (medium).

A3: annual improvement of fuel efficiency by 2% by taking measures of technology, operation and infrastructure are adopted (advanced).

Three scenarios are set for the effects by type B :

B1: no sustainable alternative fuels is used.

B2: the percentage of sustainable alternative fuels burnt by 2020 in total aviation fuel consumption amounts to 1.2%.

B3: the percentage of sustainable alternative fuels burnt by 2020 in total aviation fuel consumption amounts to 2.4 %.

Note :

According to Aviation & climate change: Industry Perspective & Policy Implications Post-Copenhagen (ATAG), consumption of sustainable aviation alternative fuel is predicted to amount to 1.5-3% of all aviation fuel consumption in 2020 and another report from ATAG (Aviation & Climate Change: Global Framework for addressing aviation CO_2 emissions) states that the sustainable alternative fuels would reduce 80% of CO_2 emission in a life-cycle perspective. Therefore, the use of sustainable alternative fuels will result in 1.2%-2.4% reduction of emissions from international air transport in 2020.

In summary, based on the practical conditions, if the three scenarios of type A are combined with the three scenarios of type B, then 9 scenarios with uncertain effects of various emission reduction measures can be formulated. Given possibilities of all the scenarios and need for contrastive analysis, the following five scenarios are selected for analysis : scenario A1B1(a combination of scenario A1 and B1 or BAU model), medium scenario A2B2 (a combination of scenario A2 with B2), scenario A2B3 (a combination of scenario A2 with B3), scenario A3B2(a combination of scenario A1 with B1) and optimistic scenario A3B3(a combination of scenario A3 with B3), as illustrated in diagram 2.

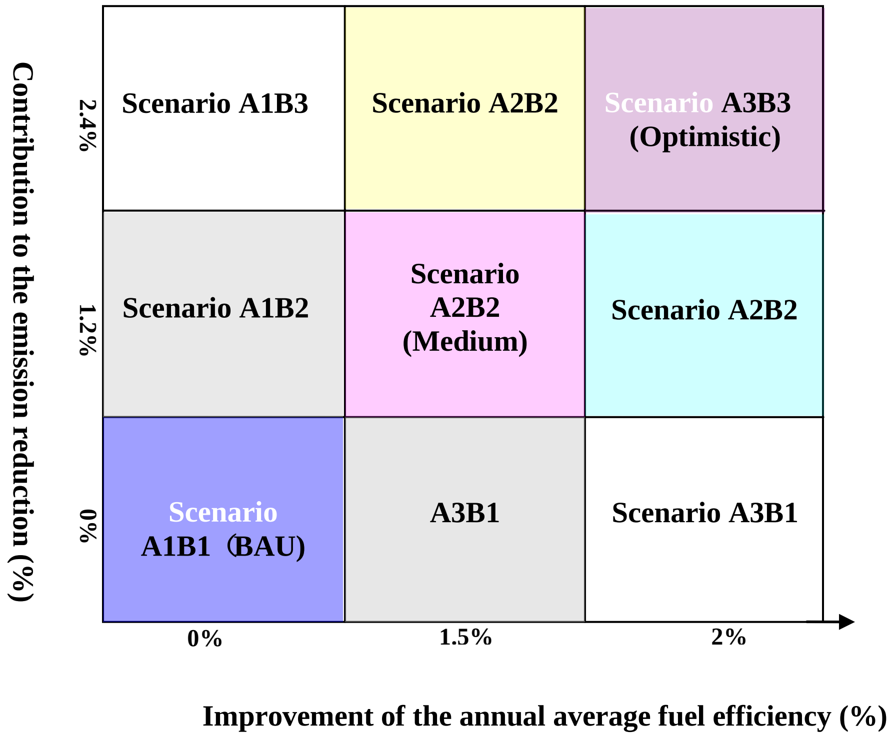

Diagram 2: Scenarios for future CO_2 emissions reduction for international air transport

2.2.4 Forecast of CO_2 emissions from international air transport under all the scenarios

The forecast of the emissions from global international air transport is an important basis for the feasibility assessment of overall goal of carbon-neutral growth. Countries and regions like EU, US, Japan and China that are placing high on the RTK ranking in 2008 are selected as the observed for the feasibility assessment of the CNG in order to forecast the emissions from international air transport. The results are illustrated in diagrams 3-7.

Diagram 3 illustrates the forecast of CO_2 emissions from global international air transport under scenarios A1B1, A2B2, A2B3, A3B2, A3B3 from 2010 to 2020.

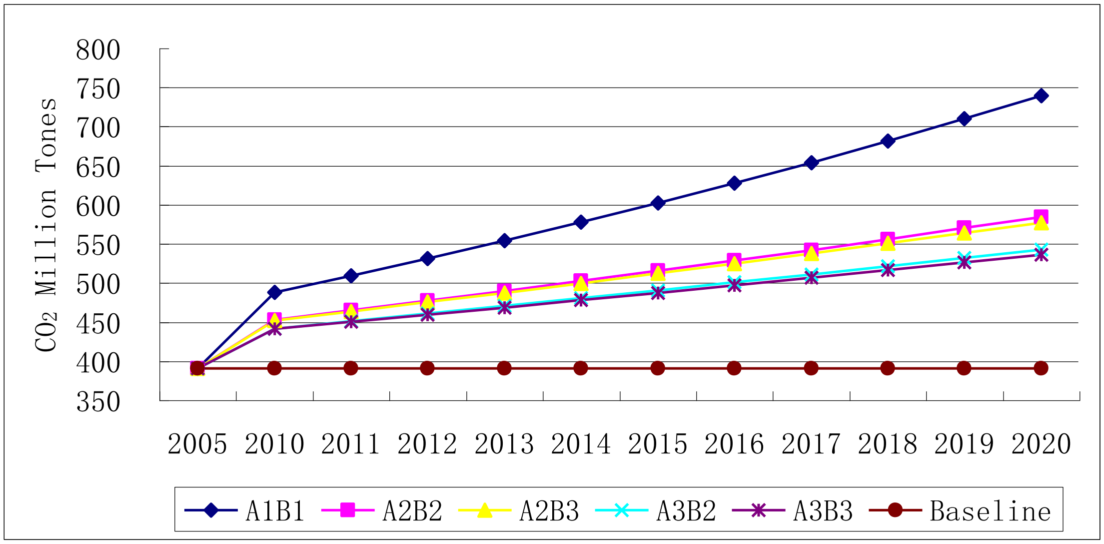

Diagram 3: Comparison between forecasted emissions from global international air transport under different scenarios

Diagram 4 illustrates the forecast of CO_2 emissions from EU international air transport under scenarios A1B1, A2B2, A2B3, A3B2, A3B3 from 2010 to 2020.

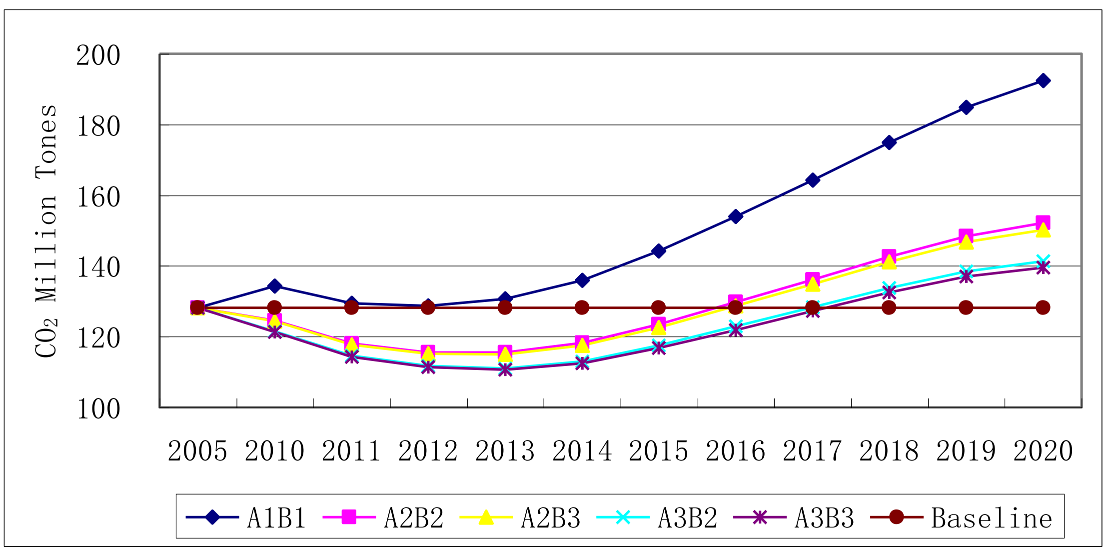

Diagram 4: Comparison between forecasted emissions from EU international air transport under different scenarios

Diagram 5 illustrates the forecast of CO_2 emissions from US international air transport under scenarios A1B1, A2B2, A2B3, A3B2, A3B3 from 2010 to 2020.

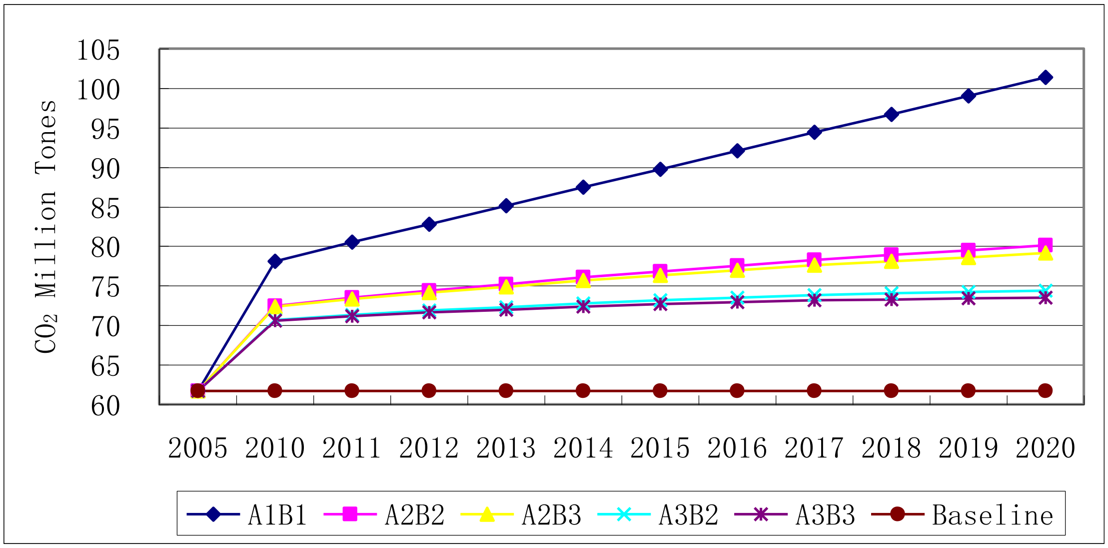

Diagram 5: Comparison between forecasted emissions from US international air transport under different scenarios

Diagram 6 illustrates forecast of emissions from Japan's international air transport under scenarios A1B1, A2B2, A2B3, A3B2, A3B3 from 2010 to 2020.

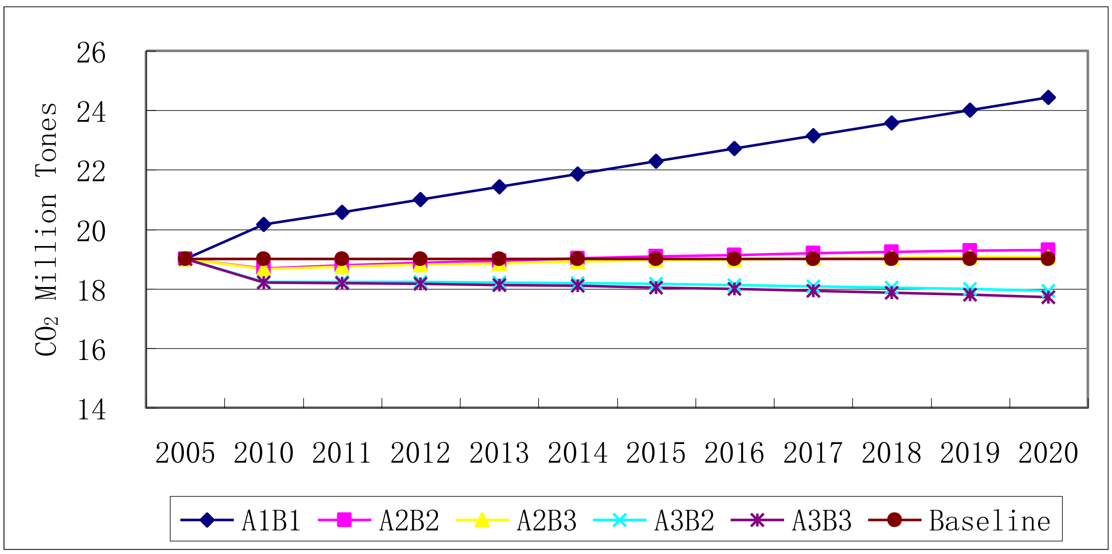

Diagram 6 : Comparison between forecasted emissions from Japan's international air transport under different scenarios

Diagram 7 illustrates the forecast of CO_2 emissions from China's international air transport under scenarios A1B1, A2B2, A2B3, A3B2, A3B3 from 2010 to 2020.

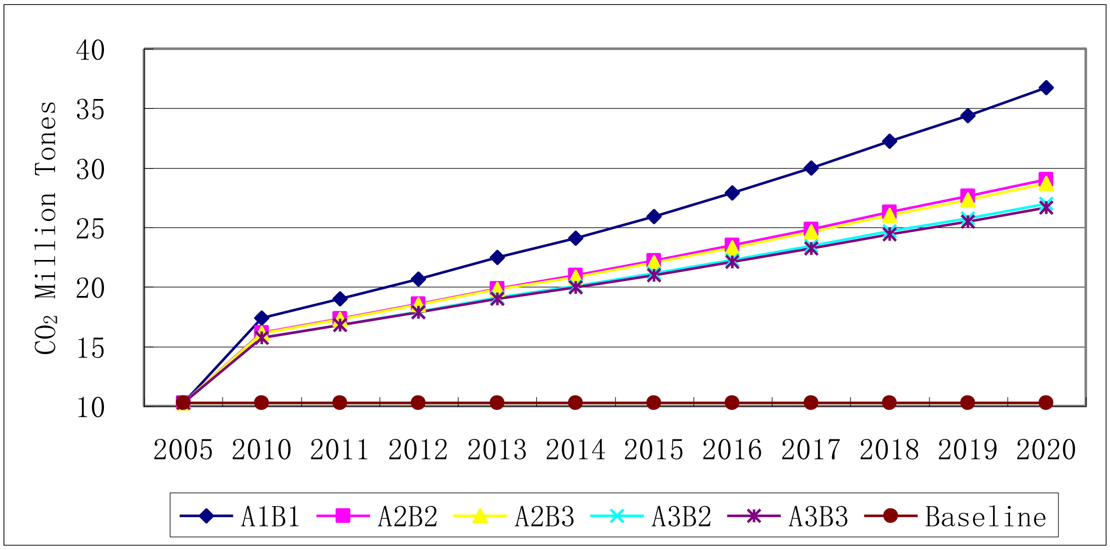

Diagram 7: Comparison between forecasted emissions from China's international air transport under different scenarios

2.3 Assessment of the CNG for global international air transport

2.3.1 CNG for global international air transport by 2020: difficult to achieve

As illustrated in diagram 3, in order to achieve CNG for global international air transport by 2020, the emissions in 2020 should be 391,000,000 tonnes. However, according to the most optimistic scenario A3B3, CO_2 emissions in 2020 would amount to 536,000,000 tonnes at least. As a result, another 37.2% of CO2 emissions has to be reduced before the achievement of CNG in 2020.

Scenario A3B3 illustrates that the space for continuing emission reduction by technology, operation and infrastructure measures and the use of sustainable alternative fuels is not large enough to achieve the CNG, if the growth rate is not undermined.

In summary, it is too difficult or idealistic to achieve the CNG for global international air transport by 2020 unless the development is sacrificed as the cost.

2.3.2 Between goals and feasibility: different countries, different pressures

Although the emission reduction targets developed by ICAO is a global aspirational one and obligations are not attributed to individual countries, any responsible country, which is committed to the goal, will take actions to reduce aviation emissions accordingly. However, the fact that can never be ignored in the implementation is that challenges and pressure to be encountered will vary due to differentiated growth stages of aviation industry in states.

As illustrated in diagram 4, if EU is to achieve the CNG for international air transport by 2020, then the emissions in 2020 should be 128, 000, 000 tonnes. According to scenario A1B1, A2B2, A2B3, A3B2 and A3B3, it is estimated that the CO_2 emissions from EU's international air transport would be 192,000,000, 152,000,000, 150,000,000, 141,000,000 and 140,000,000 tonnes respectively, that is, about 50.3%、18.8%、17.3%、10.3% and 9.0% of emissions has to be cut respectively in compliance with the CNG.

As illustrated in diagram 5, if US is to achieve the CNG for international air transport by 2020, then the emissions in 2020 should be 62, 000, 000 tonnes. According to scenario A1B1, A2B2, A2B3, A3B2 and A3B3, it is estimated that the CO_2 emissions from US' international air transport would amount to 101,000,000, 80,000,000, 79,000,000, 74,000,000 and 74,000,000 tonnes respectively, that is, about 64.2%, 29.8%, 28.2%. 20.5 and 19.1% of emissions has to be cut respectively in compliance with the CNG.

As illustrated in diagram 6, if Japan is to achieve the CNG for international air transport by 2020, then the emissions in 2020 should be 19, 000, 000 tonnes. According to scenario A1B1, A2B2 and A2B3, it is estimated that the CO_2 emissions from Japan' s international air transport would be 24,400,000, 19,300,000, and 19,100,000 tonnes respectively, that is, about 28.5%, 1.6%, and 0.3% of emissions needs to be cut respectively in compliance with the goal of carbon-neutral growth. However, according to scenario A3B2 and A3B3, in 2020 Japan can over-fulfil the CNG by 5.6% and 6.8%.

As illustrated in diagram 7, if China is to achieve the CNG for international air transport by 2020, then the emissions in 2020 should be 10, 000, 000 tonnes. According to scenario A1B1, A2B2, A2B3, A3B2 and A3B3, it is estimated that the CO_2 emissions from China's international air transport would be 36,700,000, 29,000,000, 28,700,000, 27,000,000 and 26,600,000 tonnes respectively, that is, about 257.5%, 182.5%, 179.1%, 162.5% and 159.3% of emissions has to be reduced respectively in compliance with the CNG. Compared with EU, US and Japan, China's aviation is obviously lagging behind in technology, finance and personnel capabilities. Consequently, it is impossible for China on her own to fulfil the CNG by 2020 even the most proactive emission reduction actions are taken unless the development is sacrificed as the cost.

2.3.3 Emission reduction based on responsibility and capacity: a more reasonable option

Based upon analysis and comparison above, large developing countries, which are of poorer capacities for emissions reduction and at a stage of fast growth, are to encounter more challenges and pressure to achieve the CNG than developed countries, which are of stronger capacities and at a stable stage. In other words, if the CNG attributes obligations to developing countries, it will be more difficult to realize the goal and also result in the phenomenon that a state's pressure from emissions reduction is inversely proportional to its responsibility and capacities, which is certainly of no equity. An alternative is that each state contributes to the CNG according to its own capacities and responsibility for emissions reduction, which is based on Paragraph 4 in HLM Declaration that "The different circumstances, respective capabilities and contribution of developing and developed States to the concentration of aviation GHG emissions in the atmosphere will determine how each State may contribute to achieving the global aspirational goals". But what needs to stress is that the premise of the alternative is that developed countries should take the lead in emissions reduction in accordance with Article 2.2 of KP rather than developed and developing countries reduce emission simultaneously.

The core of Paragraph 4 is to highlight each country's contribution to the concentration of aviation GHG in the atmosphere, or cumulative sum of the historical emissions. Accordingly, cumulative sum of the historical emissions per capita from international air transport from 1980 to 2008 is proposed to be taken as the index to measure each country's responsibility for emission reduction. Researches show that a country's capacity for emissions reduction is closely related to its economic development and scientific and technological level, and is to a great extent indicated by its per capita GDP. For instance, take the per capita GDP in 2008 as the index to measure the emission reduction capacity of each country. Diagrams 8 and 9 then illustrates clearly the inverse proportional relations between a country's pressure for emissions reduction and its capacities and responsibility based on the contrast.

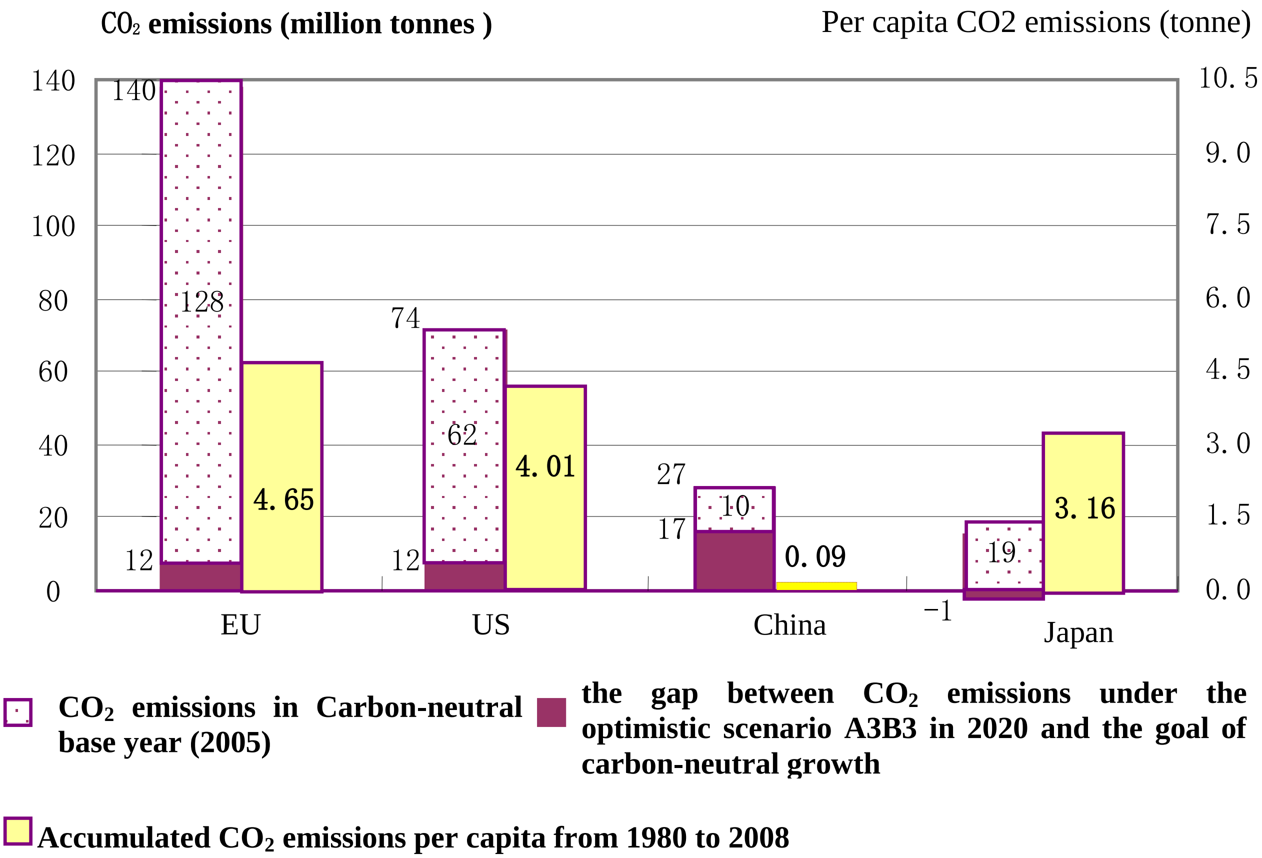

Diagram 8: Comparison between four countries' pressure from the CNG and cumulative sum of historical emissions per capita

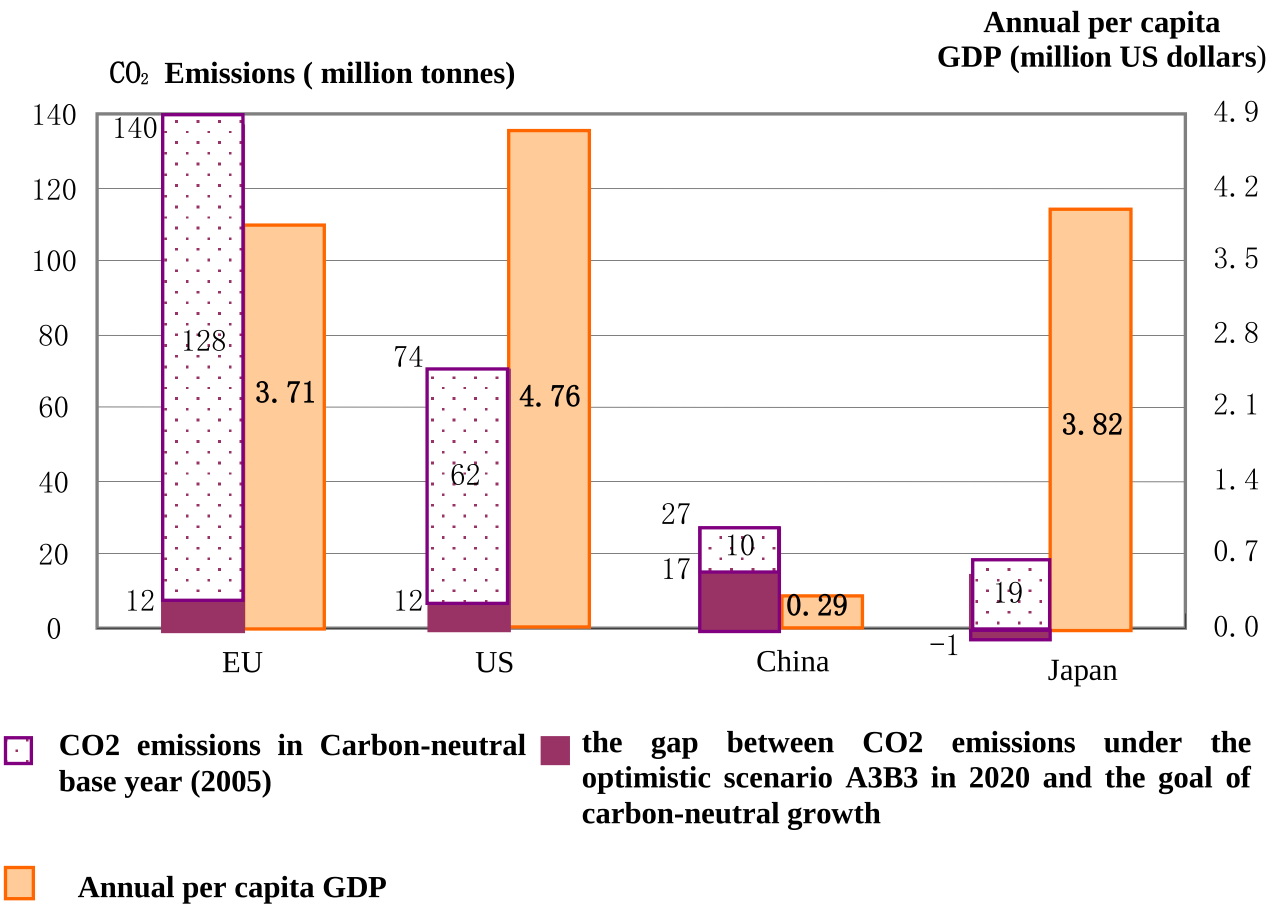

Diagram 9: Comparison between the four countries' pressure from the CNG and annual per capita GDP

Diagram 8 joined by diagram 9 indicates that those countries with higher cumulative sum of historical emissions per capita are of stronger emission reduction capacities. The point also makes sense in reality when taking into consideration that developed countries took the lead in air transport service and have been enjoying lots of experiences and core technologies for aircraft and engine manufacturing, and advanced technologies like the refinery of sustainable alternative fuel, which are certainly essential for aviation emissions reductions. Since major advanced aviation states like US, Japan and EU have stepped into a mature stage, emissions from their aviation will see a gradual decrease. Therefore, an ambitious but feasible goal based on cumulative sum of historical emissions per capita and per capita GDP will stimulate the improvement of advanced technologies and investment of sufficient funds to ensure the achievement of the emissions reduction goal on time while ensuring the development is not undermined. Moreover, the principle of interpersonal equity and people's equal rights of travelling in all countries will be safeguarded and it is also consistent with the HLM essence that responsibilities are in proportional to obligations. To sum up, it is reasonable and feasible to set more practical but ambitious medium and long-term targets of emission reduction for global international aviation with cumulative sum of historical CO_2 emissions per capita and per capita GDP as indexes for the ranking and evaluation.

3. CONCLUSIONS

3.1 There exists a 37.2% gap between the emissions in 2020 and the goal of carbon-neutral growth, which is expected not to undermine the development of international aviation in Member states and attribute obligations to individual states, given the current and measurable potential for emission reduction in global international aviation. In other words, the CNG is so idealistic or aspirational that it cannot be achieved unless measures to restrain growth are taken. In addition, it will be more than difficult to achieve the goal of CNG in global international aviation by 2020 when taking into account the fact that international aviation in different member states are at different stages of maturity and the growth of global international aviation are not developed in a balanced manner.

3.2 Based on the responsibility and capacities for emission reduction, is proposed that it will be of more equity and rational than CNG that historical cumulative sum of CO_2 emissions per capita and per capita GDP of each country is taken as the indexes for the ranking and evaluation.

4. RECOMMENDATIONS

4.1 The Assembly is invited to consider the proposed text of a) and b) in the executive summary when drafting the resolution on climate change.

— END —