Chapter 9
Aviation and Environmental Protection

From an air navigation perspective, Annex 16 (Volumes I and II) deals with the protection of the environment from the effect of aircraft noise and aircraft engine emissions—two topics hardly thought about when the Chicago Convention was signed. Aircraft noise was already of concern during the formative years of ICAO, but it was then limited to the noise caused by propellers whose tips rotated at speeds approaching that of sound. This concern increased with the introduction of the first generation jet aeroplanes in the early 1960s and accelerated with the growth in the number of jet aircraft in international operations.

Aircraft noise is a function, among other things, of the power of the engines that propel aeroplanes through the atmosphere. Reduce the power and you reduce noise, but at the same time you may affect the safety characteristics of the jet aircraft. In 1968, the ICAO Assembly adopted a resolution which conceded the seriousness of noise in the vicinity of airports, and instructed the ICAO Council to establish international specifications and associated guidance material to control aircraft noise. In 1971, the Assembly adopted another resolution recognizing the adverse environmental impact that may be related to aircraft activity. This resolution placed on ICAO the responsibility to guide the development of international civil aviation in such a manner as to benefit the people of the world and to achieve maximum compatibility between the safe and orderly development of civil aviation and the quality of the human environment.

Annex 16 dealing with various aspects of aircraft noise problems was adopted in 1971 on the basis of recommendations of the 1969 Special Meeting on Aircraft Noise in the Vicinity of Aerodromes. These aspects included: procedures for describing and measuring aircraft noise; human tolerance to aircraft noise; aircraft noise certification; criteria for establishment of aircraft noise abatement procedures; land use control; and ground run-up noise abatement procedures. Shortly after this meeting, the Committee on Aircraft Noise (CAN) was established to assist ICAO in the development of noise certification requirements for different classes of aircraft.

The first meeting of this committee developed the first amendment to Annex 16, which became applicable in 1973 and included noise certification of future production and derived versions of subsonic jet aeroplanes. During subsequent meetings, the Committee on Aircraft Noise developed noise certification standards for future subsonic jet aeroplanes and propeller-driven aeroplanes, and for future production
of existing supersonic transport aeroplane types and helicopters. It also developed
guidelines for noise certification of future supersonic and propeller driven STOL
(short take-off and landing) aeroplanes as well as installed APUs (auxiliary power-
units) and associated aircraft systems when operating on the ground.

A resolution adopted by the ICAO Assembly in 1971 led to specific action on
the question of engine emissions and detailed proposals for ICAO Standards for the
control of engine emissions from certain types of aircraft engines. The Committee
on Aircraft Engine Emissions (CAEE) was subsequently established with a view to
develop specific Standards for aircraft engine emissions. These Standards, adopted
in 1981, set limits for the emission of smoke and certain gaseous pollutants for large
turbo-jet and turbofan engines to be produced in the future; they also prohibit the
venting of raw fuels. The scope of the existing Annex 16 was widened to include
engine emission provisions and the document was retitled Environmental Protec-
tion. Volume I of the reorganized Annex 16 contains provisions related to aircraft
noise while Volume II contains provisions related to aircraft engine emissions.

9.1 Aircraft Noise

Standards and Recommended Practices for aircraft noise were first adopted by
ICAO on 2 April 1971 and designated as Annex 16 to the Convention. The
development of the Annex originated in September 1968 at the 16th Session of
the ICAO Assembly which adopted Resolution A 16-3 which recognized that the
problem of aircraft noise was so serious in the vicinity of many of the world’s
airports that public reaction was mounting to a degree that gave cause for great
concern and required urgent solution. The Assembly also noted that noise
concerned the public and civil aviation and was becoming a matter for concern
with the increase in air traffic and that the introduction of future aircraft types could
increase and aggravate the problem further unless action was taken to alleviate the
problem. Accordingly, the Assembly resolved to instruct the ICAO Council to call
an international conference within the machinery of ICAO as soon as possible;
establish international specifications and associated guidance material relating to
aircraft noise; and, to include, in the appropriate Annexes and other relevant ICAO
documents and possibly in a separate Annex on noise, such material as the descrip-
tion and methods of measurement of aircraft noise and suitable limitations on the
noise caused by aircraft that was of concern to communities in the vicinity of
airports.

In response to the Assembly Resolution, a Special Meeting on Aircraft Noise in
the Vicinity of Aerodromes was convened in Montreal in November–December
1969 to examine the following aspects related to the problems of aircraft noise:

(a) Procedures for describing and measuring aircraft noise;
(b) Human tolerance to aircraft noise;
(c) Aircraft noise certification;
(d) Criteria for establishment of aircraft noise abatement operating procedures;
(e) Land use control; and,
(f) Ground run-up noise abatement procedures.

Based on the recommendations of the Special Meeting on Aircraft Noise in the Vicinity of Aerodromes, draft International Standards and Recommended Practices for Aircraft Noise were developed, and, after amendment following the usual consultation with the Contracting States of the Organization, were adopted by the Council to form the text of Annex 16.

With the development of Standards and Recommended Practices dealing with the control of aircraft engine emissions, it was felt that all provisions relating to environmental aspects of aviation should be included in a single document. Accordingly, Annex 16 was retitled as “Environmental Protection”. Volume I of the Annex contains the existing provisions relating to aircraft noise and Volume 11 contains the provisions related to aircraft engine emissions.¹

### 9.2 Aircraft Engine Emissions

ICAO’s regulatory role in aircraft engine emissions is enshrined in Volume II of Annex 16 and is historically linked to the 1972 United Nations Conference on the Human Environment which was held in Stockholm. The position of ICAO at this Conference was developed in Assembly Resolution A18-11 which contained the following clause among others:

> in fulfilling this role ICAO is conscious of the adverse environmental impact that may be related to aircraft activity and its responsibility and that of its member States to achieve maximum compatibility between the safe and orderly development of civil aviation and the quality of the human environment;

The 18th Assembly also adopted Resolution A18-12 relating to the environment which states:

**THE ASSEMBLY:**

REQUESTS the Council, with the assistance and co-operation of other bodies of the Organization and other international organizations to continue with vigour the work related to the development of Standards, Recommended Practices and Procedures and/or guidance material dealing with the quality of the human environment;

This resolution was followed up by the establishment of an ICAO Action Programme Regarding the Environment. As part of this Action Programme a Study Group was established to assist the Secretariat in certain tasks related to aircraft engine emissions. As a result of the work of this Study Group, an ICAO

Circular entitled *Control of Aircraft Engine Emissions* (Circular 134-AN/94) was published in 1977. This Circular contained guidance material in the form of a certification procedure for the control of vented fuel, smoke and certain gaseous emissions for new turbojet and turbofan engines intended for propulsion at subsonic speeds.

It was agreed by the Council that the subject of aircraft engine emissions was not one that was solely confined to objective technical issues but was one that needed consideration by experts in many fields and included the direct views of Member States. A Council committee, known as the Committee on Aircraft Engine Emissions (CAEE) was therefore established in 1977 to pursue a number of aspects of the subject.

At the second meeting of the Committee on Aircraft Engine Emissions, held in May 1980, proposals were made for material to be included in an ICAO Annex. After amendment following the usual consultation with Member States of the Organization, the proposed material was adopted by the Council to form the text of this document. The Council agreed that it was desirable to include all provisions relating to environmental aspects of aviation in one Annex. It therefore retained the title of Annex 16 as “Environmental Protection”, making the existing text of the Annex into “Volume I—Aircraft Noise”, and “Volume 2—Aircraft Engine Emissions”.

Part I of Volume 2 of Annex 16 contains definitions and symbols and Part II contains Standards relating to vented fuel. Part III contains Standards relating to emissions certification applicable to the classes of aircraft engines specified in the individual chapters of the Part, where such engines are fitted to aircraft engaged in international civil aviation.

The balancing of airport development and ecological considerations i.e. city planning, noise pollution avoidance, is also very much a part of ICAO’s regulatory role in issues related to the effects of international civil aviation on the environment. The ICAO *Airport Planning Manual* ensures a balance between airport development and ecological considerations and includes findings of ICAO on aviation and the environment.

In its findings, ICAO records that studies of air quality at certain large airports and nearby areas reflect the fact that automobiles, airport ground vehicles and other urban pollution sources account for most of the atmospheric pollution and that airports may destroy the natural habitat and feeding grounds of wild life and may eradicate or deplete certain flora important to the ecological balance of the area. The Manual also considers the necessity to avoid contamination of rivers and streams by airport waste disposal and drainage systems, the avoidance of noise

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3*Id.* 2.1.3.
4*Id.* 2.2.1.
5*Id.* 2.4.1.
caused by aircraft to human habitation\(^6\) and highway planning.\(^7\) Finally, the document calls for a detailed study of the impact of airport development on the environment in the form of an environmental impact statement.\(^8\)

### 9.3 Other Regulatory Measures

The ICAO Assembly has, in addition, adopted several Resolutions concerning aviation and the environment. At its 22nd Assembly held in September/October 1977 the ICAO Assembly adopted Resolution A 22-12 which recognized _inter alia_ the following:

1. Advancing technology has caused aviation to become a significant influence in the environment;
2. Many of the adverse environmental effects of civil aviation activity can be reduced by, the application of integrated measures embracing technological improvements, appropriate noise abatement operating procedures, proper organization of air traffic and the appropriate use of airport planning and land use control mechanisms;
3. Other international organizations are becoming involved in activities relating to noise abatement policies;
4. In fulfilling its role, ICAO strives to achieve a balance between the benefit of accruing to the world community through civil aviation and the harm caused to the human environment in certain areas through the progressive advancement of civil aviation;

The Assembly therefore declared:

1. That ICAO is conscious of the adverse environmental impacts that may be related to aircraft activity and of its responsibility and that of its Contracting States to achieve maximum compatibility between the safe and orderly development of civil aviation and the quality of the human environment;
2. That the Council Should maintain its vigilance in the pursuit of aviation interests related to the human environment and also maintain the initiative in developing policy guidance on all aviation matters related to the human environment, and not leave such initiatives to other organizations;

The Assembly also invited States to continue their active support for ICAO’s Action Programme Regarding the Environment on all appropriate occasions as their participation in civil aviation’s contribution to the United Nations Environment Programme (UNEP) and authorised the ICAO Council, if and when it deems this

\(^{6}\text{Id. 2.5.2.}\)
\(^{7}\text{Id. 4.3.1.}\)
\(^{8}\text{Id. 2.6.1.}\)
desirable, to enter into cooperative arrangements with the United Nations Environment Programme for the execution of environmental projects financed by the United Nations Environment Fund. The Assembly urged States to refrain from unilateral measures that would be harmful to the development of international civil aviation.

At the same Session, the Assembly adopted Resolution a 22-13 on airports and the environment, observing *inter alia*:

1. The compatibility between the airport and its environment was one of the elements to be taken into account in long-term systems planning;
2. The problem of aircraft noise in the vicinity of many of the world’s airports continued to arouse public concern and required appropriate action;
3. The introduction of future aircraft types could increase and aggravate this noise unless action was taken to alleviate the situation.

The Assembly therefore requested the council to continue its work on establishing Standards and Recommended Practices relating to the alleviation of the problem and urged contracting States to adopt, where appropriate, the ICAO measures and procedures applicable.

In the following Session (September/October 1980), the Assembly adopted Resolution A 23-10 on aircraft noise and engine emissions from subsonic aircraft and requested contracting States not to allow the operation of foreign registered subsonic jet planes that did not conform to ICAO’s specifications on noise certification standards as specified in Annex 16 until 1 January 1988. At the 28th Assembly Sessions held in October 1990, the ICAO Assembly observed that while certification standards for subsonic jet aircraft noise levels are specified in Volume 1, Chapter 2 and Chapter 3 of Annex 16 and that environmental problems due to aircraft noise continued to exist in the neighbourhood of many international airports, some States were consequently considering restrictions on the operations of aircraft which exceed the noise levels in Volume I, Chapter 3 of Annex 16. The Assembly also recognized that the noise standards in Annex 16 were not intended to introduce operating restrictions on aircraft and that operating restrictions on existing aircraft would increase the costs of airlines and would impose a heavy economic burden, particularly on those airlines which do not have the financial resources to re-equip their fleets. Therefore, considering that resolution of problems due to aircraft noise must be based on the mutual recognition of the difficulties encountered by States and a balance among their different concerns, the Assembly, by Resolution A 28-3, urged States not to introduce any new operating restrictions on aircraft which exceed the noise levels in Volume I, Chapter 3 of Annex 16 before considering:

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9 See Assembly Resolutions in Force (as of 6 October 1989), ICAO Doc 9558 at II-18.
(a) Whether the normal attrition of existing fleets of such aircraft will provide the necessary protection of noise climates around their airports;

(b) Whether the necessary protection can be achieved by regulations preventing their operators from adding such aircraft to their fleets through either purchase, or lease/charter/interchange, or alternatively by incentives to accelerate fleet modernization;

(c) Whether the necessary protection can be achieved through restrictions limited to airports and runways the use of which has been identified and declared by them as generating noise problems and limited to time periods when greater noise disturbance is caused; and,

(d) The implications of any restrictions for other States concerned, consulting these States and giving them reasonable notice of intention.

The Assembly further urged States:

(a) To frame any restrictions so that Chapter 2 compliant aircraft of an individual operator which are presently operating to their territories may be withdrawn from these operations gradually over a period of not less than 7 years;

(b) Not to begin the above phase-in period for any restrictions before 1 April 1995;

(c) Not to restrict before the end of the phase-in period the operations of any aircraft less than 25 years after the date of issue of its first individual certificate of airworthiness;

(d) Not to restrict before the end of the phase-in period the operations of any presently existing wide-body aircraft or of any fitted with high by-pass ratio engines;

(e) To apply any restrictions consistently with the non-discrimination principle in Article 15 of the Chicago Convention so as to give foreign operators at least as favourable treatment as their own operators at the same airports; and,

(f) To inform ICAO, as well as the other States concerned, of all restrictions imposed.

The Assembly also strongly encouraged States to continue to cooperate bilaterally, regionally and inter-regionally with a view to:

(a) Alleviating the noise burden on communities around airports without imposing severe economic hardship on aircraft operators; and

(b) Taking into account the problems of operators of developing countries with regard to Chapter 2 aircraft presently on their register, where they cannot be replaced before the end of the phase-in period, provided that there is proof of a purchase order or leasing contract placed for a replacement Chapter 3 compliant aircraft and the first date of delivery of the aircraft has been accepted;

The Assembly, while urging States, if and when any new noise certification standards are introduced which are more stringent than those in Volume I, Chapter 3 of Annex 16, not to impose any operating restrictions on Chapter 3 compliant aircraft, urged the Council to promote and States to develop an integrated approach to the problem of aircraft noise, including land-use planning procedures around
international airports, so that any residential, industrial or other land-use that might be adversely affected by aircraft noise is minimal. The Assembly further urged States to assist aircraft operators in their efforts to accelerate fleet modernization and thereby prevent obstacles and permit all States to have access to lease or purchase aircraft compliant with Chapter 3, including the provision of multilateral technical assistance where appropriate. This Resolution superseded Resolution A23-10, which was discussed above.

Resolution A 28-3 represents a cautious balance between the concerns of the aircraft manufacturers, the airline industry and developing States who do not wish to lose in the near future, the services of Chapter 2 aircraft which are already in use and service. Although aircraft manufactured prior to October 1977 that are included in Chapter 2 of Annex 16 and called “Chapter 2 aircraft” are required to be phased out, the compromise in Resolution A 28-3 allows States that have noise problems at airports to start phasing out operations by Chapter 2 aircraft from the year 1995 and to have all of them withdrawn by the year 2002, with some exceptions. The Resolution envisages that by the year 2002 only aircraft manufactured after October 1977 and described in Chapter 3 of Annex 16 (called “Chapter 3 aircraft”) would be in operation. Following this resolution, a number of developed States have already started to phase out Chapter 2 aircraft, while giving due recognition to the compromise reached in Resolution A28-3.

In order to carry out its policies in environmental issues related to civil aviation, ICAO established the Committee on Environmental Protection (CAEP) in 1983. The CAEP is a technical committee reporting to the ICAO Council and consisting of 14 members nominated by their States. The members are experts in the field of aviation and the environment. One of the CAEPs positive contributions to ICAO’s environmental programme has been the development of a new chapter for Volume 1 of Annex 16, which contains a noise certification scheme for light helicopters as well as a number of modifications to the technical specifications of the Annex. The CAEP believes that although ICAO initiatives on Chapter 2 aircraft withdrawal will ameliorate the problem of noise near airports, it will be short lived, as the rapidly increasing proportions of international air travel in the next few years will render the benefits brought about by the initiative, nugatory.

ICAO’s active involvement in aviation related environmental issues is not without good reason, as 9 of the 27 principles contained in the Declaration of the United Nations Conference on Environment and Development (UNCED)—also known as the “Earth Summit”—held in Rio de Janeiro in June 1992. They are:

1. “States have . . . the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.” (Principle 2).
2. “The special situation and needs of developing countries, particularly the least developed . . . shall be given special priority. International actions in the field of environment and development should also address the interests and needs of all countries.” (Principle 6).

10 For more details on CAEP see Mortimer (1992) at 6.
3. “... In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.” (Principle 7).

4. “To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption ...” (Principle 8).

5. “States shall enact effective environmental legislation. Environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply. Standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries.” (Principle 11).

6. “Environmental measures addressing transboundary or global environmental problems should, as far as possible, be based on an international consensus.” (Principle 12).

7. “In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.” (Principle 15).

8. “National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, ...” (Principle 16).

9. “Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.” (Principle 17).

An analysis from the ICAO’s Committee on Aviation and Environmental Protection (CAEP) shows that global aviation fuel burn is expected to grow from 190 Mt in 2006 to a level in 2050 in the range of 280–1,430 Mt (likely in the range of 730–880 Mt). Not accounting for the impact of alternative fuels, CO2 is predicted to grow from 600 Mt in 2006 to a level in 2050 in the range of 890–4,520 Mt (likely in the range of 2,300–2,800 Mt). On a per-flight basis, fuel efficiency is expected to continue to improve through 2050. However, even under the most aggressive technology forecast scenarios, this anticipated gain in efficiency from technological and operational measures does not offset the expected growth in demand. The ICAO Secretariat and CAEP have already devoted significant resources in developing aircraft fuel efficiency parameters and continue work in related areas.

A fuel efficiency metric has been agreed upon which uses the product of payload and distance as the denominator with fuel mass used as the numerator (Commercial Aircraft System Fuel Efficiency Metric = Fuel Mass Consumed/Payload × Distance). A methodology is also being developed to account for the complete life cycle analyses of any alternative fuels. The following paragraphs address efforts in the areas of technology.

ICAO has a central role to play in planning for the implementation of operational improvements. In addition to developing the necessary Standards and guidance material, ICAO has developed a global ATM Operational Concept that was widely endorsed and used as the basis for regional planning. Every ICAO region has identified performance objectives and has developed work programmes to bring near and medium term benefits, while integrating those programmes with the
extensive work already accomplished. For example, ICAO is supporting a major technical cooperation project to implement an advanced air navigation system in the Caribbean region that is expected to substantially reduce aviation emissions in this region.

ICAO supported the development of RVSM, which was first implemented in 1997. This major operational improvement has brought significant benefits in terms of reduced fuel burn, availability of optimal flight levels, and increase in capacity. RVSM has also led to significant environmental benefits and will soon be available in all airspace around the world. Studies undertaken in the European airspace have concluded that RVSM can lead to an average saving of 80 kg of fuel per flight in addition to significant reductions in NOx and sulphur oxide emissions.

ICAO is spearheading efforts to share best operational practices in close-in procedures such as CDA (Continuous Descent Arrival) that reduces holding patterns and thus emissions. Similarly, ICAO fosters PBN (Performance Based Navigation) which results in more direct routing thereby saving fuel and reducing aviation emissions. Efficiency of air transport is inextricably linked to environmental protection by the supply and demand curve pertaining to air transport services. Public expectations and demand coupled with the traffic growth are increasing pressures on the air navigation system to, inter alia, put more aircraft in the skies, reduce delay, be environmentally sustainable, and minimize operational costs, and to do so safely. In order to assist States and regions, ICAO developed the global air traffic management (ATM) operational concept which reflects a global vision of an integrated, harmonized and interoperable PBANS up to and beyond 2025. This vision is supported by the Global Air Navigation Plan (GANP), which recognizes that near-term performance gains could be achieved through more effective planning and implementation of existing technologies, procedures and capabilities. It is contingent on ICAO and other stakeholders to ensure the consistent delivery of the GANP and its set of common and harmonized initiatives to States and regional planners. ICAO must continue to strive for global consensus and provide guidance on solutions that will, inter alia, address the introduction of new types of aircraft, and the expanded use of aircraft capabilities, thereby continuing the transition towards the global ATM.

One particular issue relevant to the aviation industry and ICAO is that significant near-term efficiency and environmental gains may be achieved by the deployment of new technologies such as: replacement of expensive infrastructure through the use of new technologies while maintaining or exceeding the existing level of performance; development of new procedures that take advantage of aircraft capabilities; shift from a static paper-based information system to a real-time and paperless information environment; development and implementation of more accurate weather forecasts.

Some States and stakeholders, however, are reluctant to implement existing infrastructure options for which global provisions are lacking. Other impediments to implementation include: legal and institutional issues concerning intellectual property; and clear guidance on how to match requirements with cost-effective solutions.
New technologies and systems that are expected to be developed and deployed within the next 10 years should be addressed at the global level to ensure interoperability and seamlessness. The radio frequency spectrum is a finite resource that is continually being encroached upon by non-aeronautical services. Therefore, an aeronautical spectrum usage and allocation plan need to be validated and sustained.

In another combined Cambridge University/MIT effort engineers have come up with what they believe is the future for commercial airliners—a radical “flying wing” designed to be so quiet that no one outside an airport will be able to hear it. Called the SAX-40, the flying wing would be 25% more fuel-efficient than modern planes and carry 215 passengers up to 5,000 nautical miles (5,750 miles) at a maximum speed of 600 mph.\(^\text{11}\) The engineers involved in the project have calculated that the SAX-40 would achieve 149 passenger miles per gallon compared with 121 for a Boeing 777. By comparison a Toyota Prius hybrid car gets 144 passenger miles per gallon. This blended wing design concept, which could come into commercial service by 2030,\(^\text{12}\) is a result of the £2.3m Silent Aircraft Initiative (SAI), a 3-year collaboration between Cambridge University and the Massachusetts Institute of Technology.

The most disturbing fact regarding achieving lower fuel consumption is that, unlike other transportation sectors, aviation currently has no viable alternative to burning fossil fuels. It is reported that aviation currently consumes 2–3% of all fuels burnt, whereas the entire transportation sector consumes 20–25% of all fuel consumed by industry and domestic home environments. Of this, road transportation uses 75% while aviation consumes 12%.\(^\text{13}\)

It is a constant endeavour of airframe and engine manufacturers to strive to develop innovative technology, particularly through regular upgrades of aircraft types and modernization of fleets. Among these innovations are achievements in weight reduction of the frame and fuselage of aircraft; development of cleaner, quieter, and more reliable engines; and thermal efficiency to improve combustion. ICAO\(^\text{14}\) has led the field in standardization in this respect, and its endeavours go back to 1981 when the Organization developed a certification standard to control the amount of oxides of nitrogen (NOX) in civil turbo-jet and turbo fan aircraft engines. ICAO’s Committee on Aviation Environmental Protection (CAEP) had led a review of technologies for the control of NOX and recommended goals for

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\(^{12}\)It must be borne in mind that this is a conceptual design and there are many technological barriers that need to be overcome to introduce these technologies into commercial use. Experts at Cambridge University have outlined challenges such as developing the strong composite materials needed to produce the oval-shaped hull and improving modern jet engines to work with the SAX-40 design. However, These challenges can be overcome and work is progressing within the Silent Aircraft Initiative.

\(^{13}\)Air Travel, Greener by Design, the Challenge, see [http://www.foresight.gov.uk/Previous_Rounds/Foresight_1999_2002/Defence_Aerospace_and_Systems/Reports/Air%20Travel%20Challenge/The_Challenge.pdf](http://www.foresight.gov.uk/Previous_Rounds/Foresight_1999_2002/Defence_Aerospace_and_Systems/Reports/Air%20Travel%20Challenge/The_Challenge.pdf).

\(^{14}\)Supra, note 6 in Chap. 1.
NOX reduction from aircraft engine technologies over 10 and 20 year horizons. CAEP produced its first report in this field at its 7th meeting in 2006 and recommendations therein were adopted by the ICAO Council in the following year.

In view of the fact that mutable developments in the global scene continue to affect climate change, numerous multinational development banks have established Climate Investment Funds (CIFs) in 2008 on a large scale. A significant contribution was made by the African Development Bank (AfDB) which developed a Clean Energy Investment Funds (CEIF) which aims at promoting investment in clean energy projects and guides the Bank’s investments in expanding energy across Africa. The Bank has also developed a Green Growth Strategy which supports and promotes low carbon climate change resilient investments in the States of the African continent.\(^{15}\)

The Inter-American Development Bank (IDB)—the oldest bank in the Latin American region—is working with more than half of its member States in investing in bio fuel programmes, the most renowned of which is the ethanol programme of Brazil. IDB is also vigorously promoting the development of next generation bio fuel initiatives.\(^{16}\) In this context, and with aviation bio fuels now approved for use in commercial jets, Boeing and Embraer are in partnership in the joint funding of a sustainability analysis with a view to producing renewable jet fuel from Brazilian sugarcane.\(^{17}\)

In addition to the abovementioned financial initiatives there are several others. The Global Environment Facility (GEF) was established by UNFCCC to operate the financial mechanism under the Convention on an on-going basis, subject to review every 4 years to provide funds to developing countries.

The Special Climate Change Fund (SCCF) was created in 2001 to complement other funding mechanisms to finance. Least Developed Countries Fund (LDCF) is intended to support a special work programme to assist the LDCs. The Clean Development Mechanism (CDM) allows a developed country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to 1 t of CO\(_2\), which can be counted towards meeting Kyoto targets.

The Adaptation Fund became operational with the first commitment period of the Kyoto Protocol in 2008 to finance practical adaptation projects and programmes in developing countries and support capacity-building activities. It is funded from an adaptation levy of 2% on CDM projects.

The Climate Investment Fund (CIF) was established in 2008 by several multilateral development banks. The CIF has balanced and equitable governance with


\(^{17}\) Boeing (2011), 283 at 6.
equal representation from developed and developing countries. The objective is to influence climate investments in the following areas: Clean Technology Fund: finances demonstration, deployment, and transfer of low carbon technologies; Strategic Climate Fund: Targeted programs to pilot new approaches and improvements; Community Development Carbon Fund provides carbon reduction financing to small scale projects in the poorer rural areas of the developing world.

The Fund, a public/private initiative designed in cooperation with the International Emissions Trading Association and the UNFCCC, became operational in March 2003. The World Bank and the International Finance Corporation have also developed carbon funds with (co-)funding by States. Similar carbon-financing initiatives are currently being developed by various other international financial institutions. The World Bank and regional development banks provide financing for investment in mitigation and adaptation measures to developing countries. This includes loans to support projects and initiatives in the transport sector. A number of nationally-based financing instruments also exist, including: the Carbon Trust in the United Kingdom, the Green Financing in the Netherlands, and the Energy for Rural Transformation in Uganda. It is notable that the World Bank Group has developed various instruments to trade greenhouse gas (GHG)\textsuperscript{18} emission rights among States.

These financing models and financing instruments have been specifically designed for climate change projects. Other funds are also available or currently under development. For instance, the United Nations Environment Programme (UNEP) is working to create a policy and economic framework in which sustainable energy can increasingly meet the global energy challenge. Recently, the Secretary General of the United Nations established the High-Level Advisory Group on Climate Change Financing (AGF) to study potential sources of revenue for financing mitigation and adaptation activities in developing countries. This funding is expected to tap into a wide variety of sources. In relation to international aviation, the AGF will also consider options relating to fiscal instruments that could apply to this sector.

International aviation currently has no dedicated financial mechanism related to climate change. Because international aviation is not covered by the Kyoto Protocol,\textsuperscript{19} it has no access to any of the Kyoto flexible financing instruments such as CIF.

\textsuperscript{18} Greenhouse gases are components of the atmosphere and contribute to the Greenhouse Effect. Some greenhouse gases occur naturally in the atmosphere, while others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Certain human activities add to the levels of most of these naturally occurring gases.

\textsuperscript{19} The Third Conference of the Parties to the United Nations Framework Convention on Climate Change (Climate Change Convention) was held from 1 to 11 December 1997 at Kyoto, Japan. Significantly the States parties to the Convention adopted a protocol (Kyoto Protocol) on 11 December 1997 under which industrialized countries have agreed to reduce their collective emissions of six greenhouse gases by at least 5\% by 2008–2012. The Kyoto Protocol to the United Nations Framework Convention on Climate Change is an amendment to the international treaty on climate change, assigning mandatory emission limitations for the reduction of greenhouse gas emissions to the signatory nations. Article 1 (a) (v) of the Protocol calls each State Party to achieve...
or CDM. The absence of a structured mechanism does not mean that there are no initiatives or specific examples of financial contributions to support aviation climate change actions. It is incontrovertible that the aviation sector needs funding, particularly against the backdrop of ICAO Assembly Resolution A 37-19 adopted at the 37th Session of Assembly of ICAO held in Montreal from 28 September to 8 October 2010. The Resolution suggests, inter alia, that States and relevant organizations work through ICAO to achieve a global annual average fuel efficiency improvement of 2% until 2020 and an aspired global fuel efficiency improvement rate of 2% per annum from 2021 to 2050, calculated on the basis of volume of fuel used per revenue tonne kilometre performed. ICAO and its Member States, with relevant organizations, are encouraged to work together to strive to achieve a collective medium term global aspired goal of keeping the global net carbon emissions from international aviation from 2020 at the same level, taking into account the special circumstances and respective capabilities of developing States, the maturity of aviation markets and the sustainable growth of the international aviation industry. In this regard, the proposed resolution suggests that the Council consider a de minimis exception for States that do not have substantial international aviation activity levels, in the submission of action plans and regular reports on aviation CO₂ emissions to ICAO. The Resolution also invites the Assembly to recognize that in the short term, voluntary carbon offsetting schemes constitute a practical way to offset CO₂ emissions, and invites States to encourage those operators wishing to take early action to use carbon offsetting, particularly through the use of credits generated from internationally recognized schemes such as the Clean Development Mechanism.²⁰

In addition to the 2% annual improvement in fuel efficiency discussed above, the 37th Session of the Assembly also considered a proposal to further explore the feasibility of more ambitious medium and long term goals, including carbon neutral growth and emissions reductions. Three States proposed that a more ambitious goal be set, of carbon neutral growth by 2020 compared to 2005 levels. In response, a developing State took the position that ICAO should be guided by the principle of common but differentiated responsibilities under the UNFCCC, and that the next task for ICAO is to assist States to achieve the goal of 2% annual fuel efficiency improvement, while the goal of carbon neutral growth is not realistic and not fair for developing States and that no State should be allowed to take unilateral actions on progressive or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and application of market instruments. See Kyoto Protocol to the United Nations Framework Convention on Climate change, UN Doc. FCCC/CP/1997/L.7/Add.1. See also, Kyoto Protocol to the Framework Convention on Climate Change, (1998) 37 ILM 22.

²⁰The Clean Development Mechanism allows a developed State with an emission-reduction or emission-limitation commitment under the Kyoto Protocol to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction credits, each equivalent to 1 t of CO₂, which can be counted towards meeting Kyoto targets. See http://www.icao.int/icao/fr/env2010/ClimateChange/Finance_f.htm.
market-based measures. The latter suggestion was given some support from other developing States.

Climate change is a complex subject. In this context, the numbers in terms of investment in climate change are staggering, as the above discussion reflects. The value of low carbon energy markets in 2050 is set at US$ 500 billion whereas the demand for projects generating credits related to greenhouse gas emissions by 2030 are envisioned at 100 billion.21

The global response to climate change is bifurcated into mitigation and adaptation. Mitigation (also called abatement) is human intervention to reduce the sources of greenhouse gases. Adaptation is adjustments in practices, processes or structure that takes into consideration the vicissitudes of climate change. Against this backdrop, the investor has certain choices: accept the scientific evidence and invest in industries that help mitigate climate change; take no action and consider scientific evidence as irrelevant and unnecessary; or look for investment opportunities, taking into account government initiatives. The last option is vigorously espoused by international organizations with the active involvement of governments. These international organizations will most likely continue to demand initiatives that mitigate climate change through such organizations as UNFCCC and the Inter Governmental Panel on Climate Change (IPCC).22 Such government initiatives are already visible in the form of cap and trade regulatory systems, taxes in various forms, incentives and subsidies and standardization for energy efficiency.

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21Investing in Climate Change – An Asset Management Perspective, Deutsche Asset Management, October 2000 at 2 and 11.

22 The IPCC is a scientific intergovernmental body set up by the World Meteorological Organization (WMO) and by the United Nations Environment Programme (UNEP). The IPCC was established to provide the decision-makers and others interested in climate change with an objective source of information about climate change. The IPCC does not conduct any research nor does it monitor climate related data or parameters. Its role is to assess on a comprehensive, objective, open and transparent basis the latest scientific, technical and socio-economic literature produced worldwide relevant to the understanding of the risk of human-induced climate change, its observed and projected impacts and options for adaptation and mitigation. IPCC reports should be neutral with respect to policy, although they need to deal objectively with policy relevant scientific, technical and socio economic factors. They should be of high scientific and technical standards, and aim to reflect a range of views, expertise and wide geographical coverage.