Aviation in a carbon-constrained world: 2050 scenarios and the implications for long-haul tourism

By Shaun Vorster, April 2013

Tourism and its 'midwife', aviation, are exposed to various global uncertainties. The basic dilemma is that unconstrained growth in aviation emissions will not be compatible with 2050 climate stabilisation goals, and that the stringency and timing of public policy interventions to control aviation emissions could have far-reaching impacts – either on the market for future growth or the natural ecosystem on which tourism depends.

Three meta-level scenarios with a 2050 horizon for the evolution of long-haul tourism (LHT) and aviation can be identified: to decarbonise and grow ('green lantern'); to do nothing, grow in the short term, but eventually face Armageddon ('grim reaper'); or to do too little too late and slow down ('fallen angel').

Two principal driving forces inform the scenario logics: carbon constraints and the long-term decarbonisation of aviation (*see Figure 1 at the end of the article*).

The 'carbon constraints' driving force is primarily a political driver and is assessed by its stringency, namely strict limits or a lax regime.

The horizontal axis ('long-term decarbonisation' of aviation) runs through IATA's decoupling target (50% below 2005 by 2050), IATA's targeted 2020 carbon-neutral growth (CNG) or emissions plateau trajectory extended to 2050, and a mere extension of the current base-case trajectory to 2050. The plausible zone excludes carbon-neutral aviation and the frozen technology extremes.

Of course, the road to 2050 starts in 2013. So where are we today?

After a recovery in international arrivals following the global economic downturn of 2008/9, 2012 marked an historic one billion international tourist arrivals. But in 2013 various uncertainties also beckon on the horizon. There is the uncertainty about the outcome of UNFCCC negotiations on a global post-2020 climate change regime and ICAO negotiations on a global sectoral MBM for controlling international aviation emissions. If negotiations in these two forums succeed, a global and progressive price on carbon combined with absolute limits on emissions may be knocking on the door of the future. This will surely affect growth in LHT, depending on what happens with the decarbonisation of aviation over the next four decades.

If negotiations fail, a fragmented regime may see further unilateral imposition of carbon constraints by major blocks such as the European Union. Or a very weak and fragmented climate regime that disregards climate change science may prevail, which would hold dire consequences for tourism destinations, especially if the average temperature increase exceeds 2°C over pre-industrial levels during this century.

Fortunately, the aviation industry has responded proactively to the prospects of a carbon-constrained world by adopting short and long term goals and IATA's Four Pillar strategy. But, of course, these are good intentions that must still be turned into actions. Even achieving what is labelled the 'current trajectory' will surely not be plain sailing.

Given these uncertainties, it is possible to imagine more than one narrative for the future (*see Figure 2*).

The 'Green Lantern' scenario

• *Where are we in 2050?*

The meaningful decoupling of aviation and LHT growth from carbon emissions exemplifies the global paradigm shift towards a green economy over the past four decades. In response to early warning signals in the 2010s that a future climate change regime will put a binding cap and an escalating price on aviation emissions, the rapidly growing aviation and tourism sectors proactively repositioned to become green lanterns of prosperity.

These sectors contribute their fair share to ongoing efforts to limit the temperature increase to below 2°C, while growth in tourism demand and its associated developmental benefits continue to outstrip all expectations. Globalisation and rapid economic growth in what was formerly known as emerging economies are driving LHT and aviation growth. The industry's four-decade-old commitment to reducing emissions to 50% below 2005 levels by 2050 became a reality. All indications are that the world will be spared the worst impacts of climate change over the remainder of this century.

• *How did we get here?*

2013 to 2020 – After receiving an unambiguous negotiating mandate at the ICAO General Assembly in 2013, the architecture of a global market-based mechanism (MBM) for international aviation emissions was finally agreed in 2016. This coincided with the conclusion of UNFCCC negotiations, which was only possible because all major economies felt comfortable that they would not be competitively disadvantaged or unfairly treated by an ambitious global climate change regime coming into effect in 2020.

Because of the long-term and legally binding nature of these global regimes, the aviation industry and governments started to invest in meaningful public-private partnerships (PPPs) towards decarbonising air transport long before 2020. 'Low-carbon' became the new buzzword for competitiveness.

2020 to 2030 – By 2030, the carbon abatement potential of operational, infrastructural and air traffic management (ATM), as well as incremental technology-efficiency improvements foreseen in 2013, had been fully realised. It was a demonstration of unprecedented political will combined with cooperation across the entire aviation value chain. The modernisation of the eight-decades-old Chicago Convention surely also played a part. Although the efficiency improvements extended linearly into the future, this alone was not enough to meet industry's CNG goal for the next decade, and the post-2020 sectoral emissions cap-and-trade scheme (ETS) became the vehicle to offset those aviation emissions exceeding a CNG plateau trajectory against other economic sectors.

The post-2020 ETS also created a long-term price incentive for R&D spending and investment in the required commercial-scale production to bring second-generation drop-in biofuels to market after 2030. Price parity with dirty kerosene jet fuel was reached by 2025.

2030 to 2050 – The big winners in the low-carbon aviation and biofuels race since 2030 have clearly been Africa, Brazil, India and China. As China rolled out its new generation of aerodynamic aircraft, Africa succeeded in allocating sufficient land for biofuel feedstock production. The massive investment in second-generation biofuels production created many new job and income opportunities.

Even though biofuels did not materialise at the scale required to meet industry's 2050 targets on its own, mainly due to limits to feedstock production, other radical new technologies, including blended-wing/body design, on-board fuel cell systems and previously inconceivable engine architectures became commercially viable by 2045. As a result, air transport became less reliant on more expensive emissions trading to offset emissions, thereby keeping the real cost of air travel stable.

• *What have been the turning points and signposts over the last four decades?*

The four-decade, low-carbon revolution required visionary political and industry leaders, who stood ready to take the tough policy and investment decisions needed. Very little would have moved forward had the major forces not buried the hatchet in climate change negotiations. The second signpost was the agreement on a long-term policy signal under ICAO, which also provided the critical price incentive beyond 2020. Only then, the different interests in the vertical aviation industry supply chain (including airframe and engine manufactures, fuel producers and distributors, airlines, airports and air transport navigation authorities) cooperated at a higher level.

The aviation industry ultimately also needed its public-sector partners to resolve outstanding operational and infrastructural inefficiencies caused by decade-old conceptions of national sovereignty, allocate sufficient land and water for biofuel feedstock production, form R&D partnerships, set global standards in ICAO, and establish creative new funding mechanisms for technology deployment to de-risk private-sector investment.

• *What were the implications for LHT destinations?*

Due to the decoupling of LHT growth from emissions growth, destinations were able to continue reaping significant social and economic benefits, but in an environmentally responsible way. This is what the new generation of green travel consumers expect. Most destinations continue to balance domestic, regional (*i.e.* land arrival) and long-haul air arrival markets, as well as leisure and business tourism, mainly to hedge against unforeseen external economic and security shocks.

Due to a collective and ambitious global climate change effort, global emissions peaked and started to decline early enough to avoid a temperature increase of more than 2°C. Other than for the most vulnerable small-island tourist destinations and least developed countries with low adaptive capacities, dealing with the unavoidable impacts of climate change on ecosystem assets and other tourism infrastructure remains manageable.

The 'Fallen Angel' scenario

• *Where are we in 2050?*

In 2050, the tourism sector is often compared to a 'fallen angel': due to its historical contribution to GDP and employment, it had so much potential, but today, it is shackled to the ground by carbon constraints. Due to the aviation sector's failure to deviate much below its 2010 'current trajectory' for decarbonisation, and in the face of the escalating price on carbon following a (delayed) global climate deal in 2025, LHT is dis-incentivised through a combination of various public policy tools. By 2040, passenger growth stalled, and by 2050, growth had moved into negative territory. The impact on global employment and GDP is negative, with the exception of a number of destinations that switched to local and regional tourism early on. Unfortunately, the global aviation industry's response over the past four decades can only be described as "too little too late", and LHT is paying the price.

• *How did we get here?*

2013 to 2030 – Unfortunately, in the 2010s, the aviation sector adopted a wait-and-see approach.

After a ten-year delay to conclude negotiations on a post-Kyoto climate regime, the major forces resolved their outstanding differences by 2025, and agreed an absolute cap on global emissions to come into effect by 2030. Because of the lost decade, the binding emissions reduction targets were extremely steep.

The aviation sector did achieve some deviation from the 'business as usual' baseline between 2013 and 2030, but the industry goal of CNG after 2020 did not materialise until 2030. Ironically, many carbon abatement opportunities with net negative costs were forfeited. It was a classic case of market failure combined with (national and multilateral) governance failure. For example, there were unnecessary delays and a lack of political will in the European Union and United States to implement the Single European Sky and the Next Generation Air Transportation System (NextGen), governments waited until 2025 to agree on interoperability standards for ATM and airport infrastructure, and so on. In addition, conflicts of interest in the vertical aviation supply chain persisted: oil companies were basically holding airlines hostage by not investing in low-carbon biofuel development. The message that 'co-opetition' was in everyone's best interest simply never hit home.

2030 to 2050 – As emissions peaked at such a late stage and such a high level, the IATA goal to reduce absolute emissions to 50% below 2005 levels by 2050, without slowing down growth in air traffic and international tourism, became an impossible dream. Even over the two decades since 2030, industry aspirations of rapid decoupling got stuck in the mud too often. As a result of a lack of early investment in low-carbon R&D and the allocation of land for second-generation biofuel feedstock production by governments, the balance of mitigation efforts shifted from the technology-driven and fuel-switching options foreseen in the 2010s to suppressing LHT demand through economic measures, i.e. changing behaviour through punitive carbon pricing and individual carbon budgets.

Before 2030, the financial and technological risks of biofuels investment were just too high for private investors. Governments also never came to the party with fiscal incentives that would de-risk private-sector initiatives. In fact, as early as 2015, it became clear that the more proactive automotive industry was going to win the race for low-carbon biofuels.

By 2040, the real cost of air travel, which now fully internalised the cost of externalities, became a serious disincentive for leisure tourism. Business travel also slowed down as carbon constraints on global trade started to weigh in, and governments invested heavily in public awareness campaigns aimed at moral persuasion, encouraging people to travel less and closer to home, and businesses to replace travel with ICT solutions as their contribution to slowing down climate change.

• *What have been the turning points and signposts over the last four decades?*

A key turning point was when climate change negotiations collapsed in 2015, and remained deadlocked for a decade. Missing the aviation industry's post-2020 CNG goal was then a given, as industry moved into reactive mode and ICAO negotiations on an MBM disintegrated. Role players in the value chain simply assumed that there would be no price incentive to invest in R&D for radical new technologies and biofuels that would make a difference after 2030. The next signpost was when climate negotiations picked up new political momentum by 2020. Immediately, it became clear that the aviation industry, with its long R&D lead times, was caught unprepared.

Of course, things could have been different had a 'wild card' outside the aviation and tourism sectors, such as a technology fix for carbon sequestration or 'fairy godmother'-type solar or hydrogen-fuelled planes, entered the scene.

• *What were the implications for LHT destinations?*

At a macro-level, many destinations de-linked tourism from aviation, and started reducing absolute aviation emissions – not through technology-driven decarbonisation, but through demand management. LHT entered its darkest decades in history. Most destinations experienced negative tourism GDP and job impacts.

Some destinations, however, had the foresight to reposition early. They decreased LHT's share in their portfolios and by 2020 shifted their focus to domestic, regional and short-haul tourism. They invested heavily in mass-transit systems rather than new airports and government-subsidised airlines. These early movers also refocused their market segmentation and value propositions from mass-based, low-cost markets to premium markets that delivered higher-yield tourists.

Due to the lost decade, many tourist destinations have to invest heavily in measures to adapt to unavoidable climate change, especially in low-lying coastal areas, small-island states and water-stressed regions. A temperature increase of more than 3.5°C is not on the horizon, but the dream of avoiding a temperature increase of more than 2°C is lost.

The 'Grim Reaper' scenario

• *Where are we in 2050?*

Like the grim reaper, aviation and LHT have been raiding the global commons without an environmental conscience ever since global climate change negotiations collapsed in the late 2010s. There is no global limit/price on carbon that internalises the cost of negative externalities, and the real cost of air travel keeps falling on the back of new economies of scale, higher load factors, technology-driven fuel-efficiency improvements and stable oil prices. Both air traffic and emissions grew nearly unabated for four decades. This was fuelled by an expanding global middle class, rapid urbanisation, growth in mega-cities, booming business travel associated with the ongoing globalisation of trade, and mass-based leisure tourism supported by expansive low-cost airline networks and a consumer mindset focused on hedonistic experiences. Climate change has already breached critical ecosystem tipping points, with devastating social and economic impacts on many tourist destinations.

• *How did we get here?*

2013 to 2030 – Climate change negotiations under the UNFCCC first derailed in 2015. Member parties increasingly lost confidence in multilateral governance and the United Nations system. This also meant that negotiations on an MBM for controlling and pricing international aviation emissions under ICAO came to an end. Anyhow, as an institution, ICAO had much more important challenges to deal with, including managing the security, for example cyber-terrorism, and navigation aspects associated with the rapid growth in air traffic worldwide. The narrow sectoral interest of a significant number of its member parties who have for decades opposed any attempts to internalise the cost of environmental externalities prevailed – and some would say quite understandably so, since the global airline industry operated on razor-thin profit margins, often not even covering the cost of capital.

Today, many play the blame game for the historic market failures and the collapse of multilateral governance.

What is clear is that very few players are blameless, including consumers who just never committed to a low-carbon lifestyle. Ironically, the airlines and aircraft manufacturers carry the least blame – they at least invested in incremental technological, operational and infrastructural efficiency improvements up to 2030 – motivated not by climate change considerations, but by the fact that fuel costs constituted more than 30 per cent of their operating costs. However, airlines' efforts were not enough. What was lacking was the political will on the part of governments to agree on an ambitious climate regime, to optimise flight routes and ensure interoperability of ATM systems, to de-risk investment in developing second-generation biofuel supply chains, and to introduce fuel-blending mandates that would have forced the most guilty parties, namely the multinational producers and distributors of kerosene jet fuel, to take the low-carbon challenge seriously.

2030 to 2050 – In the meantime, growth in LHT continued at a CAGR of more than 4.5 per cent per year. As air transport demand boomed in the absence of accelerated decarbonisation, IATA's post-2020 targets dissipated. Even with fleet renewal and efficiency gains at a normal pace up to 2030, absolute emissions reductions never materialised. There were no meaningful public-sector investments in, or incentives for switching to, second-generation biofuels after 2030.

By 2032, as the impacts of climate change became more visible and unavoidable, a new round of climate change negotiations was launched. World leaders, increasingly concerned about climate refugees fleeing low-lying coastal areas and small islands, and the implications this had for achieving the Millennium Development Goals (MDGs), convened in Brazil for the so-called Rio + 40 Earth Summit. The negotiations that followed eventually reintroduced, after a three-decade vacuum, a Kyoto Protocol-like top-down compliance regime, also for dealing with aviation emissions, but it was too late. The world was already committed to a temperature increase of 3.5°C at best.

• *What have been the turning points and signposts over the last four decades?*

When climate change negotiations stalled in the late 2010s, it was clear that the writing was on the wall for a regime that would accelerate the decarbonisation of air travel. Had there been more visionary political and industry leaders in the 2010s and 2020s, or had peak oil been realised, maybe the picture would have looked different today.

• *What were the implications for LHT destinations?*

For LHT destinations, this is 'Armageddon' – an overlap of the impending climate, energy, water, food and population crisis. Even though LHT continued to grow unabated, with positive impacts on GDP and jobs until about 2040, destinations are today struggling to deal with physical damage costs associated with climate change, as well as related socio-economic pressures. As climate tipping points are breached and impacts become irreversible, tourism assets are depleted, inter alia due to extreme weather events, water stress, sea-level rise and coastal erosion, ecosystem and biodiversity loss, and unpredictable weather patterns. That said, a limited number of destinations were able to reposition proactively, diversifying their product offerings to rely less on nature-based, climate-sensitive tourism.

Strategies for long-haul tourist destinations

However intuitively obvious the choice for the 'green lantern' scenario may sound, the tourism sector will be but one player in the low-carbon revolution. The charge for tourist destinations will be to develop robust, future-oriented strategies that allow for reflexivity, risk management and adjustment as the narrative of tomorrow unfolds.

The indicated strategic orientation requires LHT destinations to adapt to climate change, hedge against uncertainty and market risks, decarbonise underlying activities, and then, depending on the signposts or indicators for emerging scenarios, seize new opportunities and deploy contingent strategies.

This article is based on a research project by Shaun Vorster (shaun.vorster@gmail.com LinkedIn: Shaun_Vorster) at the University of Stellenbosch Business School in South Africa. The full version is available in a fully-referenced journal article "2050 Scenarios for Long-Haul Tourism in the Evolving Global Climate Change Regime" that can be downloaded at http://www.mdpi.com/2071-1050/5/1/1

Figure 1:

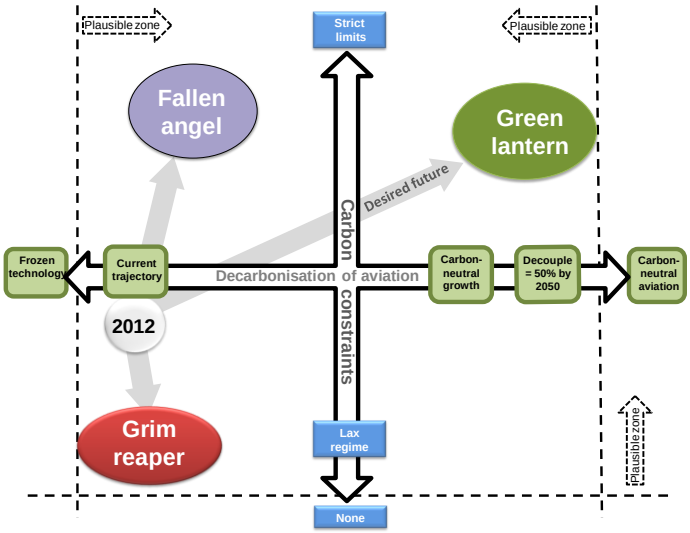
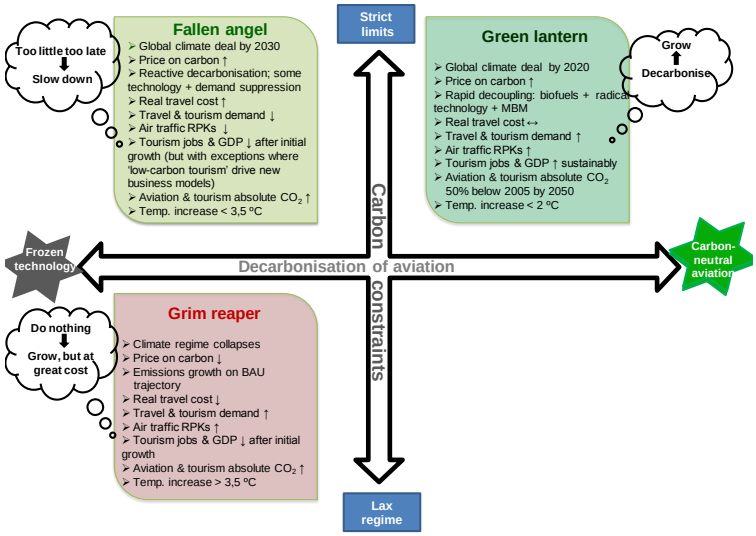


Figure 2:



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