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# Sustainable air transport—on track in 2050

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**Abstract**

In this paper three 'Images' of air travel on a sustainable path in 2050 are outlined. The method used is backcasting. A stabilization of the carbon dioxide concentration in the atmosphere at 450 parts per million is assumed to constitute a sustainable level. It is concluded that a refinement of the conventional turbofan aircraft is probably not sufficient to reach even the less demanding target level, even though a 40% reduction of fuel intensity may be achieved. The introduction of more radical aircraft configurations, e.g. the flying wing, probably has the greatest potential for reducing fuel consumption, but the development of such aircraft is uncertain. A less risky strategy is to opt for a high-speed propeller aircraft with a cruise speed which is 20–25% lower than for a conventional turbofan aircraft. This configuration entails a 56% cut of carbon dioxide emissions per passenger-kilometre compared to 2000. If this technology trajectory is combined with a development characterized by a weakened emphasis on economic growth together with less hectic lifestyles, it may be possible to reach even the most demanding of the target levels. Air travel per capita in 2050 would then be slightly higher than in 2000. If only the less demanding target level is to be reached global air travel per capita may be about 110% higher than in 2000.


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## 1. Introduction

Today the car is the main transport related cause of global warming. Air transport, however, is catching up. If present trends continue, air transport might have an impact of similar magnitude in the middle of the 21st century. In 1992, aviation was estimated to account for 3.5% of the total global warming, measured as radiative forcing (RF), caused by anthropogenic sources (Intergovernmental Panel on Climate Change, 1999). The corresponding share for emissions of carbon dioxide was 2.4%. As a comparison, passenger cars were responsible for about 10% of global emissions of carbon dioxide from fossil fuels in 1990.

In 2000, air travel amounted to 3300 billion passenger-kilometres (International Air Transport Association, 2003). It is estimated that about two-thirds of this consisted of leisure travel and one-third of business travel (Vedantham and Oppenheimer, 1998). The growth rate between 1990 and 11 September 2001 was more than 5% annually (Airbus, 2002). Both Boeing (2003) and Airbus (2002) project that passenger-kilometres will continue to grow by about 5% annually until 2020, despite the downturn following 11 September 2001. Civil air freight increases even faster than passenger travel, although it is still accountable for a minor part of emissions. Military aircraft in 1992 used between 13% and 18% of fuel for aviation but the share is projected to diminish to 3% in 2050 as civil air transport increases and military activity slightly decreases (Intergovernmental Panel on Climate Change, 1999).

Air travel per capita is unevenly distributed world-wide. For instance, the average Swedish citizen travelled about 3400 km by air in 2000 (Frändberg and Vilhelmson, 2002). Although this is about six times more than the average world citizen travels, it still corresponds to only one annual return trip London–Helsinki per capita. Thus, if present travel preferences prevail, flying costs stay low and there are little external impediments, e.g. terrorism, there appears to be no spontaneous saturation of air travel in sight.

The potential for further incremental technological improvements is considerable. A 30–40% reduction of fuel burn per available seat kilometre (ASK) seems realistic until 2050 (Greene, 1992; Intergovernmental Panel on Climate Change, 1999; Peeters Advies, 2000). If realized, this improvement would still only offset a minor part of the projected volume growth. The share of greenhouse emissions attributable to air transport may therefore increase rapidly if the volume growth is not curbed or if more radical technical solutions are not found.

It has been suggested that aircraft designed for a lower cruise speed could contribute to a smaller impact of air transport on the climate system (Barrett, 1994; Dings et al., 2000; Green, 2002). The aim here is to outline consistent Images of sustainable air travel in 2050, in order to widen the perspective regarding possible air transport futures and indicate the magnitude of changes necessary to reach acceptable emissions of greenhouse gases. A particular aim is to explore the environmental potential of using aircraft designed for lower speeds. We consider all scheduled and non-scheduled passenger air transport worldwide, but not general aviation and military air movements. Air freight is not in focus, but will be discussed to some extent since a large part of passenger aircraft also carry freight. The method used is backcasting, which is a kind of scenario approach (Robinson, 1982; Dreborg, 1996; Höjer and Mattsson, 2000). The steps in the backcasting approach are: