



KEY POLICY ISSUE

JANUARY 2008

HARNESSING TECHNOLOGY TO MEET NEW ENVIRONMENTAL CHALLENGES

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Introduction

New technology has played a major part in the aviation industry's response to key environmental challenges over the last four decades. New generations of aircraft have become quieter and more fuel-efficient, with reduced emissions. The application of new technology in engine and airframe design and manufacture has enabled the environmental footprint of the aviation industry to be reduced or limited despite continued strong growth of air travel.

The environmental agenda has also developed and shifted over this period. In the 1970s, the predominant concern was reducing aircraft noise. NOx emissions came onto the agenda in the 1980s, because of their impact on local air quality around airports. More recently, the aviation industry has been challenged to reduce its contribution to the greenhouse gas emissions that are responsible for global climate change. As new issues have arisen, previous concerns have not gone away. The aviation industry now faces the challenge of making progress across a number of different fronts.

Technology alone is not the solution. Operational measures and economic instruments also have a part to play. But the growing number of environmental challenges facing the aviation industry, and the increasing concern about global climate change, raises the issue of whether stronger policies are also needed to accelerate the development and implementation of new technologies to limit environmental impacts.

The economic case for technology policies

Market forces provide a natural incentive for businesses to invest in research and development and to embody new technologies in their products and services through investment. New technology helps reduce cost and boost efficiency, and can give a company an edge in the marketplace through new innovative products. These market mechanisms will normally be adequate to stimulate the development and application of new technology without the need for any government policy or interventions. However, there are well-established economic arguments that suggest that these normal market mechanisms will not always be adequate to ensure the best outcome for society. In technical economic jargon this is described as "market failure" and creates a case for some form of policy intervention to supplement market forces.

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One situation where this can be the case is if there are **technology spillovers** from the creation of new knowledge. In this situation, the narrow business case for investment in new knowledge will not reflect the full benefit to society as a whole. A company investing in new technology will tend to focus on its own commercial benefit, rather than the wider array of possibilities that are opened up by research and development. This creates a case for government support for investment in new technology and knowledge, either by sponsoring fundamental research in universities or supporting major research programmes within business.

Another argument for government support for technology is the impact of **uncertainty** about the future returns from research due to the long timescales involved - either because of the length of the research process itself, or in the time needed to generate a commercial return. This uncertainty may discourage risk-averse investors and hold back the development of new technology with high benefits to society as a whole.

In addition, there may be **external benefits** from new research or the more rapid application of existing technology, which the market does not recognise. Environmental impacts are a classic example of these external benefits. The benefits to the environment are not always reflected in market prices. So there is likely to be a particularly strong case for policy interventions to support new technology where these create environmental benefits that the market does not properly value.

Different policy approaches

If there is a case for supporting the development and deployment of new technology, there are different ways in which this can be done. First, policies might operate either by encouraging development of new knowledge, or by encouraging investment which results in the more rapid embodiment of technology which has already been developed. There will be an interaction between these approaches. If new technologies are embodied more quickly, it creates a stronger incentive to develop them. Similarly, new technology cannot be deployed if it has not been first developed.

Another differentiating factor is whether a policy operates by supply-push or demand-pull. A supply-push policy aims to support the development or deployment of new technology by directly intervening in the research or investment process itself. A classic example of this is government support for R&D. A demand-pull policy aims to strengthen the incentive for investment by boosting the demand for the new technology – either directly or indirectly. A good example is the tax differential created for unleaded fuel in the UK and other countries in the 1980s. Because unleaded fuel was cheaper, consumers wanted cars that would run on it, which greatly accelerated the transition to a more environmentally friendly fuel.

Policy instruments

Table 1 below shows the key policy instruments available for supporting new technology, classified according to the two dimensions discussed above. All of these are already being applied in some form in the aviation industry.

Table 1: Impact of technology policy instruments

	Research and Development	Investment and embodiment
Supply-push	Government R&D support and tax credits	Standard-setting and regulation
Demand-pull	Economic instruments (long-term)	Investment incentives Economic instruments (short-term)

Governments can and do support the development of new technology through **financial support for research and development**, either by direct funding or by tax credits. Across the advanced economies, about 30% of total research and development is directly financed by government (including university-based research), with the government contribution to R&D accounting for about 0.8% of total GDP.² Tax credits for research and development are also available in two-thirds of the advanced economies that are members of the OECD. Along with other high-tech industries, aerospace is already a beneficiary of R&D spending and support in a number of countries. For example, within the UK, the aerospace industry benefited from £153m of direct R&D support between 2004 and 2007, in addition to an estimated £60-£80m of tax credits.

R&D may result in new technology being developed, but not necessarily taken up by firms or consumers. Investment and embodiment of new technology can, however, be accelerated by **standard-setting and regulation**. We have seen this approach applied in the aviation industry through the setting of certification standards for aircraft noise and engine emissions that have been agreed at ICAO from the early 1970s onwards. In the climate change arena, the European Union is using a regulatory approach based on an emissions standard to accelerate the shift towards more fuel efficient cars with lower greenhouse gas emissions.

A more market-based approach to encouraging investment in new technology would be to use **investment incentives** rather than regulation or standards. In the UK, changing the structure of taxation of company cars has been particularly effective in encouraging a shift to more fuel-efficient vehicles with lower emissions. A similar approach is now being applied to encourage consumers to switch in the same direction, by charging differential rates of excise duty that penalise high emissions vehicles.

Investment decisions are not only affected by direct incentives, however. They can also be affected by **economic instruments** influencing the prices and costs which enter into an investment decision. There are a number of ways in which policies can affect prices and costs. One is through the application of taxes and charges. The increasing prevalence of charges related to noise and emissions at airports have had the effect of reinforcing the shift to quieter aircraft with lower emissions. An alternative mechanism to change the structure of prices and costs that is being considered in the context of climate change is emissions trading.

The most immediate impact of the application of economic instruments on investment is likely to be in terms of the embodiment of existing technologies. Economic instruments will only have an impact on longer term research and development programmes if they are perceived to have a significant impact on costs over the long-term, and their application is fairly widespread. If the impact on costs is perceived to be short-term, uncertain or restricted to a limited geographical area, economic instruments will have a minor impact on decisions to invest in new technology.

Aviation and climate change

How do these arguments relate to the issue of climate change, and the aviation industry's response to it? Most of the policy discussion so far on aviation and climate change has focussed on economic instruments. Within Europe, the development of policy is most advanced, and the decision has already been taken to bring aviation into the EU Emissions Trading Scheme (ETS). Over time, it is quite conceivable that other countries and regions outside Europe embrace emissions trading for aviation emissions. ICAO has recently published guidelines on how this might be achieved – though there remains disagreement on some of the key details.

However, the likely development of emissions trading will provide a rather slow and uncertain price signal for the development of new technology. Even if the EU is successful in applying emissions trading to departing flights to other regions, only about a fifth of global aviation carbon dioxide emissions will be included in the EU ETS – so the price signal created by European emissions trading will not directly affect the bulk of the world airline industry. Within Europe, emissions trading for aviation does not start until 2011 and 2012, and it will probably take the best part of the next decade for emissions trading to become more strongly established globally. Against this background,

² Source: OECD Science, Technology and Industry Scoreboard, 2007 (Based on 2005 data.)

there is also likely to be a lot of uncertainty surrounding future carbon prices. Prices within the EU ETS have been volatile, and futures markets only go forward for a few years.

For these reasons, the incentives and price signals provided by emissions trading for investment in new technology are likely to be relatively weak for some time. It might be argued that this does not matter at present, as the high cost of fuel in itself is giving a strong price signal for airlines and aircraft manufacturers to focus on fuel efficiency in their investment programmes, which should drive future reductions in carbon emissions. However, the price of fuel is highly volatile and uncertain, and this may not be a robust basis for policies designed to stimulate the development and embodiment of technology over the long term. Other policy instruments could have an important part to play in encouraging the development of new technologies that will support the reduction in aviation carbon emissions over the longer term.

Bali and beyond – the role of technology

At last December's Bali conference, the international community agreed a "road map" for establishing a future climate change agreement. Within this, it is clear that policies that seek to encourage the development and application of new "low-carbon" technologies will play a major part.

There may not be a major breakthrough on the horizon to enable dramatic reductions in carbon emissions from air travel. But there are a wide number of areas of new technology that can help reduce fuel burn and carbon emissions from aircraft – including the development of propulsion systems, the use of new lighter materials in aircraft manufacture, changes to aircraft structure which reduce drag, and the development of "smart" aircraft systems.³ The development of more advanced air traffic management systems should also help deliver additional reductions in emissions. Further over the horizon is the prospect of using new fuels, especially bio-fuels, to power aircraft. Accelerating technological progress can therefore play a major part in reducing the "carbon footprint" of the aviation industry.

This suggests that the global aviation industry should be looking actively at the various policy instruments that can be used to support the development and application of new technologies to reduce the greenhouse gas emissions from air travel. As climate change continues to rise up the political agenda and the process started at Bali develops, many industries will be making their pitch for government policies to support their efforts to develop new "low carbon" technologies. This would appear to be a good time for the aviation industry to be doing the same.

The views expressed in this article are the author's and not necessarily those of IATA.

³For a good summary, see the 2007 ICAO Environmental Report, pp 130-134: section on Technology within Chapter 4 "Global Emissions".