# AVIATION IN NORWAY
## SUSTAINABILITY AND SOCIAL BENEFIT

PROJECT REPORT
Summary

Oslo, 30 January 2008

# 1. INTRODUCTION

The main task of Norwegian aviation is to contribute beneficially to social and economic development in Norway by providing safe, efficient and eco-adapted air transportation within all regions of the country and to make arrangements that enable the nation to participate actively in global economic and social development.

The Intergovernmental Panel on Climate Change (IPCC) concluded in its fourth major report published in 2007 that it is highly probable that human emissions of greenhouse gases have been the main cause of the increase in global temperature since the mid-20th century. If emissions are not reduced, the global mean temperature will continue to rise. Resolving the climate problem is a major social and societal challenge. Aviation industry operations involve the emission of greenhouse gases and the sector therefore has a responsibility to find solutions for the environmental challenges.

Viewed in isolation, the industry's objectives may seem to be pulling in different directions, and balancing the various considerations relative to one another is a challenge. In the public debate, for example, calls have been made for the growth in air traffic to be halted in order to reduce greenhouse gas emissions. At the same time, attention is often focused on how important aviation is to Norwegian society and the desired development in many areas make a growth in air traffic a necessity. Examples of this include the objective of increasing tourist traffic to Norway, the need to decentralise the structure of trade and industry, public expectations of nationwide access to good health services, and the petroleum industry's reliance on air transportation.

Collectively, the aviation industry in Norway recognises these challenges and wishes to make a positive contribution to social development. In the industry's opinion, there are two scenarios that ought to be avoided:

- An increase in emissions proportional to the growth in air traffic, because the environmental consequences would be too great.
- A controlled restriction of air traffic growth because that would have negative social consequences.

A project was started in spring 2007 to promote initiatives that contribute to sustainable and socially beneficial aviation. The major goals for the project have been threefold:

**1)** To investigate initiatives to reduce the negative environmental impact of the industry. The work has concentrated in the areas for which the industry itself has responsibility and over which it can have an influence, but the project has also been looking at initiatives within associated areas, such as ground transport access to the airports.

**2)** To give a comprehensive presentation of the environmental impact of the industry.

**3)** To contribute to a comprehensive presentation of the social and economic benefit of the industry.

The project was initiated and managed by Avinor, but it is the Norwegian aviation industry collectively – represented by Avinor, the Federation of Norwegian Aviation Industries, SAS Norge, Norwegian Air Shuttle and Widerøes Flyveselskap – that is responsible for the project and this report.

The Norwegian aviation industry has been responsible for investigating initiatives to reduce the negative environmental impact. The Norwegian Institute of Transport Economics (TØI), Cicero – the Centre for International Climate and Environmental Research, and Asplan Viak have contributed background materials to the presentation of the social and economic benefit, and the environmental impact of the industry.[1)]

To ensure a thorough and transparent process, the Norwegian Confederation of Trade Unions (LO), the Norwegian Pollution Control Authority (SFT) and the main Norwegian environmental NGOs – Bellona, Friends of the Earth Norway and The Future in our hands – have participated in a 'resource group' in the project. The group has been an invaluable colloquium for discussions related to aviation and sustainable development, and has through regular meetings been informed about the progress and findings of the project. The resource group has, however, no responsibility for the results or conclusions in this report.

This project summary report provides an account of the main findings and conclusions from the project. The main project report and the background reports are available in Norwegian only.



[1)] Lian et al (2007): Bærekraftig og samfunnsnyttig luftfart [Aviation – sustainability and social benefit]. TØI Report 921/2007; Lian et al (2007) Transport til/fra Oslo Lufthavn i et langsiktig perspektiv [Transport to/from Oslo Airport in a long-range perspective]. TØI Report 902/2007; Asplan Viak (2007) Tilbringertjenesten til Stavanger Lufthavn, Sola [Ground Transport Access to Stavanger Sola Airport]. Issue: 01. Date 30.11.2007; and Asplan Viak (2007): Tilbringertjenesten til Bergen lufthavn, Flesland [Ground Transport Access to Bergen Flesland Airport]. Issue 02. Date 13.12.2007

# 2. THE SOCIAL AND ECONOMIC BENEFIT OF AVIATION

## 2.1 Norway is dependent on air transport

Airport coverage is very good in Norway, and aviation contributes to linking the country together. The administration of the country's resources and the political goals for settlement in the regions has guided the building and maintenance of the airport network. It has been documented[2] that two out of three inhabitants have access to an airport within a one-hour journey time. The cover is particularly good in western and northern Norway. The significance of this can also be illustrated by the fact that 99.5 % of the population are able to travel to Oslo and get back home again on the same day.

The industry helps provide 60,000–65,000 jobs, which is of particular importance in the regions. Overall, aviation has an impact equivalent to 4 % of the country's GDP.

Other examples of the industry's importance are:

- 13 % of all domestic flights are linked to the oil and gas sector, with 550,000 helicopter flights per annum to installations on the continental shelf.
- 30 % of all tourists arrive by air – this means of transport is showing the highest increase. Spending by these tourists in Norway amounts to around NOK 13 billion.
- On an annual basis, 400,000 patients are transported on scheduled flights. The importance to the health sector is particularly high in the northern Norway region.
- Aviation makes it possible to hold nationwide cultural and sporting events.
- The industry offers assistance to passengers such as unaccompanied minors, the elderly and disabled. This makes it an important social asset for families throughout the country, covering more than 250,000 journeys a year.
- Air cargo is crucial to the economy, the health sector etc. The majority of cargo volume and value is linked to functions that are socially vital.
- An analysis of trade and industry in Stavanger provides documentary proof of the significance of aviation to the competitiveness of Norwegian trade and industry in a globalised world.
- An equivalent analysis in Finnmark County indicates that aviation is extremely important to trade and industry and to settlement in the regions.

Strong forces will be driving the continued growth of air traffic in Norway. Some of the most important of these are:

- Long-term economic growth.
- Significant population increase.
- Continued decentralised settlement, trade and industry.
- Expected increase of several hundred thousand people with an immigrant background.
- The globalisation of trade and industry.

## 2.2 Limited alternatives to aviation

In an assessment of aviation as a means of transport, consideration must be given to the alternative means of travel that exist. In general, it might be said that for relatively short flights, there may be satisfactory alternatives, whereas for long journeys there are no real alternatives.

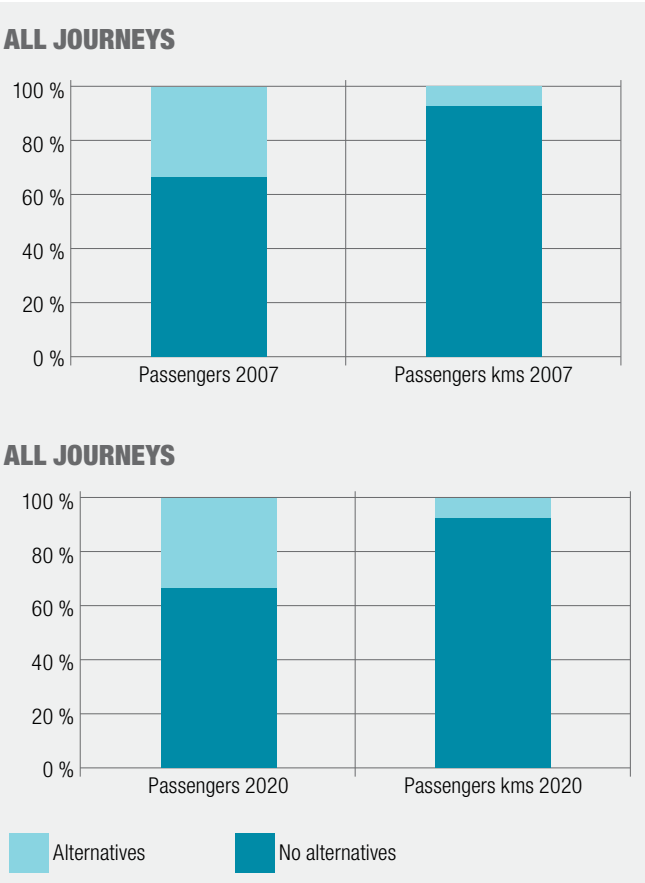



**Figure 1:** The number of passengers and passenger-kilometres in percentage terms within and to/from Norway according to the possibility of alternative transportation 2007 and 2020.



[2] Lian et al (2007): Bærekraftig og samfunnsnyttig luftfart [Aviation – sustainability and social benefit]. TØI Report 921/2007

The TØI analysis (Figure 1) indicates that for 32 % of current flights there is an alternative means of transport, but this only applies to 8 % of air transport modal share (% passenger kms), which also takes flying distance into consideration. There are alternatives internally within southern Norway[3] and between Norway and Denmark/Sweden. The most important alternative to flying is currently the private car.

By 2020, those proportions will drop to 27 % and 6 %, respectively. This means that in 2020, 94 % of air transport modal share (% passenger kms) will have no realistic alternative.

In practice, a very large number of journeys will not be made if flying is no longer an alternative means of transport.

TØI has also assessed the potential of transferring air traffic to a high-speed train service for relevant connections internally within southern Norway and between southern Norway and Denmark/southern Sweden. TØI bases its assessment on somewhat higher proportions of transferred traffic than the Norwegian National Rail Administration's study.[4] Air traffic that might conceivably be transferred to high-speed train in 2020 constitutes 14 % of passengers and 3 % of passenger-kilometres. This is included in the estimates given in the figure above.



[3] According to Table 4.5 in Lian et al (2007) Bærekraftig og samfunnsnyttig luftfart [Aviation – sustainability and social benefit]. TØI Report 921/2007, in 1998 (the last time there was a survey on this topic), between 9 % and 23 % of respondents, dependent on relationship, said they actually considered using an alternative means of transportation although they did have the option.

[4] Norwegian National Rail Administration/VWI (November 2007): Høyhastighetstog i Norge. En mulighetsstudie [High-speed railway lines in Norway. A feasibility study].

# 3. ENVIRONMENTAL FACTS

## 3.1 Aviation's impact on the climate – various methods of calculation

The media have presented greenhouse gas emissions from aviation in many different ways. Annual emissions from air traffic have been quantified from around 1 million to around 7 million tonnes of $CO_2$ and from around 2 % to 15 % of total Norwegian emissions. One main cause of these various estimates is that different methods of calculation are being used.

This project aims clarify the facts concerning the environmental status of the industry.

Aviation's contribution to Norway's greenhouse gas emissions has mainly been represented by means of three different methods of calculation[5]:

**1)** First, emissions are calculated from domestic traffic on the basis of fuel sold for domestic civil purposes. The principles used in this method are laid down in the Kyoto Protocol and are included in official national emissions statistics and reports on monitoring the targets of the Kyoto Protocol.

**2)** It is also common to calculate emissions based on the total aircraft fuel sold in the country – 'bunker fuel'. In practice, bunker fuel covers all domestic flights and international flights to their initial destination[6]. The total of all countries' bunker fuel figures forms the basis of the calculations of total global greenhouse gas emissions from aviation, thus ensuring that all emissions are included and that there is no double-accounting.

**3)** A third method of calculation provides an estimate of emissions from air traffic from inhabitants of a specific country. Such calculations try to provide a picture of the inhabitants' 'carbon footprint' related to journeys by air, by calculating the emissions from both domestic and international air journeys, as well as those between and within third countries.

It is possible to calculate the global emissions from all air travel activities for Norwegians, ('carbon footprint') by analysing travel-habit surveys, using emissions calculators, etc. This has also been done in this project. However, within the national greenhouse gas audit, it is methodically incorrect to compare total global emissions from air travel for Norwegians with contributions from other sectors in Norway. If such a share were to be calculated, an assessment would have to be made of Norwegians' global greenhouse gas emissions from aviation in relation to Norwegians' global greenhouse gas emissions from all consumption, export deducted and import included. There is no satisfactory technical or scientific basis for arriving at certain estimates for this.
In addition, there are reasons for pointing out that:

- Calculation method 3, 'carbon footprint', is not used in the official statistics of other countries, thus creating, among other things, the risk of 'double-accounting' Norwegians' air journeys if this type of method is used solely in Norway.
- There is no set method for doing calculations like these, nor is there any set international method of recording them.
- Any new methods of calculation must be developed internationally and initiatives/incentives must be laid down by international institutions.
- Journeys between third countries are mainly undertaken by foreign airlines and under the framework conditions determined by other nations. This type of travel can only be influenced by the Norwegian authorities and airlines as far as the initial destination abroad.

The Norwegian public authorities and Norwegian aviation industry can influence domestic traffic and traffic to the initial destination abroad

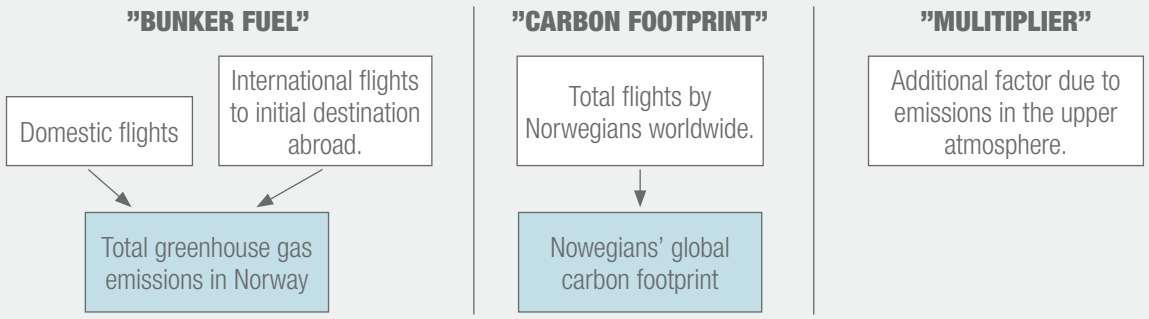



**Figure 2:** Illustration of various methods of calculating the impact of Norwegian aviation on climate.



[5] Other methods of calculation are also available. See Lian et al (2007).
[6] If these figures are to be calculated as percentages of national emissions, bunker fuel figures for both aviation and shipping must be included in national emissions.

(calculation methods 1 and 2). In addition, this is what is included in ordinary official statistics nationally and internationally. The starting point used for the initiatives in this report is therefore linked to these categories. Emissions figures for all flights by Norwegians throughout the world are nevertheless calculated and discussed.

The environmental challenges of aviation are not only linked to direct emissions of $CO_2$. The Intergovernmental Panel on Climate Change (IPCC) maintains that aviation faces special challenges because the emissions of other gases in the upper atmosphere have an added impact[7], but it is uncertain how large this impact is. However, this problem is crucial to the industry and is therefore discussed thoroughly in the report.

The figure on previous page (Figure 2) illustrates the various methods of calculation that are most often used in the public debate on the impact of Norwegian aviation on climate.

## **3.2** Civil aviation was responsible for 1.7 %–3.5 % of greenhouse gas emissions in Norway in 2005

On a global basis, aviation is responsible for a little over 2 % of collective greenhouse gas emissions. The emissions vary considerably, however, in different parts of the world.

In 2005[8], greenhouse gas emissions from domestic civil aviation were approximately 940,000 tonnes out of a total of 54.2 million tonnes of $CO_2$-equivalents[9], in other words around 1.7 % of total emissions in Norway (Figure 3). Approximately 10 % of this is linked to helicopter traffic to and from the continental shelf[10].

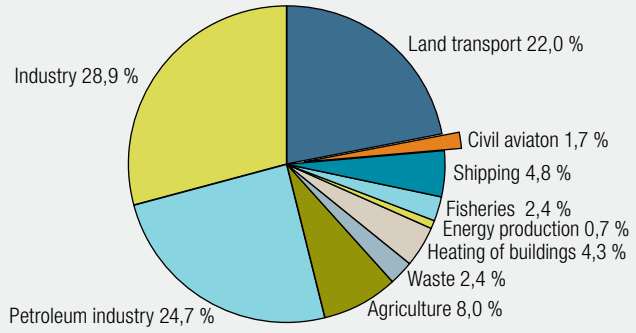



**Figure 3:** Emissions of greenhouse gases in percentage terms in Norway in 2005 distributed by sector. (Source: Report no. 34 (2006–2007) to the Storting on Norwegian climate policy. Data for civil aviation has been taken from other Statistics Norway (SSB) statistics.)

If military aviation is included, greenhouse gas emissions amount to around 1.1 million tonnes. Both civil and military emissions must be reported to the UN Framework Convention on Climate Change (UNFCCC), thereby forming the basis of the national obligations contained in the Kyoto Protocol.

If the point of departure is all of the aircraft fuel sold in Norway (bunker fuel) in 2007, the greenhouse gas emissions from aviation are calculated as being 2.1 million tonnes (Figure 4) and the share of national greenhouse gas emissions as around 3.5 %[11]. In practice, this means that all domestic flights and all flights to the initial destination abroad are included, including those undertaken by foreign airlines. The Norwegian airlines' share of bunker fuel sold was approximately 75 % in 2007.

Aviation emissions measured in bunker fuel sales are the basis for the initiatives being proposed by the industry and whose effects are being calculated in this report.

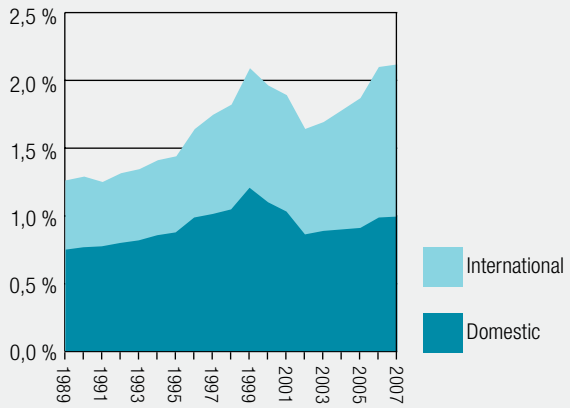



**Figure 4:** Emissions of $CO_2$ in million tonnes from domestic civil aviation and international aviation from Norway (bunker fuel)
Source: SSB sales statistics, distributed between domestic and international according to the number of departing passengers. Emissions for 2007 are provisional calculations.

The figure below provides an overall picture of the emissions from the areas discussed in the project.

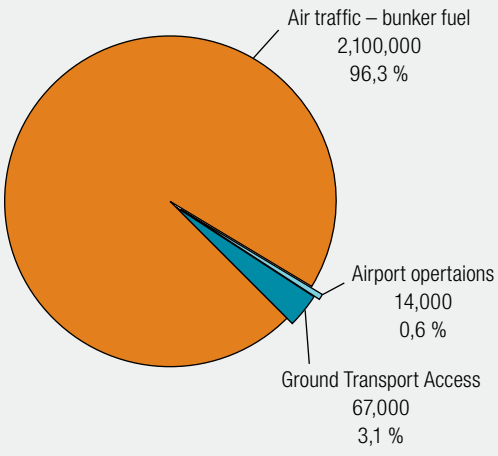



**Figure 5:** Greenhouse gas emissions from aviation in tonnes and as percentages, domestic and international (bunker fuel) (2005), airport operations (Avinor and OSL) in Norway (2006) and ground transport access in Norway (estimated) (2007).



[7] These are impacts that are not regulated by the Kyoto Protocol. The activities of other industries also imply an impact on climate that is not regulated by the Kyoto Protocol.
[8] The 2005 figures are the latest official figures. Official figures for 2006 are due to be published by Statistics Norway (SSB) in February 2008. Due to traffic growth in the past year, it is probable that the figure will be higher for 2007.
[9] $CO_2$ is the most important greenhouse gas from aviation. Other greenhouse gases are converted to $CO_2$ equivalents. In the report, the collective greenhouse gases are also referred to as greenhouse gases or, for the sake of simplicity, as $CO_2$.
[10] Initiatives concerning helicopter traffic have not been assessed in this report.
[11] If the same criteria are used as a basis for international shipping, aviation's share will be somewhat lower.

Air traffic constitutes the largest proportion of emissions from the industry (approximately 96 %). Emissions from airport operations in Norway in 2006 are estimated at approximately 14,000 tonnes (less than 1 %), while TØI has calculated that emissions from ground transport access to Norwegian airports were 67,000 tonnes (around 3 %) in 2007 (Figure 5). Emissions from airport operations and ground transport access are not recorded in the statistics of emissions from aviation, but are covered by other national statistics, such as land transport (see Figure 3 for example).

## 3.3 Emissions in the upper atmosphere require special attention

The IPCC maintains that special challenges face aviation because a majority of the emissions from air traffic occur in the upper atmosphere. There is a significant degree of uncertainty regarding the effect of these emissions, but Cicero has estimated a possible 'multiplier' of between 1.2 and 1.8 when calculated in a manner consistent with the principles of the Kyoto Protocol.[12] The primary reasons for this are the impact of water vapour when it results in contrails and additional formation of cirrus clouds, and NOx emissions which are converted to ozone.[13]

If applying this assessment to Norwegian aviation, consideration must also be given to the fact that domestic traffic operates mainly at lower altitudes and that there are few night flights. These are conditions that could contribute to a reduction in the 'multiplier'. Extensive research is currently underway, including some under the auspices of the World Meteorological Organization (WMO), which is expected to provide more certain information on this subject.

Because of considerable scientific uncertainty regarding the scale of these effects, they have not been included in this report's calculations of targets and shares of emissions, but a thorough explanation of the subject has been given in the report issued by TØI and Cicero.

The industry recognises the special challenges related to emissions in the upper atmosphere. If this effect is included, aviation's responsibility for the collective Norwegian impact on climate will be somewhat greater.[14]

## 3.4 Carbon footprint of Norwegians' air travel

International flights from Norway are generally undertaken via other countries. After the initial destination abroad, the journeys continue with foreign airlines, subject to various regulatory regimes to a large degree outside possible influence of the Norwegian aviation industry or the Norwegian public authorities. Incentives and regulatory initiatives for international traffic with foreign airlines must, in such cases, be implemented on a global basis by initiatives and processes undertaken in international forums.

TØI estimates Norwegians' total emissions from these flights as being approximately 1.2 million tonnes of $CO_2$ in 2007[15]. These are expected to increase to 2.2 million tonnes in 2020 if current emissions are extrapolated. This forecast takes into account the fact that some of today's international traffic will depart directly from Norwegian airports in 2020[16]. This means that some of these emissions will be transferred to Norwegian bunker fuel statistics, over which Norwegian airlines and public authorities will be able to have an influence. The increase in intercontinental flights from Norwegian airports has been included in the forecasts that have been used as a point of departure in this project. The actual increase in emissions is expected to be considerably lower since a series of initiatives have also been implemented internationally, equivalent to those relevant in Norway.

More than 200 airlines undertake these flights and it is not possible to provide definite estimates of the impact of initiatives by the airlines and the public authorities in the individual countries concerned.

It is in conjunction with these flights that the carbon footprint of Norwegians' air travel has been part of the public debate (Figure 2). Added here are the emissions from Norwegians' proportion of domestic air travel emissions and the proportion from Norwegians' flights to the initial destination abroad plus their return flights to Norway. TØI has calculated that the greenhouse gas emissions from Norwegians' total air travel throughout the world in 2007 were approximately 3.4 million tonnes. As mentioned previously, however, it is not methodically correct to relate this figure to the total Norwegian greenhouse gas emissions that have been calculated in compliance with the principles as used in the Kyoto Protocol.



[12] Measured in GWP (Global Warming Potential).
[13] Lian et al (2007): Bærekraftig og samfunnsnyttig luftfart [Aviation – sustainability and social benefit]. TØI Report 921/2007.
[14] Other industries also have an impact on climate beyond the greenhouse gas emissions.
[15] This figure does not include deductions for emissions from cargo in the belly of the aircraft, which can constitute around 30 % of payload on intercontinental flights.
[16] Data based on basic material for calculating Norwegians' aviation-related 'carbon footprint'. Refer to Lian et al (2007) Bærekraftig og samfunnsnyttig luftfart [Aviation – sustainability and social benefit]. TØI Report 921/2007.

# 4. TRAFFIC FORECASTS AND GREENHOUSE GAS EMISSIONS IN THE PERIOD 2007–2020 IF NO INITIATIVES ARE TAKEN[17)]

Forecasts of traffic growth are important in any assessment of future greenhouse gas emissions. Traffic growth has varied historically and will vary considerably from one year to another during the period up to 2020. At present, the sector is in a period of strong growth, which is above the historical average and the expected long-term trend. It must be emphasised that there is a great deal of uncertainty about any forecasts of traffic growth.

As regards the period up to 2020, TØI has drawn up a forecast with an average increase in annual traffic of 2.8 % at Norwegian airports[18)]. Annual growth for domestic flights is expected to be 1.9 %, with international growth being 4.4 %. The leisure market is expected to show strong growth.

The forecast above forms the starting point for the calculations carried out in the project. However, with increases in direct scheduled international flights, TØI estimates that growth in passenger-kilometres from Norwegian airports could be around 75 % (Table 1) during the period 2007–2020.

Table 1 also shows estimated emissions in 2020 if no industry-specific initiatives are taken. This includes an extrapolation of current greenhouse gas emissions per passenger-kilometre and anticipated traffic growth with no energy-efficiency initiatives being taken. The growth in passenger numbers and emissions is least for domestic and greatest for international traffic. The main reason for the calculated strong growth in emissions for international flights is the increase, as discussed, in direct scheduled flights to European and intercontinental destinations. This means that the strongest increase will be in the proportion of emissions from international traffic, which is included in the bunker fuel statistics, and therefore within Norwegian aviation's responsibility.

| | 1000 mill passenger-km | | | Mill tonnes $CO_2$ emissions, no initiatives | | |
|---|---|---|---|---|---|---|
| | 2007 | Growth to 2020 | | 2007 | Growth to 2020 | |
| Domestic flights | 5.8 | 1.6 | 28 % | 0.9 | 0.26 | 28 % |
| International flights | 10.2 | 10.4 | 102 % | 1.12 | 1.13 | 101 % |
| **Total** | **16.0** | **12.0** | **75 %** | **2.02** | **1.39** | **69 %** |

**Table 1:** Traffic trends in passenger-kilometres and calculated emissions of $CO_2$-equivalents (not including helicopters) from bunker fuel sales with no energy-efficiency initiatives in 2007 and 2020. (Drawn up by TØI using data based on Lian et al. (2007)).



[17)] In this report, the term 'no initiatives' is understood to mean 'no energy-efficiency initiatives', i.e. various technical, technological and operational initiatives that the industry can implement. The project's task has been to assess the consequences and collate the initiatives that have been taken, based on existing technology, as well as to develop and promote new initiatives.

[18)] Calculated in terms of terminal passengers at Avinor airports, where domestic passengers count twice. If the number of journeys is used as a starting point, growth becomes just over 3 % per year.

# 5. THE INDUSTRY'S PLANNED INITIATIVES FOR REDUCING GREENHOUSE GAS EMISSIONS

The project has charted potential areas of improvement within areas concerning aircraft engineering, aircraft operations and airports. Altogether, over 50 improvements are being proposed for the period up to 2020. These initiatives are based on known technology (such as aircraft types), anticipated technological developments and new initiatives that come to light during the project. The most important initiatives have been developed and adopted, or will be adopted during the course of 2008.

## 5.1 Initiatives related to aircraft engineering and aircraft operations

Initiatives related to aircraft engineering and operations are those that will have the greatest impact on emission reductions in Norwegian aviation up to 2020. Table 2 shows a summary of the main groups of initiatives to be undertaken.

| Initiatives | Emission reduction |
|---|---|
| Initiatives taken on existing fleet | 5–10 pct |
| Fleet replacement | 25–30 pct |
| Reduced emissions from taxiing | 3–7 pct |
| Oslo ASAP and 'green' landings and take-offs at Norwegian airports | 1–2 pct |
| Single European Sky (SES) | 3–5 pct |
| Total[19)] | 30–40 pct |
| Potential added impact from blend of fossil Jet A1 and alternative fuel | 10–20 pct |

**Table 2:** Principal groups of initiatives relating to aircraft engineering and operations, and emission reductions in Norwegian aviation up to 2020

Initiatives on existing fleets cover modifications such as the retrofitting of winglets (extended wing tips), engine flushing, improvements to the airframe, optimising aircraft operations procedures and upgrading planning tools and computer systems. Because of fleet replacement, the effect of some of these initiatives will only apply in the short term, whereas others will also have an effect in 2020.

Aircraft fleet replacement is expected to produce a reduction in greenhouse gas emissions of around 25–30 % by 2020 as compared to 2007. Norwegian is to replace all of its old Boeing 737 fleet with the latest generation technology (Boeing 737-800), whereas SAS Norge[20)] will already have approximately 70 % of that aircraft type in its fleet during 2008 and is planning to replace parts of its aircraft fleet with the next generation of aircraft once these become available, probably around 2015. The $CO_2$ emissions from these aircraft are expected to be approximately 30 % lower per seat-kilometre than the current generation. In addition, SAS will be implementing other initiatives on its existing fleet, such as the installation of new seats, resulting in lower weight and greater seating capacity.

It is assumed that the overall effect of initiatives to reduce taxiing times and new fuel-efficient technology for aircraft movements at the airports, will be between 3 % and 7 %.

The aviation authorities in 30 European countries are working on efficiency measures in European airspace (Single European Sky – SES). One goal of these efficiencies is to reduce greenhouse gas emissions from an average flight by 10 %. For Norway's airlines, it is anticipated that, in practice, the emission reductions will be between 3 % and 5 %, mainly because of relatively little traffic in Norwegian airspace compared to core area in Europe.

In addition, the introduction of a new traffic management system in the Eastern Norway region (Oslo ASAP) and optimised/'green' landings and departures at around 20 Norwegian airports are estimated to produce a reduction in emissions of 1 %–2 %.

Based on a total assessment of the impact of the aforementioned initiatives the industry estimates that a 30–40 % reduction in emissions by 2020 is realistic.

Finally, it is assumed that positive developments in the supply of alternative fuel and blending of carbon-neutral fuel could reduce emissions by between 10 % and 20 %[21)]. However, these estimates are uncertain and are only discussed here as an illustration of the potential for further reductions in greenhouse gas emissions from the industry, particularly after 2020. The industry's goal is to participate in trials of alternative fuels. Today, it is possible to have a blend of up to 50 % of synthetic fuel, which could also be produced from biomass[22)]. The supply of alternative fuel, price and financial incentives will be crucial to the speed at which this can be introduced.

## 5.2 Initiatives in airport operations

Greenhouse gas emissions from airport operations in Norway[23)] are estimated to be approximately 14,000 tonnes per year. In general, it is anticipated that there will be a 25 % increase in greenhouse gas emissions in the



19) In the table, the total effect of the initiatives is calculated cumulatively. (It is not correct to add up the effects of each initiative.)
20) The fleet plan for SAS, including SAS Norge, is expected to be adopted by the Board during late winter 2008.
21) Assumed reduction at 50 % blend and availability at a limited number of airports.
22) E.g.. Fischer Tropsch Bio-to-Liquid (BTL)
23) With regard to airport operations, only Avinor airports, including Oslo Airport Gardermoen, have been assessed in the project.

period 2007–2020 if no energy-efficiency initiatives are taken because of traffic growth and expansions.

Avinor has calculated that it will be possible to substantially reduce greenhouse gas emissions from its own activities in 2020, even with anticipated traffic growth. The main initiatives are outlined in Table 3.

| Initiative | Emission reductions after activity |
|---|---|
| District heating and renewable sources of energy in own heat production* | 80–90 pct* |
| Reduction in electricity consumption within Avinor | 25 pct |
| Reduction in fuel consumption in own vehicles | 20–30 pct |
| Carbon-neutral fuel in own vehicles* | 80–90 pct |
| Technological developments and initiatives related to business trips and journeys to/from work | 25–30 pct |
| Carbon-neutral fuel in standby power* | 80–90 pct |
| Potential for collective emission reductions | 30–35 pct |

* Assumes that adequate carbon-neutral fuel for heat production, standby power and vehicles is available.

**Table 3:** Initiatives and potential emission reductions in Avinor's business at the airports.

The table indicates the potential for a 30 %–35 % reduction in all of Avinor's business operations. However, there is a degree of uncertainty linked to the impact of some of these initiatives. Avinor has therefore chosen to use as its basis an objective of emissions in 2020 being 25 %–35 % lower than they would have been if no initiatives had been taken at all.

All large and medium-sized airports in Norway have hydronic heating systems, where most of the heat is currently generated in electric or oil boilers. Avinor's goal is to have heat production at these airports by 2020 based on carbon-neutral district heating, seawater heat pumps or biofuel (e.g. fired by woodchip and biogas), to ensure that between 80 % and 90 % of total corporate heat production is based on carbon-neutral sources. In 2008, Avinor will be initiating a comprehensive energy conservation project with a target of a 20 % reduction in electricity consumption during the course of a five-year period. In addition, a further reduction of 5 percentage points is anticipated during the period up to 2020.[24)]

Replacement and modernisation of the fleet of vehicles and other initiatives for reducing fuel consumption are expected to yield a fuel reduction of around 20 %–30 % during the period. In addition, Avinor is aiming for 80 % of the fuel consumed in the group to be carbon-neutral by 2020. Oslo Airport has decided to offset its greenhouse gas emissions from its own operations from the financial year 2006 onwards by purchasing UN-approved emission rights and will declare the operation 'carbon-neutral'[25)]. Avinor's objective is to declare its own operations carbon-neutral from the financial year 2008 onwards at the latest.

## 5.3 Initiatives in ground transport access

Ground transport access to the airports cause considerable greenhouse gas emissions. The responsibility for a good, eco-friendly ground transport to the airports rests primarily with local and central government authorities and with the transportation companies concerned. However, Avinor supports the objective of public transportation increasing its share of the ground transport to the airports up to 2020, and will help facilitate this by the means the group has at its disposal.

It is estimated that in 2007 total emissions from ground transport to Avinor's airports were approximately 67,000 tonnes of $CO_2$-equivalents. The largest source of emissions is the private car. Among the major airports in Norway, the public transportation proportion is highest at Oslo Airport and lowest at Stavanger and Bergen airports.

Separate studies have been carried out concerning ground transport access to Oslo, Stavanger and Bergen airports. These indicate that it is possible to guarantee good public ground transport to the airports in the longer term and that the proportion of public transportation can be increased[26)].

An assessment has also been made of the future fleet of cars, and the consequences this will have on emissions from ground transport access to the airports. TØI has based its calculations on there being 23 % lower greenhouse gas emissions per kilometre from cars and 19 % lower from buses in 2020.[27)]

| $CO_2$ emissions 2007 | | | | With fulfilled public transportation objective 2020 | | | |
|---|---|---|---|---|---|---|---|
| Oslo Airport | Bergen Airport | Stavanger Airport | Total | Oslo Airport | Bergen Airport | Stavanger Airport | Total |
| 32,700 | 8,200 | 5,500 | 46,400 | 31,300 | 7,600 | 4,700 | 43,600 |

* Assuming $CO_2$ emissions in 2007 of 170 g/km for cars and 1350 g/km for buses.

**Table 4:** Estimated $CO_2$ emissions in tonnes from ground transport to Oslo, Bergen and Stavanger airports in 2007 and in 2020, with the objectives for public transportation proportions of 70 %, 32 % and 30 %, respectively, fulfilled.

Table 4 shows estimated greenhouse gas emissions from Oslo, Bergen and Stavanger airports in 2007 and 2020. Ground transport access to these airports is responsible for approximately 70 % of total emissions from the total ground transport access to Norwegian airports. The table is based on public transportation proportions at these three airports of 62 %, 21 % and 11 % respectively[28)]. The table clearly illustrates the effect of increasing the proportions of public transportation to 70 %, 32 % and 30 %, respectively, and more eco-friendly car transportation for the three airports.

At Oslo Airport, a good, reliable range of train services with competitive prices is absolutely crucial to achieving public transportation objectives.

The most important initiatives in Bergen and Stavanger are an improved range of bus services (including new routes and a increased frequency). These are initiatives for which local and central government authorities, and the relevant transportation companies, are responsible. If the proportion of public transportation is to increase significantly, road



24) Emissions figures related to electricity consumption in 2006 are, in consultation with Det Norske Veritas (DNV), based on the assumption that less than 1 % of the electricity on the Norwegian market was imported. Greenhouse gas emissions related to electricity consumption are expected, however, to vary from year to year depending on the precipitation situation in Norway, among other factors.

25) The greenhouse gas audit has been verified by Det Norske Veritas (DNV).

26) Lian et al (2007) Transport til/fra Oslo Lufthavn i et langsiktig perspektiv [Transport to/from Oslo Airport in a long-term perspective]. TØI Report 902/2007; Asplan Viak (2007) Tilbringertjenesten til Stavanger Lufthavn, Sola [Ground transport access to Stavanger Sola Airport]. Issue: 01. Date 30.11.2007; and Asplan Viak (2007): Tilbringertjenesten til Bergen lufthavn, Flesland [Ground transport access to Bergen Flesland Airport]. Issue 02. Date 13.12.2007.

27) Assuming 2.8 % annual traffic growth measured in terminal passengers and $CO_2$ emissions of 170 g/km for cars and 1350 g/km for buses in 2007. Source Lian et al (2007): Bærekraftig og samfunnsnyttig luftfart [Aviation – sustainability and social benefit]. TØI Report 921/2007

28) Based on figures from the Reisevaneundersøkelsen (RVU) [Norway's National Survey of Travel Habits] in the first half of 2007.

improvements, bus lanes, new bus routes and possibly light rail systems will have to be brought to fruition. It is important, therefore, that local and central government authorities take overall responsibility for the aim of achieving a high proportion of public transportation.

To help facilitate this work, Avinor will take the initiative to establish a ground transport access forum for an increased proportion of public transportation to the major airports – first at Stavanger and Bergen airports. In addition, Avinor will generally make arrangements for buses, including improved facilities, improved traffic information, and marketing at the airport. It may also be of relevance to cooperate in ensuring that there is a range of public transportation services at the major airports for flights arriving late, and to adapt the infrastructure at the airport for setting up new bus routes. For example, Avinor introduced a collaborative venture in 2008 with HyNor, Stavanger Node[29] to establish a potential hydrogen bus route taking in Stavanger Airport. In addition, the Airport Express Train in Oslo, has now set up later departures for a trial period, with financial support from Oslo Airport.

A large proportion of greenhouse gas emissions from the ground transport to the airports arise from private cars and taxis. For many travellers there is no public transportation option, and Avinor therefore wants to encourage the use of more climate-friendly fuel in the fleet of motor vehicles. At present there are specific free parking spaces with charge-up areas for electric cars at Oslo Airport. Establishment of similar facilities at Stavanger, Bergen and other major airports will be assessed. In addition, an assessment is being made as to whether to provide free parking for other vehicles using 'eco-fuel', but as yet this is not applicable because it is difficult to distinguish these types of vehicle from 'normal' vehicles. At Oslo airport, however, pumps containing Bioethanol (E85) and liquefied natural gas are available. Initiatives to be taken at airports to encourage a more eco-friendly stock of cars within the taxi industry will also be evaluated.

Together with trade and industry and the municipal authorities, Avinor will also review potential initiatives at other major airports up to 2020.

## 5.4 Environment-related R&D projects

Extensive environmental research and development projects are being implemented in the aviation industry, in particular under the direction of EU and US authorities and aircraft manufacturers and their subcontractors.

Avinor and the Norwegian aviation industry will take steps during the planning period for major research and development projects in order to improve the environmental performance of the industry. The first project to be assessed will be related to the Arctic and trans-arctic flights. The industry will try to increase knowledge about the climate impact of air traffic in the upper atmosphere in Arctic regions and investigate initiatives that might reduce the negative impact of these flights. The project will be formulated in 2008 and will be looking for public and private sector collaborative partners.

The Norwegian aviation industry will also play an active role in testing eco-friendly aviation fuels. Internationally, several development projects are currently underway and the sector is encouraging the Norwegian energy industry to initiate and participate in R&D work within this field.

## 5.5 Financial instruments can contribute to reductions in emissions

As of 2008, a $CO_2$ tax of NOK 0.65 is applied to domestic flights on a per litre of jet fuel consumed basis – a total of NOK 270 million per annum. This is equivalent to a price per tonne of $CO_2$ of around NOK 234, which is more than the average quota price in the EU emission trading scheme thus far. In addition, an NOx tax of NOK 5.39 per kg of emissions below 3000 ft, is paid – a total of around NOK 20 million. The industry supports the polluter-pays principle, but has indicated that the $CO_2$ tax, in particular, leads to unfair competition. The industry primarily wishes any financial instruments to apply on an international basis.

International flights are not covered by these fees due to international and bilateral agreements. Norwegian aviation is positively disposed to the inclusion of aviation in the EU Emission Trading Scheme (EU ETS) as a replacement for the specifically Norwegian $CO_2$ tax. On the part of the EU, it has been proposed that this should apply from 2011. The system will apply in the EU-EEA area and the assignment of quotas will probably be based on traffic volume during the period 2004–2006, but there are many elements of this not yet in place. Because of the ongoing political process, it is not possible in January 2008 to estimate the final outcome, i.e. the emission mitigation or the the cost implications. A final resolution is expected to be passed by the EU in late autumn 2008. By including aviation in the EU ETS, the industry will be paying for its greenhouse gas emissions in the same way as emitters in the European power and heat generation industry and other energy-intensive industrial sectors.

The NOx tax was introduced in 2007. Trade and industry have taken the initiative of setting up an environmental fund as an alternative to a fiscal fee. It is expected that this fund, in which the Norwegian aircraft and helicopter companies will participate, will be established during the course of 2008.

During 2008, Avinor will assess various models and experiences from environmentally-differentiated charges introduced at other airports in Europe. The industry believes that financial instruments have to be harmonised in Europe and considered in the context of the industry's broader framework conditions. In addition, they ought not to be formulated as fiscal environmental fees, but should be aimed at stimulating technological development and other emissions-reducing initiatives in the industry.

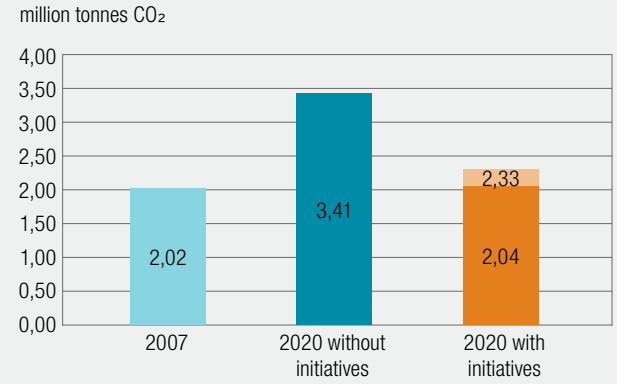


[29] HyNor – the Hydrogen Road of Norway (www.hynor.no/english).

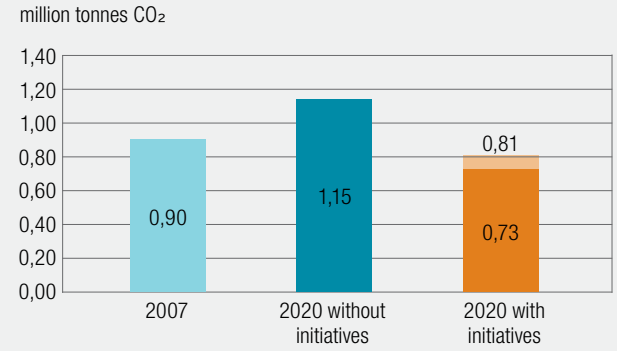
## 5.6 The effect of initiatives taken by the industry in 2020

Figure 6 summarises the effect of the initiatives outlined and discussed in the project.

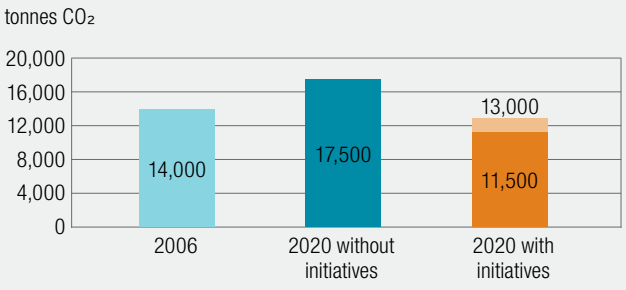
### BUNKER FUEL 2007 AND 2020




### DOMESTIC AIR TRAVEL 2007 AND 2020




### AIRPORT OPERTAIONS 2006 AND 2020




### GROUND TRANSPORT ACCESS 2007 AND 2020

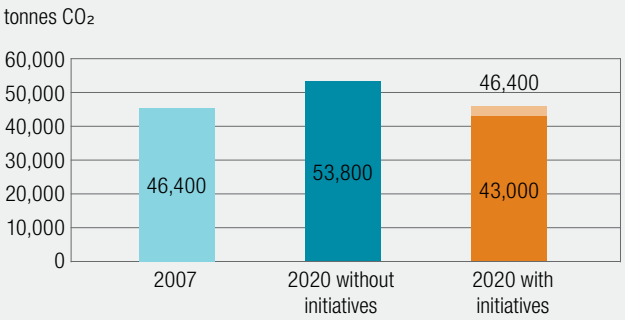



**Figure 6:** Summary representation of greenhouse gas emissions in 2007 (2006 for airport operations) and 2020, with and without energy efficiency initiatives. Note the different scales on the y-axis.

The traffic forecasts used as the basis for the calculations estimate a growth in emissions of 69 % of bunker fuel sales with no initiatives being taken. The initiatives outlined, however, will result in a reduction in emissions of 30 %–40 %, which means that greenhouse gas emissions from the industry in 2020 will be at around the same level, or only 15 % higher, than they were in 2007. In other words, the emissions in 2020 will be at a level of between 2.04 and 2.33 million tonnes, as compared to 2.02 million tonnes in 2007.

Because considerably lower growth is expected in the domestic market (28 %), the calculations indicate greenhouse gas emissions that are between 10 % and 22 % lower than in 2007, or emissions of between 0,73 million tonnes and 0,81 million tonnes in 2020, as opposed to around 0,9 million tonnes in 2007[30].

As regards airport operations, the calculations indicate that greenhouse gas emissions will be between 8 % and 18 % lower in 2020 than in 2007, even with considerable growth in traffic. This equates to emissions of between 11,500 and 13,000 tonnes in 2020, as opposed to 14,000 tonnes in 2007.

The responsibility for good, eco-friendly ground transport access to the airports is primarily held by local and central government authorities and the relevant transportation companies, but Avinor will also be helping to reduce the environmental load from the ground transport within using the instruments which the group has at its disposal. The reports from Asplan Viak and TØI indicate that the emissions in ground transport access to Oslo, Bergen and Stavanger airports in total may be 19 % lower in 2020 than they would have been if no initiatives were taken. If the public transport objectives are achieved, emissions are estimated to between 43,000 and 45,700 tonnes in 2020, as compared to 46,400 tonnes in 2007.

The initiatives outlined in the project will be implemented up to 2020. The respective airlines and Avinor are responsible for implementing the initiatives in accordance with their areas of responsibility. Every three years, up to 2020, the industry will evaluate the impact of the initiatives.



[30] Does not cover helicopters.

There will necessarily be a certain degree of uncertainty connected with forecasts up to 2020. The most important factors that might weaken/strengthen the impact of the industry's initiatives are traffic growth, technological developments, the potential phase in of alternative fuels and the general competitive situation.

## 5.7 Traffic and greenhouse gas emissions 1990–2020

The following figure shows the link between flights[31] and $CO_2$ emissions from bunker fuel sales during the period 1990 to 2020.

**AIR TRAVEL FROM NORW AIRPORTS AND $CO_2$ EMISSIONS FROM BUNKER SALES 1990–2020**

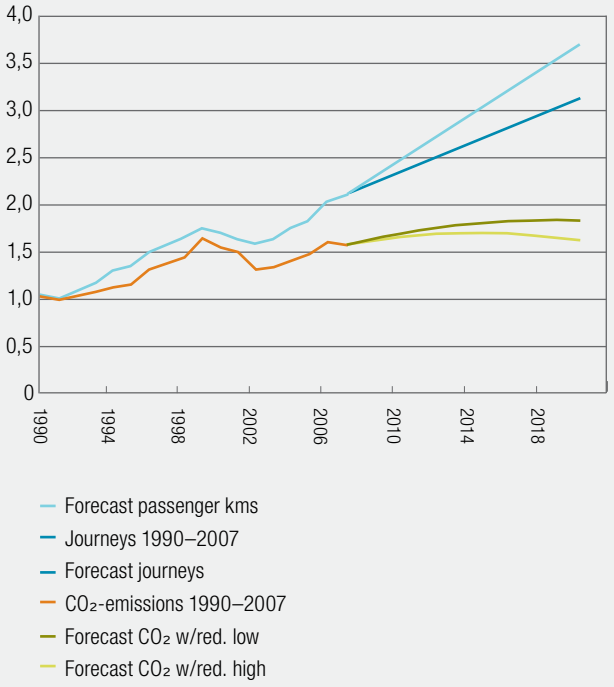



**Figure 7:** Air travel and $CO_2$ emissions from bunker fuel sales during the period 1990–2007, and forecasts of traffic growth, measured in number of journeys, and greenhouse gas emissions up to 2020 (indexed).

During the period 1990 to 2007, there has been an average annual growth in air traffic from Norwegian airports and in $CO_2$ emissions of 4.6 % and 3.6 % respectively (Figure 7). The impact of the initiatives the industry has taken will strengthen this trend. Emissions in 2020 will be at around the same level as in 2007 or a little higher, despite continued significant traffic growth.

The following figure shows the link between traffic growth and $CO_2$ emissions domestically during the period 1990 to 2020.

**DOMESTIC AIR TRAVEL AND $CO_2$ EMISSIONS 1990–2020**

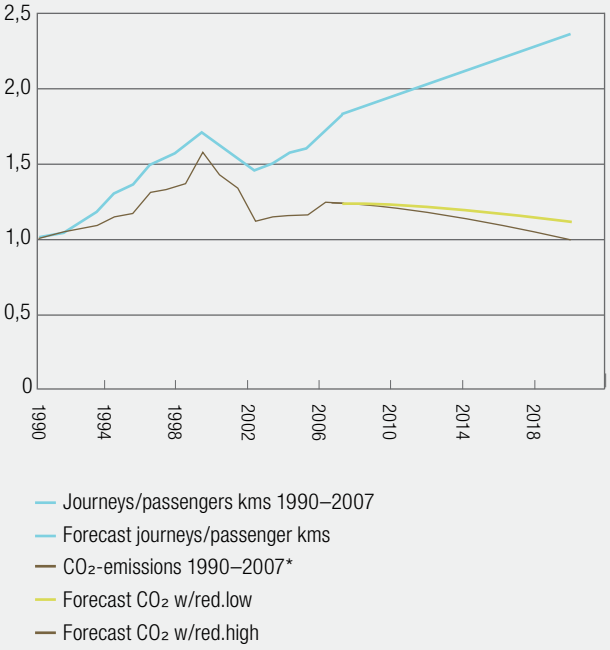



**Figure 8:** Illustration of expected trend in domestic traffic growth for flights/passenger-kilometres, and greenhouse gas emissions with and without initiatives being taken 2007–2020 (indexed).

*Assuming unaltered distance per journey

Figure 8 indicates that the industry's environmental performance is improved in the domestic market during the period up to 2020 viewed in relation to the historical trend. Because the growth in domestic air traffic is expected to be less than for international traffic, the initiatives taken by the industry will lead to emissions being 10 %–22 % lower in 2020 than in 2007.



[31] The figure only shows the historical trend in the number of journeys because no historical data exists for passenger-kilometres. The forecast for increases in passenger-kilometres is stronger than for journeys.

# 6. DEVELOPMENT OF SOCIAL ROLE AND IMPROVEMENT IN ENVIRONMENTAL PERFORMANCE

The TØI report[32] documents the fact that Norway is completely dependent on a well functioning air transportation system to maintain settlement and employment opportunities and to ensure good contact with the outside world for the population and for trade and industry. This need will become even stronger in future years.

Strong policy instruments will be needed if growth should ever come to an end. The social consequences would be immense in that case. A few examples would be:

- If financial policy instruments are chosen, such as a considerable increase in fees, this would impact on airfares, causing social redistribution among consumers and disadvantages for trade and industry and for the population in the peripheral regions of Norway.
- In principle, there are no alternative means of transportation other than air. A lack of supply will therefore weaken mobility within the Norwegian society.
- Restrictive measures may contribute to an annual reduction in revenue from air-tourism of NOK 15 billion.
- The competitiveness of trade and industry in an increasingly globalised market will be negatively affected.

On the other hand, the consequences of climate change form the most important challenge, globally and for Norway. Aviation therefore has to bear responsibility for reducing its impact on climate. This must be accomplished by the industry covering the costs of the environmental disadvantages that are being inflicted upon society (the 'polluter pays' principle) and by implementing initiatives to reduce emissions. With this project, the industry has outlined tangible initiatives that will make considerable improvements to the industry's environmental performance. The most important initiatives have already been developed and adopted, and decisions will be made on implementing the rest once the technology becomes available.

The objective of the Norwegian Climate Policy is to ensure that emissions from the transport sector in Norway should not increase by more than 1 %–12 % in 2020 relative to 2007[33]. With the initiatives the industry is outlining in this report, the emissions from domestic aviation will be 10 %–22 % lower in 2020 than they were in 2007. In other words, the industry is moving further with the initiatives it is taking than is being planned for the transport sector.

Through this project, the industry has made it clear that the disparity between growth in air traffic and the climate challenge has been greatly reduced. This should allow industry to develop its role in society, while at the same time also making a positive contribution to fulfilling general political objectives concerning the need for the transport sector to be more environmentally responsible.



[32] Lian et al (2007) Bærekraftig og samfunnsnyttig luftfart [Aviation – sustainability and social benefit]. TØI Report 921/2007

[33] Report no. 34 (2006–2007) to the Storting on Norwegian Climate Policy, as it is referenced in Section 7.3 in the transport departments and Avinor's Proposal for a National Transport Plan 2010–2019. (There may be some uncertainty linked to the assumptions on which the Report to the Storting's reference projection is based. The transport sector has therefore asked for a clarification.)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