Climate Change and Tourism

Responding to Global Challenges

UNWTO, 6 June 2008
(draft)

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Foreword

The Second International Conference on Climate Change and Tourism (Davos, Switzerland, October 2007) was a milestone event that brought together a wide variety of stakeholders and delivered a clear commitment for action to respond to the climate change challenge. It underscored the need for the tourism sector to rapidly respond to climate change if it is to develop in a sustainable manner, which will require actions to: mitigate greenhouse gas emissions from the tourism sector, derived especially from transport and accommodation activities; adapt tourism businesses and destinations to changing climate conditions; apply existing and new technologies to improve energy efficiency; and secure financial resources to assist regions and countries in need.

The Davos Declaration highlighting these actions is a huge step forward and presents concrete recommendations to the key interest groups involved in tourism. This is indeed necessary, considering that tourism is today one of the world's largest economic sectors, and represents an activity that forms an integral part of modern societies in both developed and developing countries. It is, above all, a vital element in poverty reduction efforts and for the achievement of the UN Millennium Development Goals.

In the context of the Davos meeting, the report "Climate Change and Tourism: Responding to Global Challenges", which was commissioned to a group of prominent researchers, encompasses the status of knowledge on the complex relationship between climate change and tourism. The publication notes the vulnerability of the sector to climate change and the impacts of tourism on climate itself. The report provides an excellent basis to address the global phenomenon of climate change, as well as to develop practical tools that can be used by tourism policy-makers and managers to foster the sustainable growth of the industry. The impacts and opportunities pertinent to the tourism sector are also underlined in the 2007 reports of the Intergovernmental Panel on Climate Change and the Global Environment Outlook.

The Davos Conference and the London Ministerial meeting held in November 2007, together with the release of this report, are an integral part of the common UN system effort to develop a climate change response framework, and constituted the tourism input at the UN Climate Summit held in Bali in December 2007. This process is possible thanks to the close collaboration between the World Tourism Organization, the United Nations Environment Programme and the World Meteorological Organization, and we are confident that it will contribute to the establishment of an effective and comprehensive climate change framework for the post-2012 period. The three agencies have joined forces with the aim of ensuring an effective response to the challenges ahead, in the true spirit of the 'Delivering as one' message of the UN family.

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Introduction

This publication reflects the importance attached by the tourism sector to the impacts of climate change and contains valuable scientific and technical information. It also constitutes an important input in the ongoing commitment of the United Nations to respond to the challenge of climate change.

The publication contains two distinct parts:

The first, entitled "The International Debate" collects the main results of a series of events focused on climate change and tourism, which took place in the second half of 2007. The participants at the Davos International Conference (1-3 October 2007) adopted a Declaration, which represents the position of a wide spectrum of tourism stakeholders from the public and the private sector. The Davos Declaration acknowledges the urgency to further assess the impacts deriving from the relation between tourism and climate change and sets out directions for common actions from the tourism sector. At the Ministerial Summit held in London on 13 November 2007 and at the UNWTO General Assembly (Cartagena de Indias, Colombia, 23-29 November 2007) the Davos Declaration was extensively reviewed, and a number of important considerations, which complement and further elaborate on its content, were discussed and adopted.

The London Conclusions and the Resolution adopted by UNWTO Member States in Colombia reflect the consensus reached in these forums and reiterate some key messages: climate change should be addressed without losing sight of other priorities, especially poverty alleviation and tourism contribution to the Millennium Development Goals; there should be no discrimination against developing countries by creating obstacles to their economic development; financial resources should be secured for those especially vulnerable to climate change; a disproportionate burden should not be imposed on the tourism sector; and initiatives to address climate change in the tourism sector should be integrated within the existing UN framework.

The second part is a technical report, which analyzes in detail the relations between tourism and climate change, the impact of climate change at destinations, the adaptation options and strategies and the implications for tourism demand patterns. The report contains as well the first detailed assessment ever made of greenhouse gas emissions from tourism related activities, together with an analysis of mitigation policies and measures.

This study was committed by UNWTO, in cooperation with the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO), to a team of prominent experts, with reviews by relevant staff of the three international organizations as well as by other external reviewers. UNWTO elaborated a set of tourism statistical data to be used for the calculation of greenhouse gas emissions while the expert's team took responsibility for the scientific aspects of the technical study relating to climate change, which are based on the broader research carried out by the Intergovernmental Panel on Climate Change (IPCC). The Annexes contain a detailed description on methodology and terminology used for these calculations. A summary of the preliminary findings of this report was presented at the Davos Conference, and it is included as the executive summary of this report.

We wish to thank all those who have contributed to this important work.

Luigi Cabrini

Director, Sustainable Development of Tourism
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Chapter 11

Emissions from Tourism: Status and Trends

This Chapter is the first attempt to estimate CO_2 emissions from both international and domestic tourism and thus the contribution of tourism to human-induced climate change. The Chapter provides an overview of CO_2 emissions and radiative forcing for 2005 and a 'business-as-usual' scenario for 2035, using an approach specifying different tourism activities (transport, accommodation, and other activities *). The goal is to provide a first baseline for the discussion on tourism's contribution to climate change, as well as the identification of strategies to reduce emissions from this sector (see Chapter 12).

The reported amount of CO_2 emissions attributed to tourism varies considerably, depending on, among others, the definition of what constitutes 'tourism'. The share of radiative forcing caused by tourism activities varies even more depending on the greenhouse gases included apart from CO_2 emissions. According to UNWTO's definition, 'tourism' refers to "[…] the activities of persons travelling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited", thus including international and domestic tourism, overnight and same-day trips, for all purposes of visit (leisure, business, and other). For the purpose of tourism statistics and in conformity with the Basic References on Tourism Statistics [625], visitors (international and domestic ones) are classified as a) tourists (overnight visitors) and b) same-day visitors.

Existing data on tourism demand (international and domestic) present several constraints for emission inventories. For that reason, UNWTO prepared for the purpose of this report a specific set of tables with approximations of consistent worldwide tourism volumes for the baseline year of 2005 based on the various indicators in its own database and on air transport data from ICAO and IATA. These tables contain a mix of hard data, estimations – missing data are extrapolated or derived from similar countries – and approximations – where only little data are available (see Annex 1).

Global warming is often expressed as a change in average surface temperatures, resulting from changes in the planetary radiative balance, and determined by the concentration of greenhouse gases in the atmosphere (Chapter 8). In this Chapter, the contribution of tourism to global warming is assessed using two metrics: CO_2 emissions and radiative forcing (RF). While CO_2 is the most important greenhouse gas from human activities, other greenhouse gases also make significant contributions to global warming. This is particularly relevant for the impacts of aviation, which, at cruise altitude, has an additional impact on global warming (see Box 23). For most non-carbon greenhouse gases it is possible to calculate a carbon dioxide equivalent, i.e., a factor that allows for comparison of the warming caused by CO_2 and non-CO_2 greenhouse gases. This is not possible for aviation, as most additional emissions are not well-mixed in the global atmosphere nor long-lived. [626, 627] For this reason, radiative forcing is used for the purposes of this report as the second metric to calculate aviation's contribution to global warming. Radiative forcing measures the extent to which emissions of greenhouse gases raise global average temperatures (see Box 23). CO_2 emissions and RF are estimated for the year 2005 (see Section 11.1). Based on projections of tourism growth, the results are then used to build a 'business-as-usual' emission scenario for the year 2035 (see Section 11.3). Supporting methodological information can be found in detail in Annexes 1 and 2.

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* From the perspective of the tourist and many tourism researchers, tourism is divided into transport, accommodation and activities. From a business perspective all tourism related activities are determined as 'activities', thus including transport and accommodations. Therefore we designated all those activities that do not comprise the return transport to the destination nor accommodation 'other activities', including local transport, all local leisure activities, business activities (meetings, conferences), visits to restaurants, bars, cafes, excursions in the destination region, etc.

Box 23 Understanding the contribution of aviation to climate change

Carbon dioxide is the most important greenhouse gas (GHG), accounting for 77% of global anthropogenic warming [628], but is not the only GHG contributing to anthropogenic climate change. [629] The warming caused by GHG emissions other than CO_2 is usually expressed in CO_2 equivalents to allow for comparison of the contribution of various GHG emissions, measured over a period of 100 years. This implies that CO_2-equivalents can only be calculated for GHG with a lifetime of more than ten years. [630] Consequently, the comparison of emissions from aviation – including nitrogen oxides forming ozone and methane as well as water vapour forming contrails (the white condensation bands often visible behind aircraft) and cirrus clouds – is difficult, as these emissions are short-lived and not well mixed in the atmosphere. An alternative parameter to assess the contribution of aviation to climate change is the radiative forcing index (RFI) [631], which is the ratio of all radiative forcing caused by aviation since 1945 and the radiative forcing caused by CO_2 emissions from aviation over the same period. The RFI can however only be applied to calculate accumulated radiative forcing, and not for emissions occurring in any single year. In 2000, the radiative forcing caused by non-carbon emissions from aviation was estimated to be almost equal to the accumulated warming effect of all aviation-related CO_2 emissions since 1945, i.e., corresponding to an RFI of 1.9. [632] However, there is considerable uncertainty regarding the impact of contrail-induced cirrus clouds, and 1.9 may be seen as the confirmed minimum, with a possible RFI of up to 5.1. Note that the RFI is not a constant, as it develops over time as a function of the growth rate of aviation-related CO_2 emissions in comparison to the overall RF – i.e., the development of emissions in other sectors. The future RF is thus dependent upon the development of aviation as well as development in other sectors. A RFI can thus not be used as an 'uplift' factor for CO_2 emissions.

11.1 Current CO_2 Emissions and Radiative Forcing from Tourism

11.1.1 Introduction: Global Tourism Demand

The tourism industry uses energy in several activities – for transport to and from, as well as within the destination, in accommodation establishments and in a range of other tourism activities, the latter including for the purpose of this report local transport within the destination. Most energy use in tourism, as in many other economic sectors, is based on fossil fuels, with only a fraction of energy being generated through renewable energy sources. Calculations of the contribution of tourism to climate change have so far focused mainly on international tourism due to limited availability of comprehensive data on domestic and same-day tourism demand. For the purpose of this publication, UNWTO prepared an approximation of domestic tourism based on the limited data available in order to include this in the calculation of emissions.

Tourism demand (overnight and same-day; international and domestic) is estimated to have accounted for about 9.8 billion arrivals in 2005. Of these, 5 billion arrivals are estimated to be from same-day visitors (4 billion domestic and 1 billion international) and 4.8 billion from arrivals of visitors staying overnight (tourists) (4 billion domestic and 800 million international). Taking into account that an international trip can generate arrivals in more than one destination country, the number of trips is somewhat lower than the number of arrivals. For 2005 the global number of international tourist trips (i.e., trips by overnight visitors) is estimated at 750 million. This corresponds to 16% of the total number of tourist trips, while domestic trips represent the large majority (84% or 4 billion).

Table 11.1 presents an overview of the worldwide approximate numbers of arrivals and trips (both same-day and overnight) for international and domestic tourism broken down by transport mode. Data in the table show that the share of trips using air transport is relatively small (17% of tourist trips, 1%

of same-day trips) as compared to the total volume of trips, exception made for interregional travel – i.e., between Europe, the Americas, Asia and the Pacific, Africa and the Middle East – where air travel accounts for 92% of all tourist trips. Nonetheless, it is important to note that globally, these long-haul interregional trips account for no more than 3% of all tourist trips (130 million vs. 4.75 billion trips).

Table 11.1 Approximate tourism volumes, 2005 [a]

(billions)	**Total**	**of which:**		**of which:**	
		Domestic	**International**	**Intraregional**	**Interregional**
Total trips	9.75	8.00	1.75		
Same-day	5.0	4.00	1.00	1.00	0.00
over land/water	5.0	4.00	0.99	0.99	
by air	0.05	0.04	0.01	0.01	
by air (%)	1	1	1	1	
Tourist					
Arrivals	4.80	4.00	0.80	0.65	0.15
Trips[b]	4.75	4.00	0.75	0.61	0.13
over land/water	3.93	3.52	0.41	0.40	0.01
by air	0.82	0.48	0.34	0.22	0.12
by air (%)	17	12	46	35	92

[a] Green: estimated volumes based on UNWTO country data or other sources; yellow: approximate volumes (as only little data are available);

[b] Trip volumes are derived from available arrivals data as one trip can produce more than one arrival (see Annex 1).

Source: UNWTO 2007c (see Annex 1)

11.1.2 Transport Emissions

It is a complex task to determine CO_2 emissions from tourism transport world wide. For air transport at least figures on overall traffic are available, such as the estimated number of trips (860 million) and the number of passenger kilometers (4 trillion). However, assumptions have to be made in order to reasonably subdivide this into the various categories of trips (same-day and overnight, domestic, intraregional, interregional) and regions. Surface transport is quite more complicated as only very scarce data are available on distances travelled for tourism purposes.

Several attempts have been made to analyse tourism transport and its contribution to emissions in individual nations or regions.[633, 634, 635, 636] These studies indicate, for instance, that for all citizens of the then EU25 plus Norway and Switzerland, emissions of CO_2 for domestic and international tourism (by car, train, coach and air) amount to 250 million t CO_2.[637] It also indicates that 55% of tourism transport emissions by Europeans are caused by the 20% of trips based on air transport (see Box 24). Transport volumes are forecasted to grow by 122% between 2000 and 2020. while the number of trips is forecasted to increase by 57%, thus mirroring a considerable increase in average trip length. Consequently, CO_2-emissions from tourism transport in Europe are expected to increase by 85% between 2000 and 2020. Detailed data are also available for tourism by the French (*Suivi de la Demande Touristique*[*], a regular survey of 20.000 citizens). Analyses of the data show that passengers arriving by air account for only 11% of all tourist nights, but represent 46% of all tourist transport emissions.

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[*] See http://www.tns-sofres.com/sofres/secteurs/sesame/souscription-suivi-demande-touristique.php for general information and http://www.tourisme.gouv.fr/fr/z2/stat/memento/memento_2007.jsp for detailed data (chapter 5 for France).

A common challenge faced by previous analyses of CO_2 emissions has been data limitations. An ideal data set would include information on the origin and destination of tourists, the routing, transport mode and operational factors, such as occupancy rates (load factors), as well as information on engine types. No such systematic information exists for worldwide tourism, and the following analysis is thus based on multiple data sets, including the set of tables and approximations of consistent worldwide tourism volumes developed by UNWTO for this report (see Annex 1).

One procedure for measuring CO_2 emissions is to multiply average emissions per passenger kilometre (pkm) with travel distances. CO_2 emissions per pkm vary substantially among different transport modes. Table 11.2 provides emission factors for transport in the EU, showing that:

- coach and rail have the lowest factor, 0.022 kg CO_2/pkm and 0.027 kg CO_2/pkm, respectively; the difference between coach and rail is mainly caused by occupancy rates (see Table 11.2); in terms of per seat kilometre emissions, rail is much lower (0.016 kg/skm) than coach (0.020 kg/skm);
- in the mid-range, are emissions from cars (0.133 kg CO_2/pkm) and from flights of 1,000 or more km (0.130 kg CO_2/pkm);
- flights of less than 500 km have the highest emission factors (0.206 kg CO_2/pkm), as take offs and climb-outs consume disproportionately high amounts of fuel.

The following Sections provide a discussion of global tourism emissions from air and ground transport, as well as estimates of the total transport emissions from international and domestic tourism.

Table 11.2 Emission factors for tourism transport modes in the EU context

Mode	CO_2 factor (kg/pkm)	Occupancy rate/load factor (%)
Air < 500 km	0.206	
500-1,000 km	0.154	
1,000-1,500 km	0.130	
1,500-2,000 km	0.121	
> 2,000 km	0.111	
Air world average [(a)]	0.129	75
Rail	0.027	60
Car	0.133	50
Coach	0.022	90

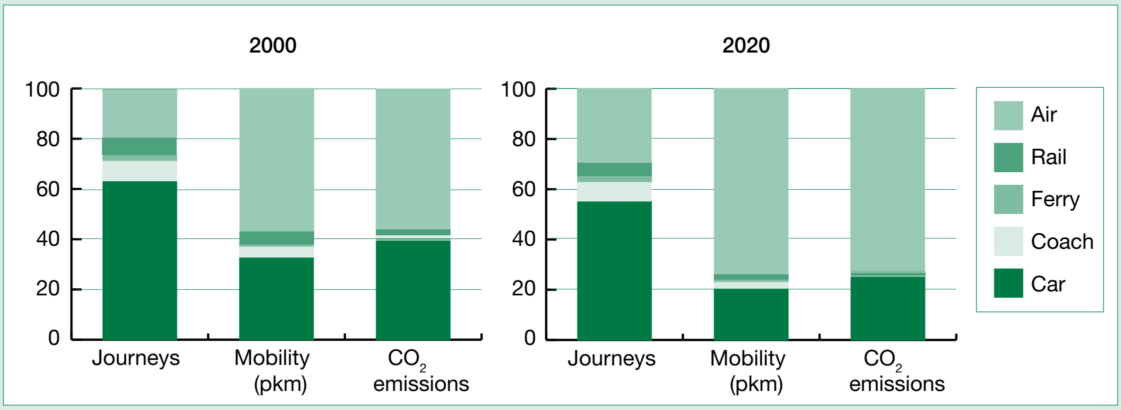
(a) This value is calculated in Section 11.1.2.1.

Source: Peeters, P. et al. (2007b)

Box 24 CO_2 emissions from European Union tourism transport

While there is no comprehensive analysis of global emissions from tourism transport, a detailed EU study [639, 640] has provided some insight into the importance of emissions from different tourism transport modes and market segments. Several tourism data sets were combined to develop a comprehensive origin-destination table for five transport modes and including international (i.e., intercontinental) and domestic tourism from and within the then 25 member states of the EU plus Switzerland and Norway. Based on the number of trips and the average trip distances between origin/destination for the various transport modes, total distances travelled as well as emissions of CO_2 and other pollutants were calculated. In 2000, most trips were made by car, while air travel represented the major share of passenger kilometres travelled as well as the largest source of CO_2 emissions (Figure 11.1). As a consequence, air transport, though accounting for 20% of all trips, causes 55% of all CO_2 emissions and an even higher share of radiative forcing. The projected increase in the share of trips and passenger kilometres means that the proportion of CO_2 emissions from air transport is expected to increase to approximately 72% in 2020, while the share of trips by air will rise to 29%. With the increased RF of aviation emissions at high altitude taken into account, the relative contribution of air travel to global warming in this analysis would actually be much higher.

Figure 11.1 Trips, mobility and CO_2 emissions of all tourism trips by EU25 citizens (including domestic, intra-EU25 plus Switzerland and Norway, and intercontinental) in 2000 and a forecast for 2020 (%)



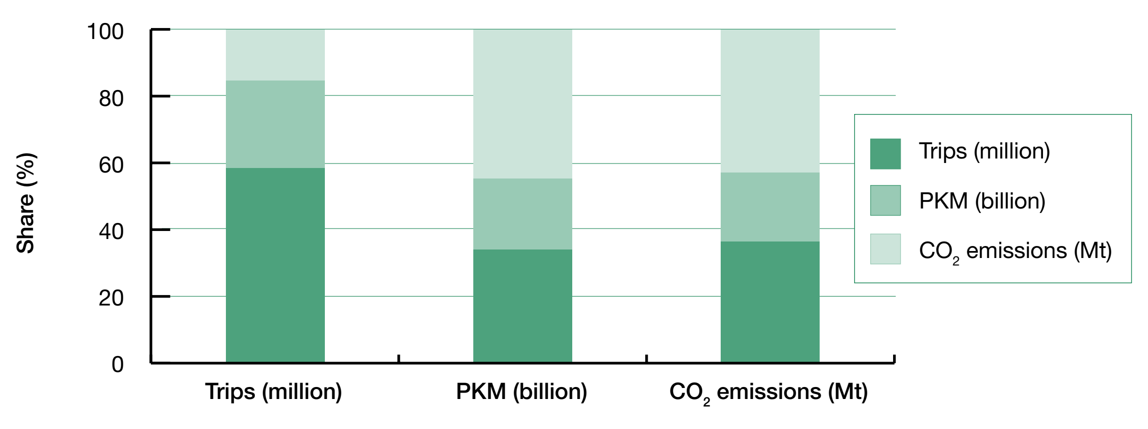
Source : Peeters, P. et al. (2004).

11.1.2.1 Aviation

The tourism share of aviation-related CO_2 emissions can be estimated from the well documented contribution of commercial aviation, which includes all passenger traffic and freight transport. Emissions from all commercial aviation are estimated to be in the order of 640 Mt CO_2 in 2005 [641], with a share of tourism-related emissions of 80.5% (see Annex 2.2.2). Consequently, the tourism-related share of aviation emissions is 515 Mt CO_2. Given global distances of about 3,980 billion pkm travelled by air (i.e., the total distances covered by air transport as shown in Table 11.3), a global emission factor for passenger transport can be derived, which is 0.129 kg CO_2 per pkm.

Figure 11.2 shows the estimated distribution of air transport regarding the number of trips, transport volume (in billion pkm) and CO_2 emissions. The most important finding is eventually that though international tourist trips by air (intra- and interregional) stand for about 45% of all international tourist trips (see Table 11.1), they represent 87% (321 Mt CO_2) of emissions of international tourist trips (371 Mt CO_2 – see Table 11.3).

Figure 11.2 Tourist air transport: trips, passengers and CO_2 emissions, 2005



Radiative forcing by aviation

Emissions caused by aviation at flight altitude cause an additional warming effect. This effect may be 2–5 times the radiative forcing caused by CO_2 (see Box 23), and it is therefore important to make a distinction between CO_2 emissions and the total contribution of aviation to radiative forcing (RF).

The radiative forcing caused by aviation is estimated to have contributed 0.053 W/m^2 (excluding the impact of contrail-induced cirrus clouds) [642, 643] to the total human-induced radiative forcing of 1.6 W/m^2. [644] Aviation transport thus contributes 3.3% to global radiative forcing, not considering contrail-induced cirrus clouds (note that the IPCC assumes a range of 2–8% as aviation's contribution to global RF; see also Box 23). The share of tourism travel in global aviation is estimated to be of 73% (for calculations see Annex 2.2.2), and the corresponding RF for tourism related air transport would thus be 0.039 W/m^2 or 2.5% (excluding cirrus) and up to 6.1% if the maximum estimate for cirrus-related radiative forcing is considered.

11.1.2.2 Road and rail

The most important land-based tourism transport mode in industrialized countries is the car. [645, 646] Other transport modes, such as rail and coach, as well as water transport are less important in terms of global passenger volumes, and even less so with respect to CO_2 emissions, due to their relatively high energy efficiency.

The CO_2 emissions from rail, coach and water-borne transport are more difficult to calculate because data on the number and length of trips are more scattered and only available for a limited number of countries. In this analysis, global emissions from international and domestic tourism are calculated for each surface-based mode of transport by multiplying an estimated average distance travelled per trip by the total number of trips and the emission factor per pkm (emission factors can be found in Table 11.2; see Annex 2.2.1 for further details). To facilitate calculations, an average emission factor for coach and rail (0.025 kg/pkm) was used. Further assumptions were made regarding average trip distances and the modal split between car and other transport modes (including coach and rail; see Annex 2.2.1). The results show that all tourism transport other than aviation, are estimated to have caused emissions of **465 Mt CO_2,** the bulk of this, 420 Mt $CO_{2,}$ is estimated to be attributable to travel by car– Table 11.3).

Of all emissions by surface traffic, 122 Mt CO_2 corresponds to the 5 billion same-day trips (of which 4 billion are estimated to be domestic and 1 billion international, see Table 11.1). The 3.5 billion domestic tourist trips (surface transport) account for 293 Mt CO_2 and the 410 million international tourist trips (surface transport) to 49.5 Mt.

11.1.2.3 Overview of all transport emissions

Table 11.3 summarizes the CO_2 emissions from international and domestic tourism transport. Total CO_2 emissions from tourism transport are estimated to be in the order of **982 Mt CO_2,** 52% of these is estimated to be caused by air travel (515 Mt CO_2), 43% by car (420 Mt CO_2), and 5% by other means of transport – coach, rail and water borne – (45 Mt CO_2). Simultaneously, from the 982 Mt CO_2 emissions, 86% originate from tourist trips (i.e., from overnights visitors) and the remaining 14% from same-day tourists. Within emissions generated by tourists (850 Mt CO_2), 56% comes from domestic tourist trips and the other 44% from international tourist trips. Nonetheless, it is important to stress that emissions per trip vary substantially. While 4 billion domestic tourist trips generate 479 Mt CO_2 emissions (120 kg per trip), 750 million international tourist trips are responsible for almost the same level of emissions (371 Mt CO_2 or 494 kg per trip).

Table 11.3 Overview of estimated number of trips, distances and CO_2 emissions from tourism related transport, 2005

	Total	Same-day visitors (domestic and international)	Tourist trips (overnight)			
			Domestic	International		
				Total	Intraregional	Interregional
All tourism						
Total number of trips (million)	**9,750**	5,000	4,000	750	615	135
Passenger kilometres (billion)	**9,147**	1,237	4,832	3,077	1,313	1,763
Average return distance (km)	**938**	247	1,208	4,102	2,135	13,063
Total CO_2 emissions (Mt)	**982**	133	479	371	153	218
CO_2 kg per km	**0.107**	0.107	0.099	0.121	0.116	0.124
CO_2 emissions (kg/trip)	**101**	27	120	494	248	1616
Air						
Total number of trips (million)	**870**	50	480	340	215	125
Passenger kilometres (billion)	**3,984**	60	1,340	2,585	833	1751
Average return distance (km)	**4,580**	1,200	2,791	7,602	3,875	14,012
Total CO_2 emissions (Mt)	**515**	11	185	321	104	217
CO_2 kg per km	0.129	0.177	0.138	0.124	0.125	0.124
CO_2 emissions (kg/trip)	**592**	212	385	945	484	1737
Surface						
Total number of trips (million)	**8,880**	4,950	3,520	410	400	10
Passenger kilometres (billion)	**5,162**	1,177	3,493	492	480	12
Average return distance (km)	**581**	238	992	1,200	1,200	1,200
Total CO_2 emissions (Mt)	**465**	122	294	49	49	1
CO_2 kg per km	**0.090**	0.104	0.084	0.101	0.101	0.079
CO_2 emissions (kg/trip)	**52**	25	83	121	121	95

	Total	**Same-day visitors (domestic and international)**	**Tourist trips (overnight)**			
			Domestic	**International**		
				Total	**Intraregional**	**Interregional**
of which:						
Car						
Total number of trips (million)	**5,956**	3,641	2,028	287	282	5
Passenger kilometres (billion)	**3,354**	892	2,117	344	338	6
Average return distance (km)	**563**	245	1,044	1,200	1,200	1,200
Total CO_2 emissions (Mt)	**420**	115	259	46	45,0	0.8
CO_2 kg per km	**0.125**	0.129	0.122	0.133	0.133	0.133
CO_2 emissions (kg/trip)	**71**	32	128	160	160	160
Other (train, coach, ship, etc.)						
Total number of trips (million)	**2,924**	1,309	1,492	123	118	5
Passenger kilometres (billion)	**1,809**	285	1,376	148	142	6
Average return distance (km)	**619**	218	922	1,200	1,200	1,200
Total CO_2 emissions (Mt)	**45**	7	34	4	4	0.2
CO_2 kg per km	**0.025**	0.025	0.025	0.025	0.025	0.025
CO_2 emissions (kg/trip)	**15**	5	23	30	30	30

Sources: Approximations by UNWTO based on UNWTO, ICAO and IATA (see Annex 1), and estimated emissions, surface transport modal split and average distances by the expert team (see Annex 2).

As seen, the modal split of trips and emissions varies substantially between international and domestic tourism, as well as regarding transport modes. Figure 11.3 illustrates the dominance of domestic trips in all transport modes. Figure 11.5 shows the split of CO_2 emissions between domestic and international travel by transport mode. In international tourist trips, air travel causes 87% of CO_2 emissions (321 Mt CO_2), while in domestic tourism the car is the most important contributor to emissions, accounting for 54% (259 Mt CO_2). With regard to radiative forcing (Figure 11.6), air travel is the major contributor both domestically and internationally. It causes approximately 67% of the overall contribution of tourist transports to climate change. Note that 'other transport' is used in an estimated 1.6 billion tourist trips, i.e., more than one third of all trips, but causing just 3% of the radiative forcing.

Figure 11.3 World tourism transport volume by mode of transport, 2005

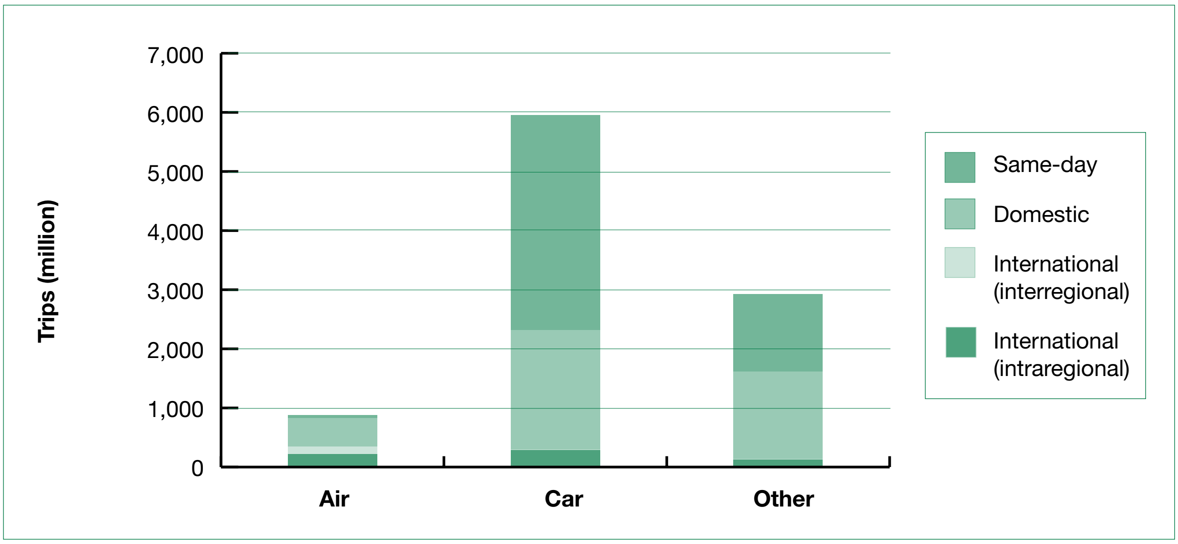


Figure 11.4 World tourism passenger kilometer volume by mode of transport, 2005

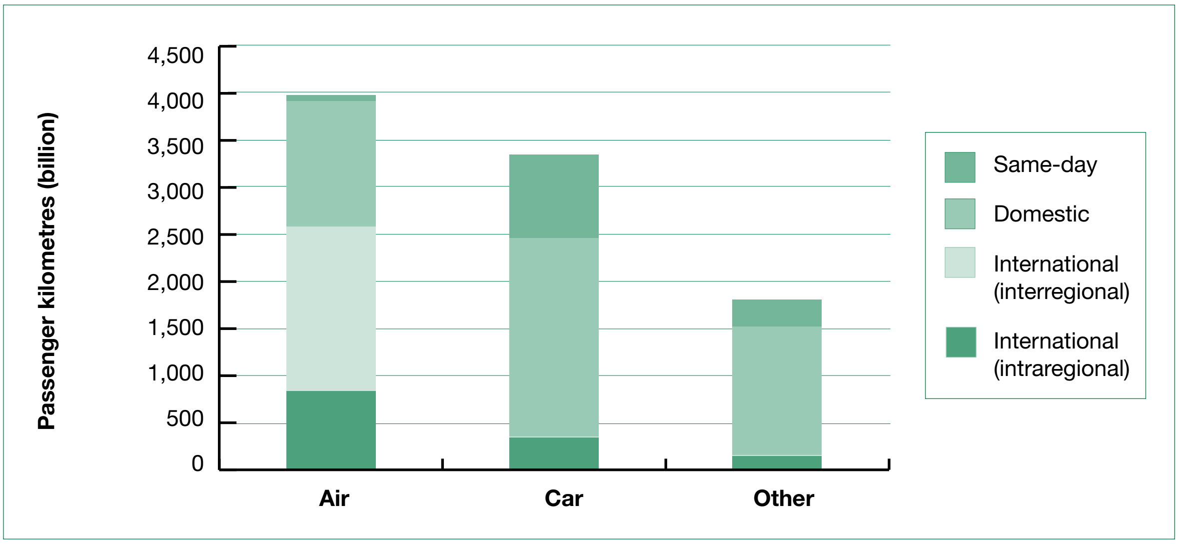


Figure 11.5 CO_2 emissions by tourism transport, 2005

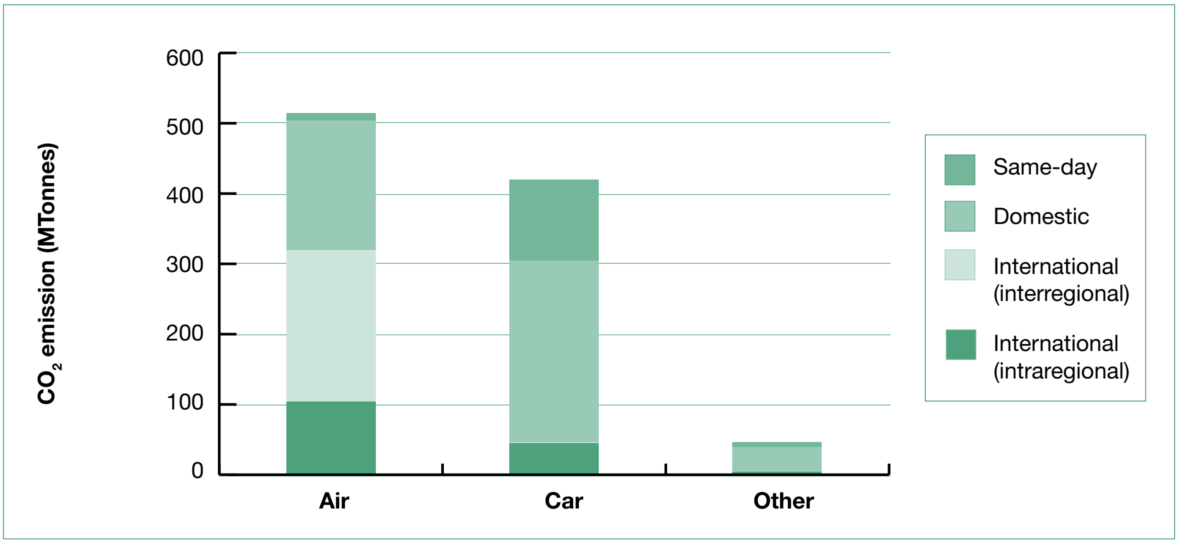
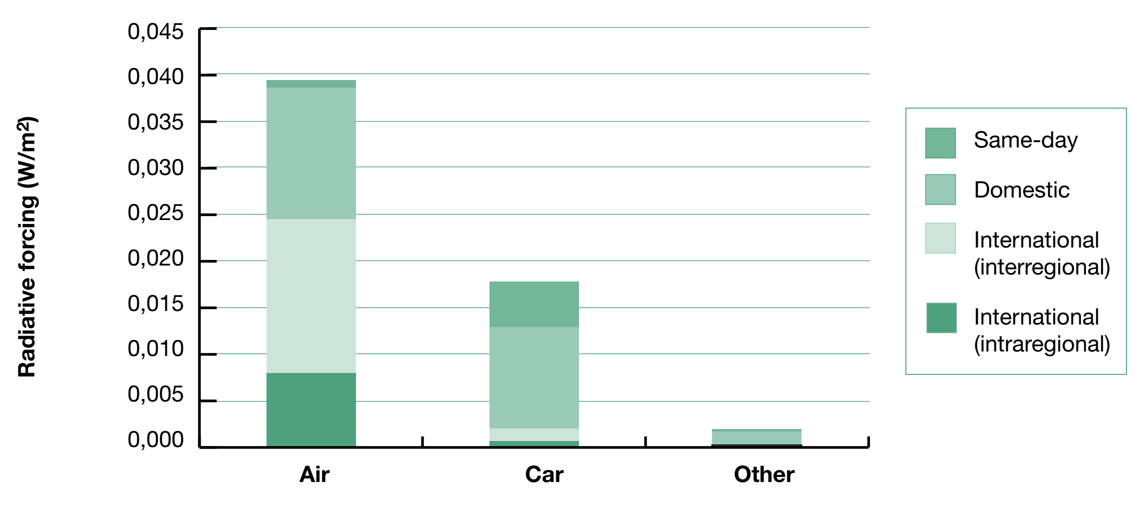


Figure 11.6 Radiative forcing by tourism transport (excluding impacts of cirrus), 2005



11.1.3 Accommodation

Internationally, more than 80 different accommodation categories can be identified, including hotels, hostels, motels, pensions, bed and breakfast, self-catering accommodation, bungalows, vacation homes, holiday villages, campsites and farms, to give just some examples. Energy use in the different types of accommodation includes heating/cooling, cooking, illumination, cleaning, and, in tropical or arid regions, the desalination of seawater. Average energy use has been found to vary substantially by type of accommodation (Table 11.4).

Table 11.4 Average energy use by type of accommodation[647]

Type of accommodation	Energy use per guest night (MJ)	Emissions per guest night (kg CO_2)
Hotels	130	20.6
Campsites	50	7.9
Pensions	25	4.0
Self-catering	120	19.0
Holiday villages	90	14.3
Vacation homes	100	15.9
Estimated average	**98**	**15.6**

The calculation of emissions from accommodation can be achieved by multiplying the number of tourists by length of stay and an emission factor (CO_2 per guest night). The total number of international guest nights is estimated by UNWTO to be in the order of 6.1 billion. For domestic tourism, the total number of guest nights is estimated at 13.7 billion. While an average of 19 kg CO_2 per international guest nights is estimated, the emissions for domestic tourism are assumed to be at 11.5 kg CO_2 per guest night, because of lower emission levels in accommodation used by domestic tourist in developing countries (see Annex 2.2.3). Total CO_2 emissions associated with accommodation are estimated at **274 Mt** (see Table 11.5).

Table 11.5 Overview of estimated number of trips, guest nights and CO_2 emissions from tourism accommodation, 2005

	Total	Domestic	International
Tourist trips (overnight)	**bn**		
total	**4,7**	4,0	0.75
in hotel and similar (H & S)	**1,7**	1,3	0.37
other CE & private	**3,0**	2,7	0.37
tourists in H & S (%)	**36**	33	50
Guest-nights	**bn**		
total	**19,8**	13,7	6,1
in hotel	**5,9**	3,8	2,2
other CE & private	**13,9**	9,9	4,0
Room-nights in H & S	**bn**		
total	**3,9**	2,5	1,4
avrg person per room	**1,5**	1,5	1,5
Average nights	**nights**		
total	**4,2**	3,4	8,2
in hotel	**3,5**	2,8	5,8
other CE & private	**4,6**	3,7	10.6
CO_2 emissions			
total CO_2 emissions (Mt)	**274**	158	117
average CO_2 per night (kg)	**13,8**	11,5	19,0
average CO_2 emissions (t/trip)	**0,058**	0,039	0,156

a) H & S: hotel and similar establishments

b) CE: collective establishments, except for hotel and similar, this includes campsites, rented apartments, bungalows, etc.

c) Green: data estimated from UNWTO country data or from external sources; yellow: approximated data

d) Half of domestic guest nights is assumed to be from developing source markets and half from high income source markets, which are assumed to have produced 4 kg of CO_2 and 19 kg of CO_2 per guest night respectively. The term 'high income' is used for the group of countries designated by the World Bank as 'high income economies' (see http://go.worldbank.org/K2CKM78CC0).

11.1.4 Other Tourism Activities

Tourists visit attractions and participate in a wide range of activities at the destination. Emissions caused by these activities vary widely between various categories of attractions, such as museums or theme parks, outdoor-oriented activities and events (e.g., sport events or concerts) or shopping. Data on energy use and emissions caused by these tourist activities are rarely available, except for some larger attractions like theme parks or ski areas. One exception is a study of the energy use and emissions related to tourist activities in New Zealand. [648]

With no systematic international data on tourism activities being available, an average energy use of 250 MJ of energy for 'other activities' during an average international trip was estimated at about 40 kg of CO_2 emissions.[649] This calculation includes local transport. While 250 MJ may be a suitable estimate for international leisure tourists, shorter and less activity-oriented business trips are likely to be less energy-intense, and are here assumed to be one fifth of this value (50 MJ per trip). For visit friends and relatives (VFR) tourism, a value of 100 MJ per trip is assumed, as less energy-intense, family-related activities will be the focus of this segment. The breakdown of travel purposes for international tourism was based on UNWTO [650] with 50% arrivals estimated in 2004 for leisure purposes, 26% for VFR, health, religion and other and 16% for business. The weighted average energy consumption for tourist activities is thus estimated to be 170 MJ per trip, corresponding to emissions of 27 kg of CO_2 per trip. These numbers are valid for international tourists. For domestic tourists in high income economies the international per day emissions have been multiplied with the average length of stay to calculate the per trip emissions for activities. This means 11 kg per domestic trip in high income economies. For domestic tourists in developing countries we again assume the amount of energy associated with tourist activities to be one quarter of the amount consumed by tourists from high income economies and thus used 2.7 kg per trip. Extrapolated to all 4.75 billion tourist trips in 2005, emissions from tourist 'activities' are estimated to be in the order of **48 Mt CO_2.**

11.1.5 Total CO_2 Emissions and RF from Global Tourism in 2005

Table 11.6 shows the estimated contribution of tourism to global warming (including transport, accommodation and other tourism activities) in terms of CO_2 emissions as well as of radiative forcing (RF). The contribution of aviation to RF was derived from existing research. [651] For other means of transport, for accommodation, and other tourism activities, the RF was calculated proportionally to these sectors' contribution to emissions of CO_2. To do so, the authors have assumed that the growth rate of emissions from aviation has been equal to that of all other tourism sectors since 1945, as the calculation of RF is based on accumulated emissions of CO_2.

Table 11.6 Estimated emissions (a) from global tourism (including same-day visitors), 2005 (b)

	CO_2		Contribution to RF (W/m^2) (c)	
	Mt	**Share in tourism (%)**	**Excluding cirrus**	**Including maximum cirrus impact**
Air transport	515	40	0.0395	0.0979
Car	420	32	0.0176	0.01973
Other transport	45	3	0.0021	0.0021
Accommodation	274	21	0.0116	0.0116
Other activities	48	4	0.0020	0.0020
Total tourism	**1,302**	**100**	**0.0734**	**0.1318**
Total world (d)	**26,400**	**–**	**1.6**	**1.7 (e)**
Share of tourism in total world (%)	4.9	–	4.6	7.8

(a) Estimates include international and domestic tourist trips, as well as same-day visitors (base year 2005).

(b) Colours represent the degree of certainty with respect to the data and underlying assumptions. Green represents a degree of uncertainty of +/–10%, blue +/–25% and red +100%/–50%.

(c) The share of tourism in total radiative forcing is lower than in CO_2 emissions alone because the global CO_2 emisions account just for the year 2005, while radiative forcing gives the impact of all CO_2 emissions accumulated in the atmosphere since the industrial revolution. The contribution for aviation and tourism started to become significant only after 1945, and thus accumulated over a much shorter timespan.

(d) Annual fossil carbon dioxide emissions (including those from cement production), according to IPCC (2007a), *The Physical Science Basis.* [652]

(e) This value is higher to account for the impact of cirrus.

As shown in Table 11.6, estimates for CO_2 and RF excluding cirrus are rather good, with an error margin of up to 25%. Taking into account the respective calculation's uncertainty, this means that tourism's contribution to global CO_2 emissions is estimated to range between 3.9% and 6.0%, while the contribution for RF ranges from 3.7% to 5.4%. Including the maximum contribution of cirrus would result in a share of between 4.4% and 9.0% (see Figure 11.7).

Figure 11.7 Estimated contribution and uncertainty ranges of tourism (including same-day tourism) to global CO_2 emissions and radiative forcing, 2005

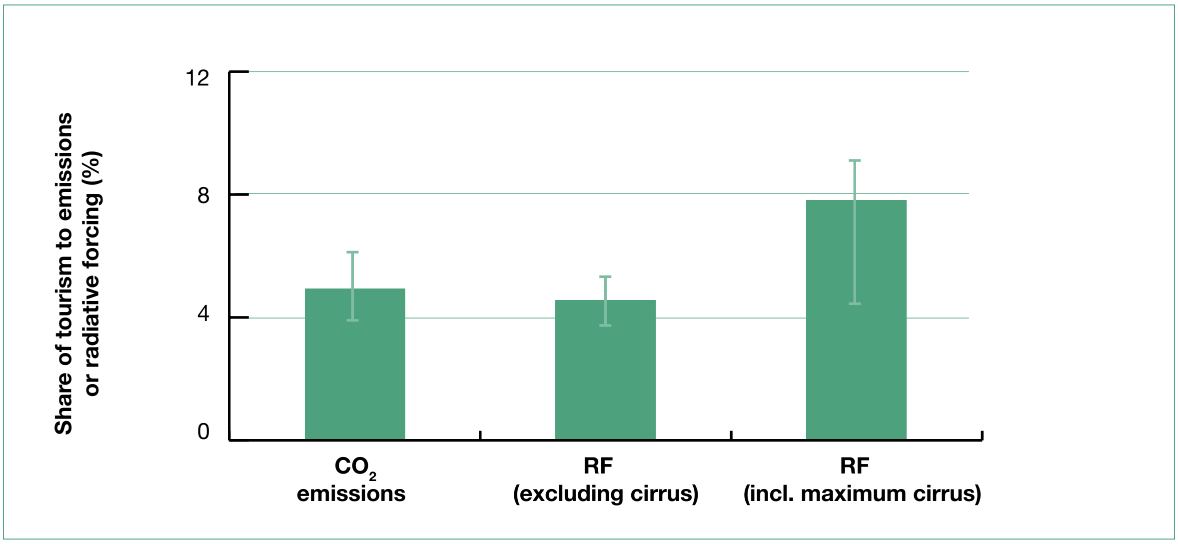


Figure 11.8 shows that tourism transport to and from the destinations accounts for 75% of all emissions of CO_2 emissions from tourism, while accommodation stands for 21% and other tourism activities for 4%. For radiative forcing, the transport share increases to 81% (excluding cirrus) and up to 90% if a maximum cirrus impact is included.

Figure 11.8 Estimated share of tourism activities to tourism CO_2 emissions and radiative forcing (including same-day visitors), 2005

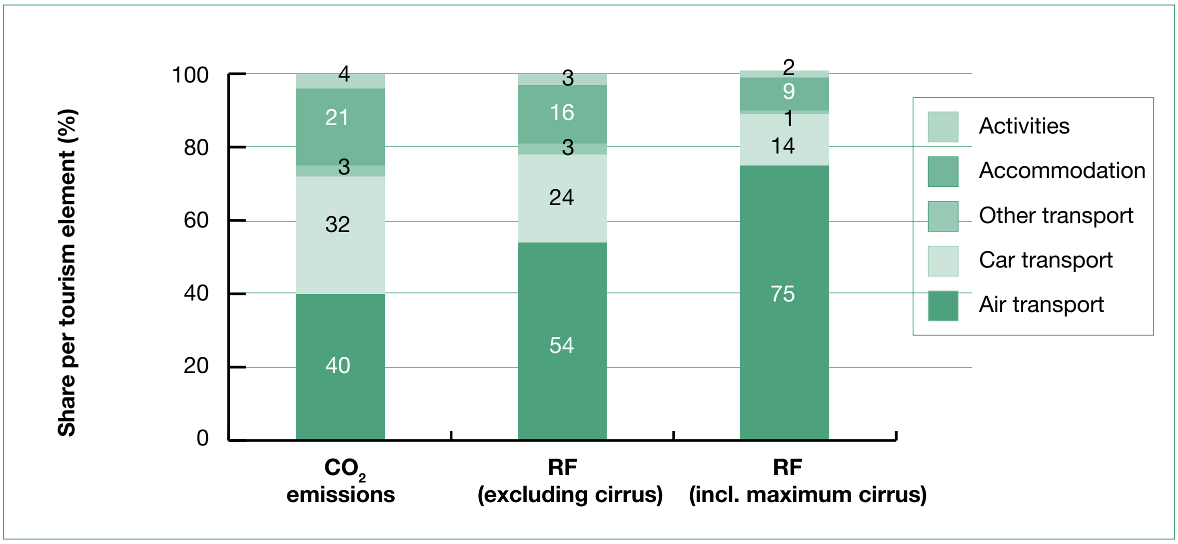


Figure 11.9 Estimated contribution of tourism activities to CO_2 emissions (including same-day visitors)

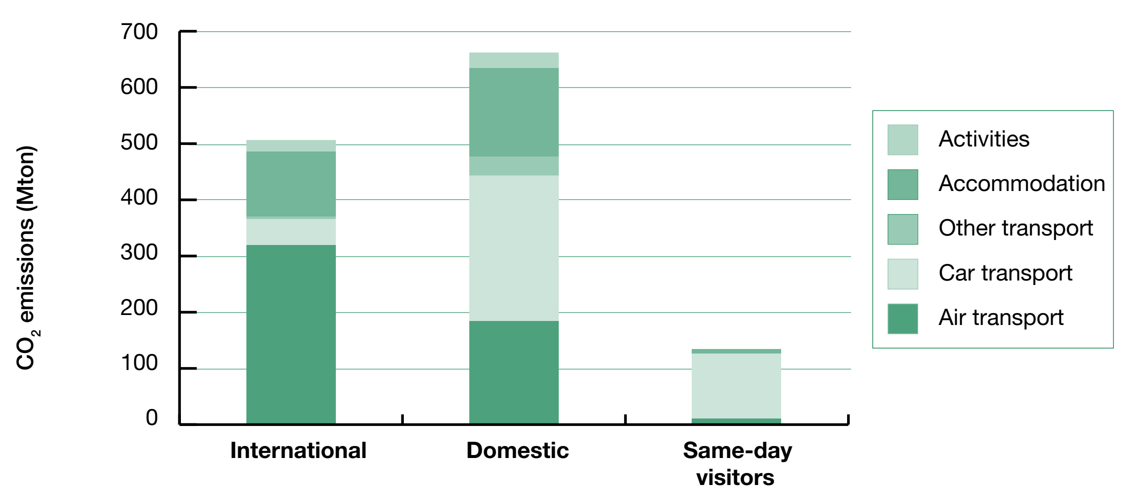


Figure 11.9 presents a breakdown of CO_2 emissions for all tourism activities and forms of tourism. Most emissions are caused by domestic tourism. However, due to the far higher number of domestic trips (4 billion vs. 750 million international), there is an important difference in per-trip emissions: these are estimated at 0.678 t CO_2 per trip for international trips, 0.258 t CO_2 per trip for domestic trips in the high-income markets, and 0.074 t CO_2 per trip for domestic trips in the developing countries (these figures include accommodation and activities and thus are larger than those given in Table 11.3).

As outlined, calculations in this report only consider energy throughput. As the construction of hotels, airports and aircraft, cars and roads all consume considerable amounts of energy, a lifecycle perspective accounting for all energy 'embedded' in tourism would be better suited to assess tourism's contribution to climate change. However, this would demand a detailed calculation of energy used for construction, and the energy embodied in the various goods, products and materials used in the various tourism activities. Another issue not considered here is indirect energy use, as tourism accounts, for instance, for considerable amounts of freight, such as transport of food and other goods for tourism. Small destinations, and in particular island destinations may import a significant part of these by ship or aircraft.

Taking into account all lifecycle and indirect energy needs related to tourism, it is expected that the sum of emissions would be higher, although there are no specific data for global tourism available.

11.1.6 CO_2 Emissions from Intra-regional and Interregional Travel

From table 11.6 it followed that air transport contributes a bit over half of CO_2 emissions attributed to tourism transport (not considering radiative forcing), i.e., 515 Mt of 981 Mt. Air transport's contribution is not so much higher because of a high per km emission, but because of the comparatively long average travel distances. In fact, from Table 11.2 it can be seen that the average CO_2 emissions per kilometre for air travel (0.129 kg/person km) is about equal to the average emission of a private car when used by two persons (0.133 kg/person km).

In order to understand better the contribution of the various travel modes and also to better identify the mitigation potential, it is useful to know more about origin and destination of trips. Table 11.7 shows an assessment based on data by UNWTO, ICAO and IATA of the number of international tourist trips within and between regions, and the related travel distances and emissions.

Air transport accounts for an estimated total of 870 million trips from a total of 9.8 billion trips (domestic and international, same-day and overnight). Of these trips by air, the bulk, 820 million (94%), are overnight trips and some 50 million are same-day trips. Given the travel time needed, travel distance for same-day trips is limited with an estimated average return distance of 1,200 km. Given the comparatively small number of same-day trips by air and the short distance, the overall contribution to CO_2 emissions is estimated to be fairly small (11r Mt).

Table 11.7 Approximation of trip volume and tourism transport emissions by region of origin and destination, 2005

	Total		By air					
	Trips (million)	CO_2 emissions	Trips	Kms	Kms	CO_2 emissions		
		Total Mt	Million	Billion	Avg return	Total Mt	Per km	T/trip
Total	9,750	981	870	3,984	4,600	517	0.130	0.59
Same-day (dom. and int.)	5,000	133	50	60	1,200	11	0.177	0.21
tourists	4,750	848	820	3,924	4,800	506	0.129	0.62
within regions	4,615	630	695	2,173	3,100	289	0.133	0.42
domestic	4,000	478	480	1,340	2,800	185	0.138	0.39
Europe			66	122	1,900	17	0.138	0.26
Americas			272	888	3,300	123	0.138	0.45
Asia and the Pacific			127	303	2,400	42	0.138	0.33
Middle East			8	14	1,700	2.0	0.138	0.24
Africa			6	11	1,800	1.5	0.138	0.25
international within own region	615	153	215	833	3,900	104	0.125	0.48
Europe	366		126	313	2,500	39	0.125	0.31
Americas	96		37	178	4,900	22	0.125	0.61
Asia and the Pacific	117		41	318	7,800	40	0.125	0.97
Middle East	18		7	14	2,100	1.8	0.125	0.27
Africa	16		5	10	1,900	1.2	0.125	0.24
between regions	135	218	125	1,751	14,000	217	0.124	1.74
short-haul	30	11	20	77	3,900	10	0.125	0.32
long-haul, predominantly from-to	104	208	104	1,674	16,000	208	0.124	1.99
high income-developing	40	79	40	639	16,000	79	0.124	1.99
developing-developing	5	9	5	76	16,000	9	0.124	1.99
developing-high income	24	49	24	392	16,000	49	0.124	1.99
high income-high income	35	70	35	567	16,000	70	0.124	1.99

Sources: Approximations by UNWTO based on UNWTO, ICAO and IATA (see Annex 1) and estimated emissions and surface transport modal split and average distances by the expert team (see Annex 2).

Intra-regional travel (within regions)

The vast majority of tourists travelling by air, move within their own region, either on domestic trips (480 million) or on international trips (215 million). Depending on the geographical characteristics of the regions, the mix of domestic and international traffic varies considerably. In the Americas and in Asia and the Pacific, a comparatively big share of traffic is domestic, owing to large countries with large populations such as United States, China, India or Brazil. In Europe on the other hand, a comparatively large share is international, due to relatively large number and small size of the countries. Most of the intraregional trips will be short- and medium-haul, although a limited part of it represents long-haul travel within regions, such as between North America and South America or between North-East Asia and Oceania.

With regard to CO_2 emissions, the largest contributions related to intra-regional air travel can be attributed to, in decreasing order, domestic travel within the Americas (123 Mt), domestic travel within Asia and the Pacific (42 Mt), international traffic within Asia and the Pacific (40 Mt), international travel within Europe (39 Mt), international travel within the Americas (22 Mt) and domestic travel within Europe (17 Mt).

It is interesting to note that air traffic flows within Africa are only very small, with some 6 million domestic air travellers and 5 million international air travellers, together accounting for less than 1% of CO_2 emissions (3 Mt) by intra-regional air travel. The contribution of the Middle East is also fairly small, with 8 million domestic air travellers and 7 million international air travellers within the region, generating a bit over 1% of all CO_2 emissions (4 Mt) by intra-regional air travel.

Interregional travel (between regions)

A comparatively large share of passenger flight kilometres, and thus emissions, corresponds to air travel between the various UNWTO regions (Europe, Americas, Asia and the Pacific, Middle East and Africa). An estimated 125 million of trips by air are to another region. Of these trips, some 20 million are actually to short- or medium-haul destinations bordering the region of origin, for instance from Europe to North Africa (11 million) or to the Middle East (11 million), from the Middle East to Europe (2 million), from the Middle East to South Asia (0.3 million) or from South Asia to the Middle East (estimated at 3.5 million, i.e., some 70% of travel from Asia and the Pacific). Some 104 million trips can be considered interregional long-haul trips, generating an estimated 1,674 billion passenger kilometres and 208 Mt CO_2 emissions (40% of air transport emissions).

Although data on a country to country base are only available for the largest flows, UNWTO has developed a matrix (see Annex 1) allowing for a breakdown of trip volumes by regions of origin and (sub)regions of destination. Based on this matrix an assessment has been made of the flows between high-income and developing countries*. It should be taken into account that those flows are categorised by the predominant direction, as high-income or developing source markets or destinations can not always be isolated, for instance in North-East Asia, though considered predominantly developing, some high-income countries are included, such as Japan.

A third of long-haul trips, corresponding to some 40 million, are from predominantly high-income economies to destinations in developing countries, with as most significant flows:

- from Europe and Americas to North-East, South-East and South Asia, respectively 15 million and 8 million trips;
- from Europe to sub-Saharan Africa (5 million trips);
- from Europe to the Caribbean, Central and South America (9 million).

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* This divison is based on the World Bank Country Classification by Income Group where developing countries are all countries from the low to upper middle income categories (see http://go.worldbank.org/K2CKM78CC0)

Some 35 million long-haul trips take place from high-income to high-income countries, mostly travel between Europe and North America:

- from Europe to North America (15 million);
- from Americas to Europe (18.5 million trips, predominantly from North America but including some from Caribbean, Central and South America).

Some 24 million long-haul trips originate from developing countries heading to high-income countries, with as most significant flows.

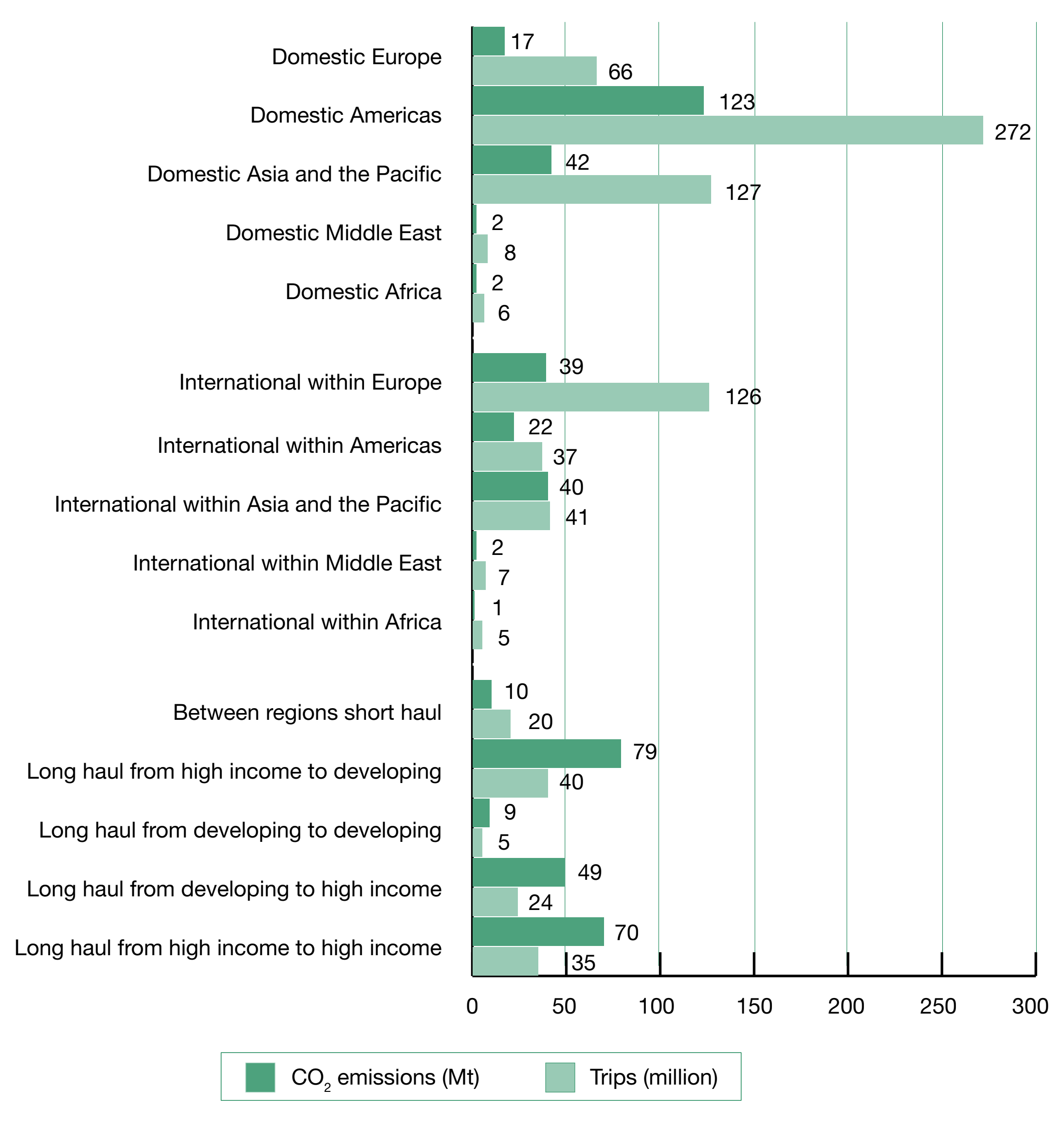
- from Asia and the Pacific to Europe (13 million) and North America (8.4 million);
- from Africa to Europe (2.2 million) and North America (0.3 million);
- from the Middle East to North America (0.2 million).

Some 5 million long-haul trips take place between developing countries in different regions, with as most significant flows:

- from Asia and the Pacific to the Middle East (1.5 million, i.e., excluding some 70% of arrivals from South Asia that are considered short- and medium-haul);
- from the Middle East to North-East and South-East Asia (0.5 million);
- from Asia and the Pacific to Africa (1 million);
- from Africa to North-East, South-East and South Asia (0.8 million);
- from Asia and the Pacific to the Caribbean, Central and South America (0.6 million).

Those trips are for all purposes, including leisure, business, visiting friends and relatives, health, pilgrimage and other. Worldwide and for all modes of transport, just over half of all international tourist arrivals were motivated by leisure, recreation and holidays (51%), business travel accounted for some 16% and 27% represented travel for other purposes, such as visiting friends and relatives (VFR), religious reasons/pilgrimages, health treatment, etc., while for the remaining 6% of arrivals the purpose of visit was not specified (see Annex 1). No detailed data are available on the mix of purposes for the various interregional flows, but anecdotical evidence indicates that a proportionally large share of trips are for the purposes of business and for visiting family and friends, due the internationalisation of business and trade and to international migration patterns.

Figure 11.10 Tourist trips and CO_2 emissions by air transport, 2005



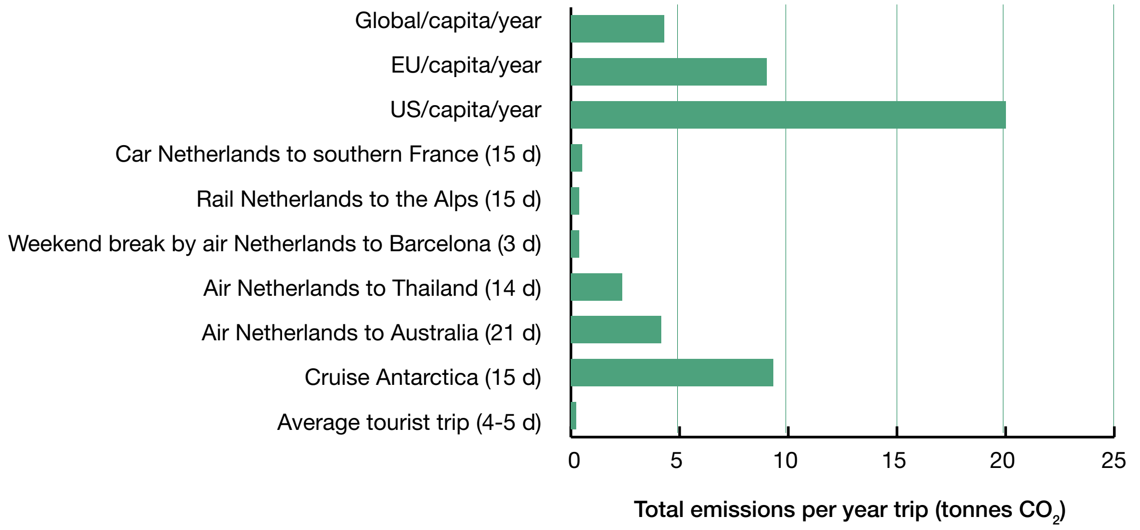
Based on ICAO and IATA data the overall number of passenger kilometres are estimated for interregional flights (i.e., between regions), however, no precise information is available for distances flown for each traffic flow. For this reason, the average return distance flown is assumed equal for all four long-haul flows to about 16,000 km. With respect to CO_2 emissions, this results in a total of 79 Mt for travel from high-income source markets to destinations in developing countries, 70 Mt for travel from high-income source markets to high-income destinations, 49 Mt for travel from developing source markets to destinations in high-income countries and 9 Mt for travel from developing source markets to destinations in developing countries. This is of interest, as it confirms that long-haul travel from the high-income source markets causes a relevant share of emissions and the highest per trip emissions at an average of 2.0 ton per trip. However, it should not be overlooked that a considerable part of this traffic is to destinations in developing countries, where tourism receipts are a vital source of subsistence and development.

11.2 Emissions Related to Individual Holidays

Section 11.1.5 has shown that CO_2 emissions from tourism are significant, even though they may seem to appear small in comparison to other economic sectors. Results also show that trip distance is an important variable, with long-haul international air travel being a comparatively major contributor to overall emissions. Given still considerable growth in tourism demand, a perspective only focused on the global contribution of tourism to climate change may thus be misleading. As global emissions from tourism are the sum of individual trips, a perspective on these is provided in this Section. This is of particular importance in the context of mitigation strategies (see Chapter 12).

Emissions vary widely between trips. A fly-cruise to Antarctica, for instance, may entail emissions 1,000 times larger than those of a domestic cycling holiday. Figure 11.11 illustrates this for a number of journeys. These figures were found by using the great circle distances for the specific trips, the average emissions per pkm as given in Table 11.2 and the average emissions for accommodation and other tourism activities as used for all calculations for tourists from high income economies. According to UNWTO estimates, an average tourist trip lasts 4.15 days (for all international and domestic tourist trips – see Annex 1) and causes emissions of 0.25 t CO_2.* The vast majority of trips produce lower emissions, but a small share is highly emission-intense. For instance, a 14-day holiday from Europe to Thailand may cause emissions of 2.4 tonnes of CO_2, and a typical fly-cruise from the Netherlands to Antarctica produces some 9 t CO_2.[653] Even holidays said to be eco-friendly, such as dive holidays, will cause high emissions in the range of 1.2 to 6.8 t CO_2 (see Box 25). These figures show that emissions caused by a single holiday can vastly exceed annual per capita emissions of the average world citizen (4.3 t CO_2), or even the average EU citizen (9 t CO_2). However, many holidays cause comparably low emissions, only marginally increasing overall per capita emissions. Figure 11.12 illustrates this by breaking down annual emissions to per-day emissions for various examples of holidays. Emissions will largely depend on the choice of transport mode, with air transport generally increasing emission levels substantially. Other factors of importance for per day emissions are the distances travelled as well as the length of stay, the accommodation chosen or the activities carried out at the destination. Destination choice has thus a considerable impact on the ecological impact of various journeys.[654]

Figure 11.11 Annual per capita CO_2 emissions and emissions caused by various journeys (emission factors as for 2005 technology)



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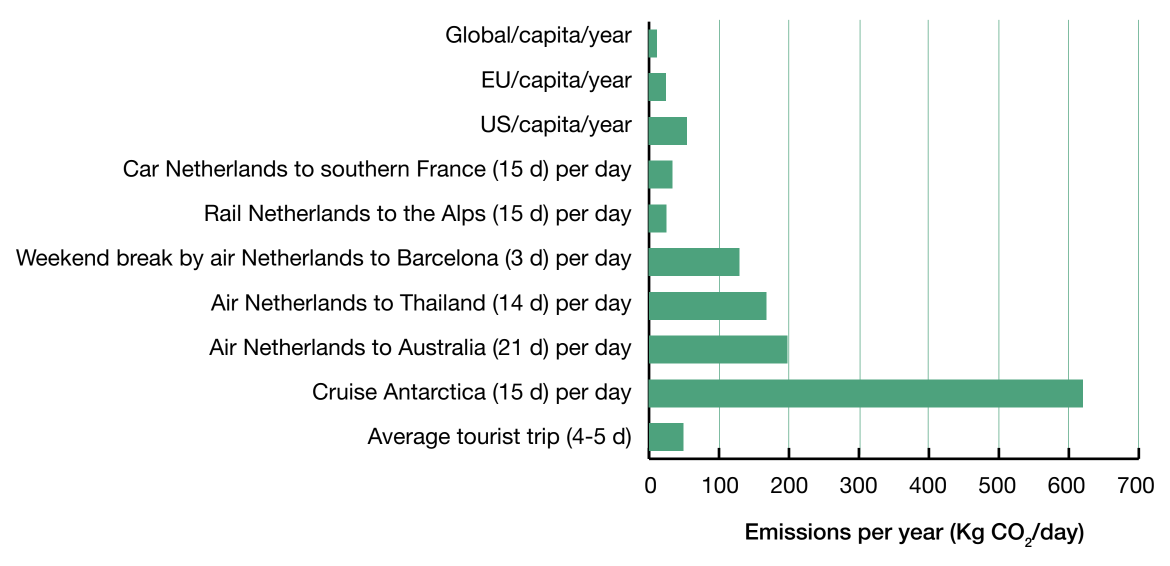
* This number is found by dividing all emissions from Table 11.6 minus the emissions from same-day tourism by all tourist trips in Table 11.3 = (1308-107) Mt / 4.75 billion).

Figure 11.12 Daily average emissions per person and emissions per tourist-day for various journeys (emission factors as for 2005 technology)



Box 25 Dive tourism emissions

Visiting popular dive sites usually involves a flight, as many popular dive sites are located in warm or tropical destinations. [655] To exemplify emissions caused by a dive holiday, imagine return distances of 7,000 pkm, corresponding to a trip from the UK to Egypt, and 30.000 pkm, corresponding to a trip from the UK to Australia. These would cause emissions of 0.8 t and 4.8 t CO_2. [656] If divers carry on diving equipment, this might add on the weight of the aircraft and lead to higher fuel use. On the distance from the UK to Australia, 1 kg of additional weight will lead to additional fuel use of approximately 0.7 kg (return flight), corresponding to emissions of almost 6 kg CO_2-equivalent per kg of baggage.

At the destination, divers will cause additional emissions through their stay in various accommodation establishments, using various means of transport and developing other activities (including dive trips). Depending on how energy is generated, corresponding emissions will be in the order of up to 120 kg CO_2 per bed night. Dive trips mostly cause emissions from the boat trip. Emissions caused by Australian tour boat operators for example are in the order of about 60 kg of CO_2 per trip if the boat uses a diesel engine or 27 kg CO_2 if the boat uses a petrol engine. [657] Overall, a dive holiday may thus cause emissions of between 1.2 t and 6.8 t CO_2. This can be compared to globally 'unsustainable' emissions of about 4.3 t CO_2 per person per year.

11.3 Scenario on the Development of Emissions from Tourists

CO_2 emissions from tourism have grown steadily over the past five decades to its current estimated level of 5% of all anthropogenic emissions of CO_2 (Section 11.2.5). In this section a projection is provided on the development of emissions for tourist activities only (thus excluding same-day visitors). The reason for excluding same-day visitors is that the current numbers of same-day visitors are the least certain part of the data. There are no time-series available to base any growth of same-day visitor trips on, nor is there any projection in the literature available, and finally, the current share of same-day in emissions is low and expected to stay relatively low. The future growth of tourists' emissions will depend upon three major trends:

- **Growing tourism demand:** the number of tourist trips is for the purpose of this report projected to grow exponentially over the coming three decades. According to UNWTO's *Tourism 2020 Vision* [658], the number of international tourist arrivals is forecast to reach 1.6 billion by 2020. an increase of nearly 100% over 2005 (803 million). It is unclear how domestic tourist volumes will develop, but rapid growth can be expected in many markets as well, and in particular in developing countries like India and China. Current growth rates in domestic tourist trips in India and China have been in the order of 10% per year in recent years. [659, 660]
- **Increased long-haul travel:** according to *UNWTO's Tourism 2020 Vision,* the share of long-haul tourism is projected to increase from 18% in 1995 to 24% in 2020 [661], which, given the overall growth in tourism, implies that the number of long-haul trips will more than triple between 1995 and 2020. Furthermore, average trip distance is also increasing. In the EU, the number of trips is projected to grow by 57% between 2000 and 2020, while the distances travelled are expected to grow by 122%. [662]
- **More frequent holidays:** There is a trend of more frequent holidays over shorter periods of time. Consequently, guest night numbers are likely to grow at a slower pace than the number of trips, distances travelled and corresponding CO_2 emissions.

In the framework of this report, we developed several scenarios considering different mitigation options, in order to estimate how emission of global tourist activities might be mitigated in the future (see Chapter 12 for the results of these scenarios).

These scenarios are based on a 'business-as-usual' scenario projection. This was built to the year 2035, in order to provide an estimate on how emissions might evolve when actions are not taken in a comprehensive manner at an appropriate scale in the tourism sector. This scenario is based on projected tourism demand growth rates, as well as distances travelled by various means of transport. These projections also take into account that the number of arrivals is expected to grow faster than the number of guest nights due to the trend of reduced length of stay (see Table 11.8 for the assumptions and Table 11.9 for the references used).

Emissions also depend on changes in energy efficiency. For air transport, estimates of high efficiency gains [663] were assumed (Table 11.10). For cars, efficiency improvements were assumed to be moderate in the developed world and somewhat higher in the developing world, as strong economic growth in many regions will result in a comparably new car fleet (Table 11.10). For other means of transport, a 1% increase in efficiency was assumed. Energy efficiency per tourist night was assumed to be constant, as efficiency gains in this sector are likely to be outpaced by higher standards (e.g., concerning room size) in accommodation. Other activities can also be expected to become rather energy-intense, even when the average length of stay declines and efficiency measures are taken. This is primarily because there is a recent trend towards motorised activities (Table 11.10).

Table 11.8 Model assumptions: tourist arrivals and travel distance growth rates average annual growth (%/year) between 2005 and 2035

	Air transport (distance)	Car transport (distance)	Other transport (distance)	Accommodation (number of nights)	Tourism volume (number of trips)
International	5.3	2.3	2.0	4.0	4.5*
Domestic	11.1	7.5	3.7	5.3	6.3

* UNWTO forecasts a 4.1% annual growth of international tourist arrivals until 2020. The figures in this table, including the 4.5% growth of international tourist arrivals until 2035 is based on estimation carried out by the expert author team of this report. However, UNWTO assumes that the growth might even slow down due to a number of factors, for example the maturing and saturation of main tourism markets.

Table 11.9 Model assumptions: references for tourist arrivals and travel distance growth rates

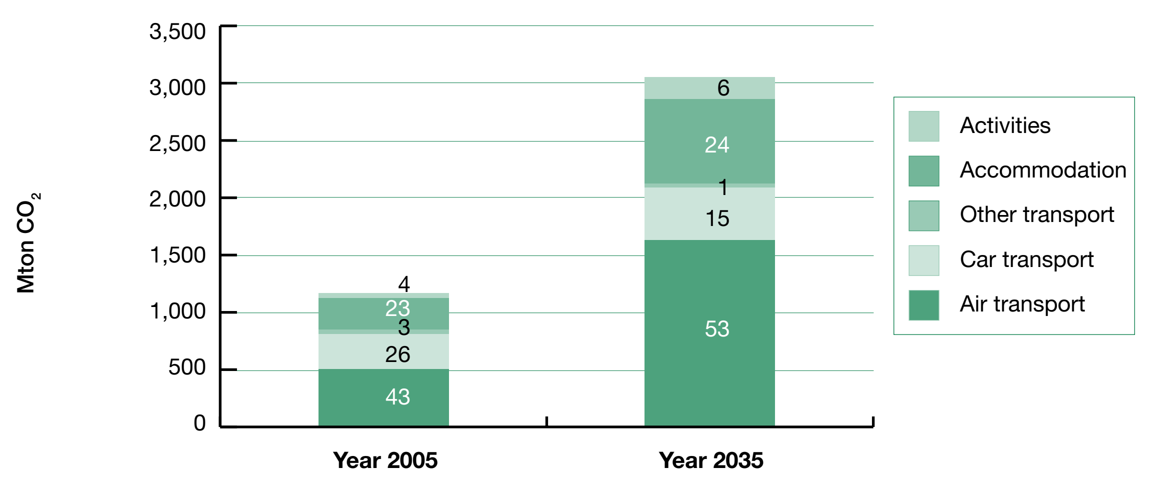
	Air transport (distance)	Car transport (distance)	Other transport (distance)	Accommodation (number of nights)	Tourism volume (number of trips)
International	Boeing [664]	MuSTT study [665]	Expert estimate	MuSTT study	Expert estimate
Domestic	Boeing	MuSTT study	MuSTT study	MuSTT study	Expert estimate

Table 11.10 Model assumptions: efficiency changes (%)

	Air transport (overall reduction between 2005 and 2035)	Specific energy use car transport (change per year)	Other transport (change per year)	Accommodation (change per year)	Activities (change per year)
International	-32	-1	-1	0	+1
Domestic (developed world)	-32	-1	-1	0	+1
Domestic (developing world)	-32	-2	-1	+2	+2

The results of the 'business-as-usual' scenario, based upon the expert's extrapolation of UNWTO's *Tourism Vision 2020* are shown in Figure 11.13. The number of tourist trips is projected to grow by 179%, while guest nights would grow by 156%. Passenger kilometres travelled is expected to rise by 223%, while CO_2 emissions are estimated to increase at somewhat lower levels (161%) due to efficiency improvements. The share of aviation-related emissions would grow from 40% in 2005 to 52% by 2035 (Figure 11.13). Within the accommodation sector, emissions are forecast to increase by 170%, while for other tourism activities, growth is expected to be at 305%.

Figure 11.13 Comparison of current emissions caused by tourist trips (overnight) and projections of emissions for the year 2035 under the assumptions of a 'business-as-usual' scenario (%)

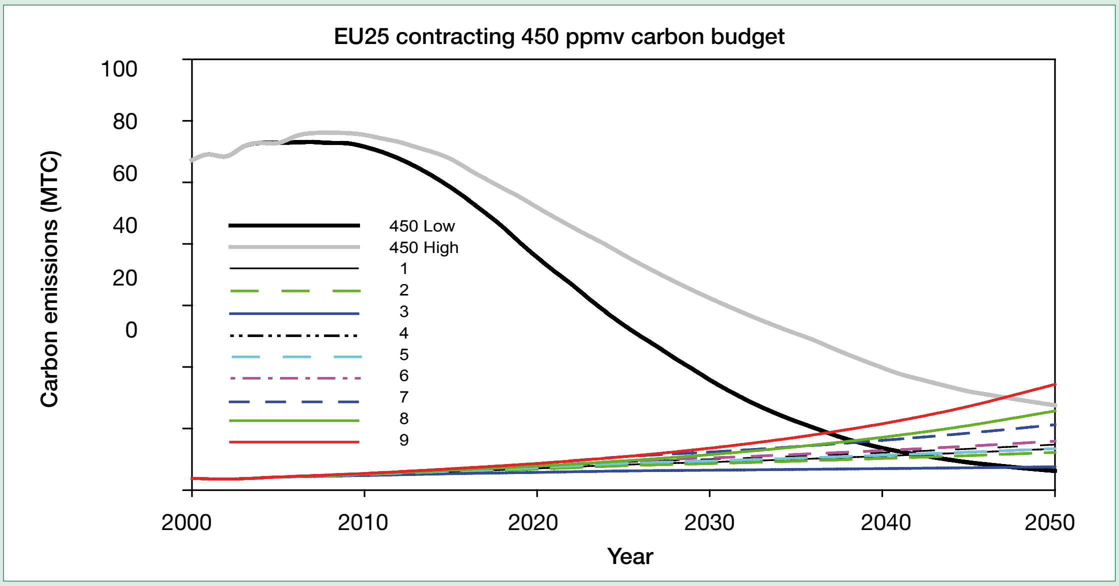


The latest global emissions projections by IPCC *show a 30 year (2000–2030) change in overall emissions of at best a reduction by 6% up to an increase by 88%. This is much lower than the 152% growth seen here for emissions generated through tourist trips. This development of CO_2 emissions from tourism is also in stark contrast to emission reduction needs. Tourism-related CO_2 emissions will reach 2,942 Mt by 2035 under the 'business-as-usual', up from 1,167 Mt in 2005 (this figure excludes same-day visitors emissions). Box 26 illustrates the implications of such developments with regard to aviation in the EU.

Box 26 Emission reduction goals and the development of aviation emissions in the EU

The upper two curves in Figure 11.14 shows the maximum amount of annual emissions of CO_2 in the EU in a +2° C warming scenario, as agreed upon by the EU as the maximum temperature change acceptable to avoid 'dangerous interference with the climate system'. [666] The lower curves show the projected levels of emissions from aviation for a range of scenarios in the European Union, under mixes of optimistic and pessimistic assumptions about technical efficiency improvements and aviation growth. The Figure shows that in a 'business-as-usual' scenario, emissions from aviation alone would in several cases correspond to the maximum amount of emissions that can be emitted within the EU by 2050. The implication is that a 'business-as-usual' growth scenario for aviation is not feasible, if the EU 2° C maximum warming scenario is to be taken seriously

Figure 11.14 EU emission reduction targets and aviation emissions



Based on Bows, A. et al. (2077)

In terms of radiative forcing, tourism's contribution to global warming will grow even faster, given an increase of RF in the order of 192% (excluding cirrus) to 209% (including maximum cirrus), corresponding to 0.198 W/m² (without cirrus) and 0.387 W/m² (including maximum cirrus). Figure 11.15 shows a breakdown of CO_2 emissions and RF for tourism by 2035. According to this 'business-as-usuals' scenario, aviation would be responsible for 53% of the total tourist trips emissions (CO_2 only) from an estimated 40% in 2005 and even higher shares for RF (compare for 2005 in Figure 11.8).

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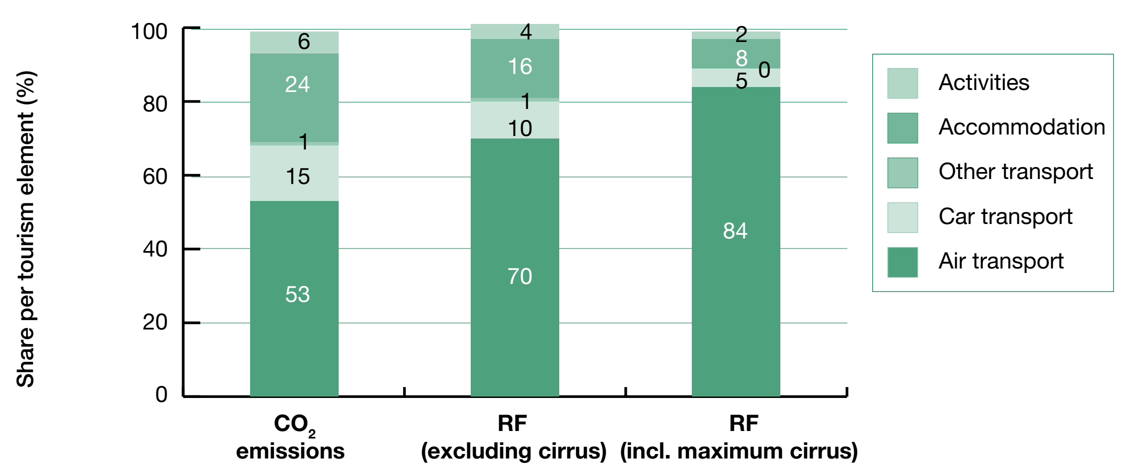
* 30-year growth projections for 2000-2030. IPCC (2007c), figure SPM 4 on page 7.

Figure 11.15 CO_2 emissions and radiative forcing shares of different tourism sectors by 2035 (excluding same-day visitors)



11.4 Conclusion

This Chapter represents the first detailed attempt to assess the global share of CO_2 emissions attributable to tourism, which is here estimated to be around 5% (within a range of 3.9% to 6.0%). Measured in radiative forcing, the contribution of tourism to global warming is estimated to be 4.6% (excluding cirrus-related effects), with a range from 3.8% (excluding cirrus-related effects) to a possible maximum of 9.0% (including maximum cirrus-related effects). The ranges reflect the uncertainty associated with current assessments.

It should be noted that results are based on a number of assumptions, and it remains an important task for the future to further develop worldwide comprehensive tourism demand data on transport, accommodation and other activities.

Furthermore, it is important to start a more complete assessment of the use of various forms of accommodation and average emissions per accommodation type and class. The same is true for other tourism activities. The latter should also include local transport at the destination and specifically address the issue of touring that can comprise significant amounts of travel and consequent emissions.

Regarding CO_2 emissions by sector, it is clear that transport generates the largest proportion of emission (75%). In terms of radiative forcing (contribution to 2005 climate change) the share of transport is significantly larger and ranges from 81% to 89%, with air transport alone accounting for 54% to 75% of the total. Variation in emissions from different types of tourist trips is large, with the average domestic tourist trip generating 0.12 t CO_2 and the average international tourist trip 0.49 t CO_2. Long-haul and very luxury cruises can however generate up to 9 t CO_2 per trip (i.e., 18 times the emissions caused by an average international tourist trip). The majority of tourist trips cause only small amounts of emissions, though. For instance, international tourist trips (i.e., overnight tourist trips) by coach and rail, which account for an estimated 16% of international tourist trips, stand only for 1% of CO_2 emissions generated by all international tourist trips (transport emissions only). In contrast, a small number of energy-intense trips is responsible for the majority of emissions, i.e., the air-based passenger transport (17% of all international tourist trips) is estimated to cause about 40% of all tourism-related CO_2 emissions and 54–75% of the radiative forcing. Likewise, long-haul travel between the five world regions stands for only 2.2% of all tourist trips (excluding same-day tourism), but contributes around 16% to global tourism emissions (including accommodation, activities, overnight and same-day tourism).

The 'business-as-usual' scenario developed for 2035 shows that there will be considerable growth in CO_2 emissions and RF in the tourism sector, if systematic mitigation measures are not implemented. As a consequence, a comprehensive strategy is required to reduce tourism-generated emissions. Chapter 12 provides a discussion on the range of technological, behavioural, managerial and policy measures and initiatives that can bring tourism on are more sustainable emission pathway.

Chapter 12

Mitigation Policies and Measures

Climate change mitigation relates to technological, economic and social changes as well as substitutions that lead to emission reductions. Mitigation poses a challenge when significant reductions in emissions cannot be achieved by technological restructuring alone, but also requires behavioural and structural change. Tourism-related emissions are growing rapidly, but mitigation policies need to address a number of dimensions, such as the need to stabilize the global climate versus people's desire to rest, recover and explore; or the need to reduce long-haul emissions versus tourism's role in development and poverty alleviation. Climate change mitigation policies within tourism have to find a balance between such potentially conflicting objectives. Clearly, decisions on climate change and tourism have implications for local, national and global, as well as inter-generational equity and all these aspects need to be taken into account to arrive at an effective policy mix.

Emission reductions should thus ideally combine various instruments, such as voluntary-, economic-, and regulatory ones. Instruments are more effective when targeted at different stakeholder groups, including tourists, tour operators, accommodation managers, airlines, manufacturers of cars and aircraft, as well as destination managers. Instruments could also be applied with different emphasis in different countries, so as not to jeopardize the development and poverty reduction opportunity offered by tourism to developing countries.

It is clear that for those actors being pro-active in addressing climate change, mitigation offers a range of business opportunities. Given current societal trends, it seems that there will be new markets for environmentally oriented tourists and opportunities to develop new low-carbon tourism products.

Four major mitigation strategies for addressing GHG emissions from tourism can be distinguished: [667]

- **Reducing energy use** (i.e., energy conservation): this can for example be achieved by changing transport behaviour (e.g., more use of public transport, shift to rail and coach instead of car and aircraft, choosing less distant destinations), as well as changing management practices (e.g., videoconferencing for business tourism).
- **Improving energy efficiency:** this refers to the use of new and innovative technology to decrease energy demand (i.e., carrying out the same operation with a lower energy input).
- **Increasing the use of renewable or carbon neutral energy:** substituting fossil fuels with energy sources that are not finite and cause lower emissions, such as biomass, hydro-, wind-, and solar energy.
- **Sequestering CO_2 through carbon sinks:** CO_2 can be stored in biomass (e.g., through afforestation and deforestation), in aquifers or oceans, and in geological sinks (e.g., depleted gas fields). Indirectly this option can have relevance to the tourism sector, considering that most developing countries and SIDS that rely on air transport for their tourism-driven economies are biodiversity rich areas with important biomass CO_2 storage function. Environmentally-oriented tourism can play a key role in the conservation of these natural areas.

Mitigation can be achieved through various mechanisms, including technological improvements, environmental management, economic measures, and behavioural change. Policy can support all of these mechanisms. The following Section will set out with a discussion of mitigation options in the transport sector. This will be followed by an overview of mitigation options for tourism establishments. Policy options to support mitigation will be provided within each Section. Finally, tourist behaviour that is relevant to climate change mitigation will be discussed.

12.1 Transport

As outlined in Chapter 11, transport accounts for 75% of the total GHG emissions caused by tourism. Aviation and the private car are the major contributors to tourism transport emissions. Current trends show a strong growth of air transport at the expense of car, coach and rail in the developed world, while in the developing world, both car and air transport grow to the disadvantage of public transport (bus, rail). The challenge for tourism transport is to increase fuel efficiency of all transport modes, and to facilitate a modal shift towards rail and coach. Furthermore, the growth in distances travelled demands strong attention.

12.1.1 Air Transport

Fuel is now a major cost for airlines at about 20–25% of direct operational costs, [668] which should be a compelling argument for aircraft manufacturers to design fuel-efficient aircraft. Space and the weight that can be carried are both limited on board of an aircraft, and high fuel consumption is thus also a factor negatively affecting maximum payload-range, take-off and landing capabilities.

Fuel-efficiency of aircraft has been improved for jet aircraft introduced in the 1950s (Figure 12.1). The IPCC expects future emission reduction potentials from combined improved engine and airframe technology in the order of 20% between 1997 and 2015 and 30–50% between 1997 and 2050. [669] Several advanced technologies have to be combined to reach this Figure (Box 27). At the moment it is thought that the ultimate reductions of fuel consumption per pkm that can be achieved through technological change are in the order of 50%. However, these are for economical reasons not likely to be achieved. Furthermore, it should be noted completely new aircraft configurations like the blended wing body or a propulsion system based on fuel cells and hydrogen* have a large temporal lag of several decades between the conception of a new technology and the full operational use of it in the total fleet.

Based on actually achieved energy efficiency in the history of jet aircraft (up to 1997), a regression curve has been constructed. From this curve it has been calculated the expected reduction between 2000 and 2050 will be less than 40%. [670] Note that the new Boeing B787 Dreamliner fits neatly in the regression curve.** The A380 is even some 10% above this curve. [671]

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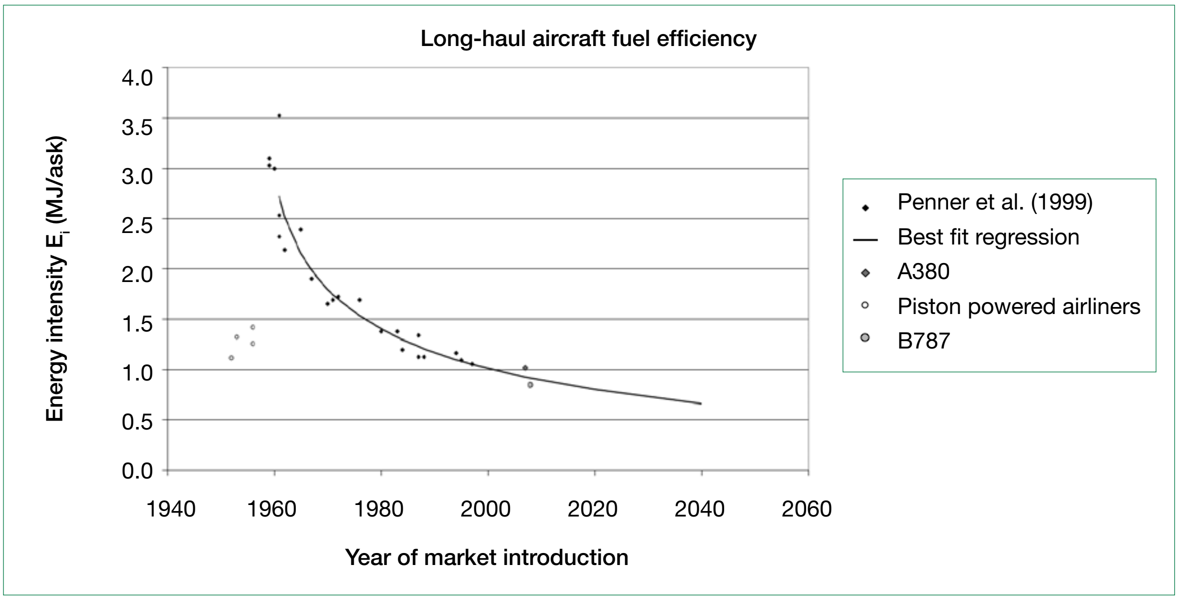
* See for example technology break-throughs proposed by Masson, P. J. et al. (2007), *HTS Machines as Enabling Technology for All-electric Airborne Vehicles.*

** The Dreamliner is 20% more fuel efficient than its competitors, that all entered service in the 1990s. The curve shows the same 20% for this eleven-year period to 2008, the year of market introduction planned for the B787.

Figure 12.1 Historic and expected future trends in fuel efficiency for aircraft



Source: Peeters, P. and Middel, J. (2006)

Box 27 Engine and airframe technology

The expected advances in engine and airframe technology to date are: [672, 673, 674]

- development of gas turbine engines with a higher bypass and pressure ratios;
- optimisation of the balance between increasing fuel efficiency (i.e., through higher temperatures and pressure ratios) and reduced NOx emissions (by optimised combustion chambers and combustion control);
- higher lift-to-drag ratios by increasing wing-span, using, wing-tip devices, increased laminar flow on the wings and advanced airframe skin designs (e.g., riblets);
- structure weight reductions;
- new aircraft configurations for example the blended wing body.

Alternative fuels

Various aircraft using alternative fuels have recently been discussed. For instance, hydrogen powered aircraft would use a clean source of energy. However, neither Boeing nor Airbus are currently developing such an aircraft, and it should also be noted that hydrogen is a secondary energy, rather an energy carrier; i.e., unless it is produced from carbon-neutral primary energy sources there will be no global reduction in GHG emissions. Producing hydrogen from renewable sources is also constrained by lack of infrastructure, considerably higher costs, and competing uses of renewable energy. Furthermore, using liquid hydrogen in conventional turbojets would eliminate CO_2 and particle emissions but not reduce the problem of NO_x-emissions, and it would also lead to the release of larger quantities of water vapour (about 2.6 times). Both would cause additional radiative forcing (see Box 23, Chapter 11).

Currently available biofuels are not suitable for use in aviation, except in a very low mix ratio with jet fuel. Aviation fuels must stay liquid at low temperatures, and also have a high energy content by volume. Fuels such as biodiesel or ethanol do not match these requirements well. However, a biofuel tailored for aviation could possibly be developed in the future. Virgin Atlantic in partnership with Boeing aims to develop such a fuel within the next five years. Nevertheless, several problems remain unsolved regarding biofuels. These relate to the sustainability and efficiency of production and increasing competition over land, especially arable land area (see Box 29).

Air traffic management

Fuel reductions of up to 10% can be expected from improved operations and air traffic management (ATM), mainly by reducing congestion and optimising flight paths. Optimisation of air traffic management will be facilitated through new navigation systems such as the Galileo satellite navigation system being developed in Europe. [675] The primary factor in optimization of ATM in Europe is overcoming the political hurdles in getting a common system, such as realigning FIR boundaries. Also, achieving higher load factors would decrease the emissions per pkm. Currently, load factors typically vary between 70–75% on international routes (and up to 90% for charter planes). Fuel use also depends on the density of the seating, as more people carried in the same space will increase the overall weight of the aircraft, but reduce per capita fuel use. Seating density can vary substantially. Boeing, for example, offers the 777–300 with in between 368 to 500 seats. Low cost carriers and charter planes typically have the highest seat densities, which can result in fuel reductions per seat kilometre of up to 20–30%. In contrast, flying business-class (with ample space) is more carbon intense than flying economy class due to the lower number of passengers carried. A recent study found that emissions in business and first class are 133% and 250% higher, respectively, than those of economy class. [676] There is also a noteworthy recent trend towards small, executive aircraft (hired or owned), which are even more carbon intense than business- or first class.

Aircraft manufacturers pursue different concepts to improve service and fuel efficiency. Boeing is focusing on point-to-point connections; i.e., longer non-stop flights with medium-sized aircraft (200–250 seats). The use of advanced technologies means that Boeing's 787 Dreamliner (rolled out in July 2007) is 20% more fuel efficient at the same air speeds compared with today's commercial jets. In contrast, Airbus continues to build on the hub-and-spoke concept (i.e., the use of large aircraft from central airports, to which passengers have to travel from smaller airports). Their A380, a double-decker aircraft with an initial capacity on offer of 555 seats, has a non-stop range of 14,800 km to connect major hubs. Airbus however also offers smaller aircraft, such as the A350XB.

Wider initiatives by the airline industry

Corporate social responsibility is taken up by more and more airlines. Airlines try to be as fuel efficient as possible by continuously renewing their fleet, introducing fuel saving technologies; reducing engine–on time when on the ground; reducing operating empty weight by removing excess amounts of water, catering; choosing more efficient flight paths, etc. An increasing number of airlines also produce annual environmental reports. [677, 678, 679]

In their last Annual General Meeting in 2007, IATA outlines four challenges on their pathway to a 'zero emissions future'.

1. **Air traffic management:** IATA calls for a Single Sky for Europe, an efficient 'Pearl River Delta' in China and a next generation air traffic system in the US, to be implemented by governments.
2. **Technology:** IATA calls on the aerospace industry to build a zero emissions aircraft in the next 50 years. Basic research on a zero-emissions aircraft should be coordinated.
3. **A global approach:** IATA asks the International Civil Aviation Organization (ICAO) and its 190 Member States to deliver a global emissions trading scheme that is fair, effective and available for all governments to use on a voluntary basis.
4. **Green businesses:** IATA is developing 'IATA Project Green' to help airlines implement global best practice Environmental Management Systems.

12.1.2 Surface Transport

Car transport

The car is the most widely used mode of surface-bound transport for tourism. Most cars used by tourists are privately owned, but rental cars take an increasing share of car use at destinations. In this Section we describe the general technological developments with respect to the emissions of cars and give some examples of what destinations and fleet owners can do to reduce emissions.

In car transport, most vehicles still operate with traditional petrol or diesel based combustion engines. Improvements in fuel efficiency have been made through advanced engine technology (e.g., direct fuel injection) and more efficient transmission. In the last 15 years, however, the advances in energy efficiency have been counteracted by the development of more powerful, larger vehicles with more technological extras such as air conditioning. As a result, average fuel consumption has basically stagnated since the 1990s. [680] Consequently, the most substantial reductions in fuel use could be achieved by using smaller vehicles, based on the combination of lower weights, less power, and reduced speeds. In some countries, rental vehicle fleets are more efficient than the average vehicle as they tend to be newer and have smaller engines. [681] Tourism businesses could build on this leadership role and promote fuel-efficient vehicles.

Alternative engine technologies include electricity-powered vehicles, hybrid vehicles and the use of biofuels or hydrogen. Electric vehicles are very energy efficient and they have no tailpipe emissions of harmful pollutants (which makes them attractive for tourism), although the power plant producing the electricity will emit them,* unless renewable energies or nuclear power are used. [682] There are a number of down sides to electric vehicles, mainly related to battery capacity, battery loading and unloading energy losses, added weight and volume of batteries, as well as energy losses at power stations. Most of these disadvantages do not exist for electric trains, trams, metros and trolley busses that are directly coupled to the grid. Most batteries using electric vehicles have a limited autonomy and driving range of about 300 km, and recharging can take up to 8 hours. Notwithstanding this, electric vehicles have become popular in some destinations because they are quiet and non-polluting. Yosemite National Park is an example where electric buses were put into service for tourism purposes. Some cities use electric-powered buses, trolleys, and mini cars for tourists (Figure 12.2). However, these are exceptions in comparison to the majority of tourism transports.

Figure 12.2 Electric vehicle fleet for tourists in Werfenweng, Austria

Photo credit: Scott, D.

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* Emission abating is more effective at larger scale such as for electric power plants. Low emission technology (wind, solar) can be used directly and does not need inefficient energy transformation processes, for example to produce hydrogen.

Hybrid vehicles have two power sources, namely electricity and petrol or diesel. The hybrid vehicles differ from the original battery vehicles in that they recharge the battery using the petrol or diesel engine. Emission reductions of CO_2 can be in the order of up to 50% for hybrid cars compared with those only having combustion engines. Toyota's cumulative (across all years) sales of hybrid vehicles exceeded 1 million in 2007. [683] Of those, nearly 345,000 hybrids were sold in Japan, while 702,000 were sold abroad. Avis Portugal introduced 50 Honda hybrid cars in their fleet. In July 2007, Avis added more hybrid cars to its fleets. There are now 1,000 Toyota Prius in their fleet across different locations in the United States. Twenty hybrid cars will be available in Avis' fleet in London by summer 2007. Other rental car companies engage in similar 'green initiatives' (see also Box 28).

The carbon emissions from cars can also be reduced by using fuel cells in combination with hydrogen as fuel. This technology is theoretically ready for introduction, but main caveats are the distribution and production of hydrogen; the latter may even entail higher emissions of carbon dioxide if electricity for hydrogen production is generated in coal-fired power stations, but not if based on wind or solar energy.

Box 28 EV Rental Cars

EV Rental Cars started operations in 1998 in the United States with the goal to rent environmental vehicles and become the first rental vehicle company to offer an all-hybrid-electric vehicles fleet. Since then, EV Rental Cars' fleet has grown to more than 350 cars at 8 locations throughout the country. The company has won numerous environmental awards, including the 2000 Calstart Blue Sky Award and the Clean Cities Environmental Citizenship Award.

EV Rental Cars has prevented substantial amounts of greenhouse gas emissions and claims to have passed on to its customers more than US$ 1 million in fuel costs savings by acting environmentally.

There is increasing interest in biofuels as an alternative to petrol and diesel. Biofuels are already added to petrol and diesel (e.g., E85 is ethanol blended in petrol up to 85%). The advantage of adding ethanol to conventional fuel is that cars do not require changes in the fuelling system. Some rental car companies already use biofuel, for example Avis Scandinavia operates 400 ethanol-powered Saabs in its fleet.

The use of compressed natural gas (CNG) and liquefied petroleum gas (LPG) also reduces CO_2 emissions compared with traditional petrol or diesel engines. The gases contain less carbon, the recovery and processing are less energy intense, and other emissions (e.g., carbohydrates) are less toxic. [684] Fuel switching from diesel to CNG can reduce CO_2 emissions, but may lead to an increase in methane and NO_x emissions, thus reducing the overall benefit of lower GHG emissions. Another drawback is the inconvenience of accommodating heavy high-pressure tanks.

> "Biofuels might play an important role in addressing GHG emissions in the transport sector, depending on their production pathway. Biofuels used as gasoline and diesel fuel additives/substitutes are projected to grow to 3% of total transport energy demand in the baseline in 2030. This could increase to about 5–10%, depending on future oil and carbon prices, improvements in vehicle efficiency and the success of technologies to utilize cellulose biomass."
>
> IPCC (2007c:18), Summary for Policymakers

Box 29 Biofuels

Biofuels are based on biomass, either plant material or waste products from the food chain. All these raw materials have used carbon dioxide from the atmosphere to grow and are therefore considered renewable and of a low carbon footprint. However, the production of biofuels still causes significant CO_2 emissions, as it is usually based on the use of fossil fuels (e.g., transport, fertilizer). Emissions depend on the material used and the production process. Sugarcane based ethanol from Brazil, for example, has been found to be very efficient, whereas biofuel derived from corn in the United States is comparatively carbon intensive.

There are two basic types of biofuel. Biodiesel is made from vegetable oil or animal fat. It can be used in any diesel engine and can be mixed with mineral diesel in any percentage. Ethanol (an alcohol, like methanol) is the most common biofuel worldwide and it is used in petrol engines. It can be produced from sugar cane, wheat and corn and other biomass.

With an increasing interest in biofuels for transportation, the question arises whether large areas can be dedicated to the production of fuel, at the expense of other uses (such as forestry or food production). One scenario for 2020 shows that if all oil-based transport would be run on biofuels, area requirements would be in the order of 0.75 to 5.0 billion hectares, which can be compared to the current agricultural area of 1.5 billion ha, with another 3.5 billion ha being used for cattle grazing. [685] In addition to land use discussions, there is also concern that plantations will replace natural habitats (sugar cane or palms for oil). Thus, the production of biofuel can have huge implications for biodiversity and ecosystems in a wider sense (e.g., affecting global hydrological cycles). Sustainable land use for the production of biofuel crops has to be considered carefully. In the light of limitations to the production of biofuels, managing demand for energy remains central to achieving sustainable transportation.

Rail transport and busses

The main advantage of rail and coach is their high energy-efficiency compared to other transport modes. Rail and road mass transit systems using electricity from the grid can be made carbon neutral using renewable energy. Swedish Railways, for instance, have recently switched to renewable energy from wind- and hydropower. Swiss Railways run entirely on renewable energy sources and have done so many decades already by using their own hydroelectric plants. [686] Both Dutch and Austrian railways buy growing shares of renewable electricity.

It could be argued that railway and bus systems can offer advantages such as their central location in many cities, frequent departures, and punctuality. The actual operational energy consumption for trains depends among others on the speed, landscape relief (ups and downs) and the number of accelerations. [687] There are a number of technological developments that can improve the energy efficiency of trains, such as hybrid locomotives, regenerative breakage and kinetic energy storage systems. [688] Finally, railways may further increase load factors. For instance, the French double decker TGVs use almost the same amount of energy as the single deck ones, but can carry 40% more passengers. The main challenge for rail will be to reduce energy use for high-speed trains. Overall, railways have good opportunities to contribute to further reductions in emissions.

Urban public transport systems include light-rail transit and metro or suburban rail, and increasingly large-capacity buses. Bus Rapid Transit (BRT) systems have been developed in Curitiba, Brazil and are now in place in many South American cities. BRT offers the opportunity to provide high-quality, state-of-the-art mass transit at a fraction of the cost of other options. Bus Rapid Transit utilises modernised buses on segregated busways and incorporates such features as pre-board fare collection, safe and user-friendly transit stations, simplified transfers and routings, and superior customer service. Other destinations in the Asia, Australia, Europe, and North America have started to take up BRT as well.

Box 30: East Japan Railway Company [689]

The East Japan Railway Company operates over 13,000 rolling stock and 1,700 stations, and carries 16 million passengers. An annual 'Sustainability Report' is produced. The following goals (established in 1996) were achieved by 2002:

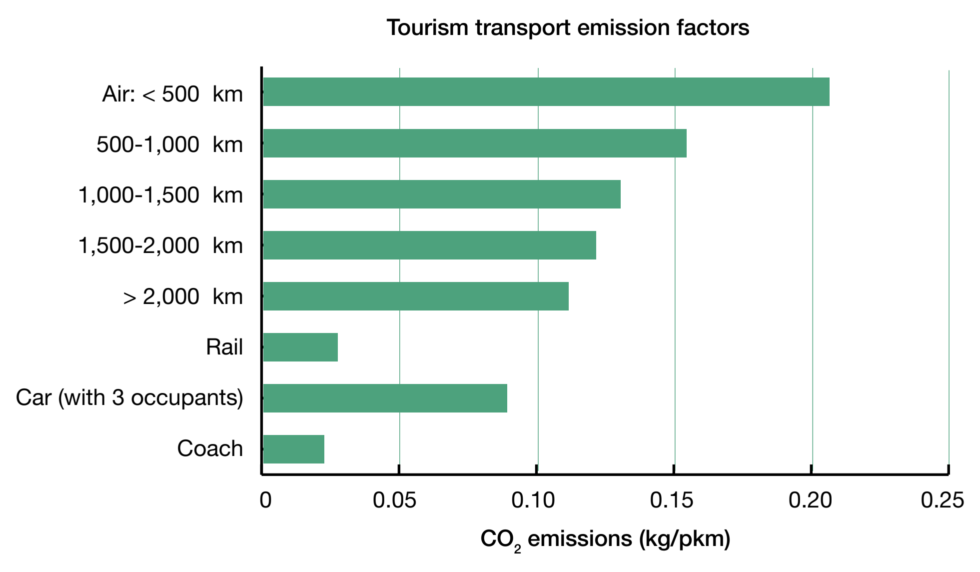
- 20% reduction of CO_2 emissions in general business activities;
- 80% of railcars are energy-saving cars, which consume about half the electricity of conventional railcars;
- 15% reduction in energy consumption for train operations in proportion to unit transportation volume;
- 60% reduction of NO_x emissions at a company-run thermal power plant;
- the promotion of environmentally friendly driving practices has lowered the instances of quick acceleration; this has reduced energy use and also accident rates by 38% over three years;
- implementation of specific environmental conservation activities (including tree planting) on an annual basis;
- the carbon efficiency of JR has improved from 94.5 to 71.5 tonnes of CO_2 per billion yen.

12.1.3 Modal Shift

As rail and coach transport have lower emissions than air and car transport (see Figure 12.3), a modal shift from air and car transport to rail and coach will help to reduce tourism transport emissions. Up to distances of about 1,500 km, rail and coach capture significant shares of the markets and thus are to some extend alternatives to air transport. The share of rail depends strongly on the rail travel time excess over the air trip. More than 50% of the rail-air market is captured by rail for times of up to 2.5 hours. If the rail travel time increases to over 5 hours the share reduces to below 10%. [690] High market shares can be captured by developing high-speed railway networks implying lower travel times. For instance, in the EU25, about one third of all tourist journeys by air cover less than 1,500 km and could theoretically be replaced by rail and coach, if high quality infrastructure is offered. This would correspond to emission reductions (CO_2) of about 8% of all EU tourism transport emissions. However, a modal shift of 100% of all air transport trips below 1,500 km one-way is not very likely to happen. Even 10% will require a strong incentive from the sector. This would just reduce emissions by less than 1%. A 20% shift from car to rail would result in a reduction in CO_2 emissions of 4–5%. This would require the entire EU to achieve the performance of the Swiss public transport system. Furthermore this shift has several other advantages in terms of traffic safety, noise, air quality, space use, congestion and space for parking at congested destinations.

Another option for short-haul travel is to shift from jet aircraft to turboprop aircraft. Though the variance between different regional aircraft types is large, it appears that regional turboprops are significantly (between 10–60%) more fuel efficient than regional jets. [692]

Figure 12.3 Relative carbon dioxide emissions for tourism transport modes at average seat occupation and different stage lengths; based on EU data



Based on Peeters, P. et al. (2004).

High-speed trains have become important links between major European cities. Eurostar has proved to be a strong competitor and dominant market player in comparison with airlines (such as BA or Air France) on the London-Paris route. Similarly, other countries try to boost their high-speed rail network to substitute train for short-haul flights (e.g., in France on the Paris-to-Marseille route, Shikansen network in Japan, and the Madrid-Seville route in Spain). Overall, however, the participation in railway travel is comparatively small with the exception of Japan (see Box 29). The market share of train of passenger transport in Japan is 19.9%, while it is 6.1% in the EU, and 0.3% in the USA. For all intra-EU25 tourism transport in 2000 the share of rail is 5% and of coach 6.7% (in terms of pkm). But differences between countries are very large. The highest percentage is reached by the Swiss population at over 20% share, while countries as Ireland reach less than 3%.

Table 12.1 Modal mix for passenger transport (pkm) in selected countries for 2004 (billions)

	EU 25	EU 25 (%)	USA	USA (%)	Japan	Japan (%)
Passenger car	4,458	76.7	6,544	84.8	757	63.1
Bus/coach	502	8.6	226	2.9	86	7.2
Railway	352	6.1	(24) [b]	0.3	239	19.9
Tram and metro	75	1.3	(25)	0.3	(33)	2.8
Air	428 [a]	7.4	896	11.6	84	7.0

(a) Only intra-EU 25

(b) Values between parenthesis are from the 2005 version of the ERF dataset

Source: European Union Road Federation (2007)

12.1.4 Destination Mobility Management

There is increasing consideration of ‘soft’ measures to encourage a modal shift towards sustainable forms of transport. [693] Initiatives can range from destination-wide transport management (e.g., car-free resorts) to travel restrictions on certain routes, encouragement of public transport use, establishment of cycle paths or -networks, and other benefits offered at tourist attractions or accommodation to non-car users. Soft measures also involve improved information systems (for instance concerning departure times), better reliability of public transport systems, increased personal security, and improved transfer facilities to connect different types of public transport.

The role of urban planning is increasingly recognized as central to achieving sustainable cities (Wheeler, 1998). Since much tourism is taking place in cities, these developments are highly relevant for tourism. Wheller suggests a framework for sustainable cities, which includes compact, efficient land use; less automobile use yet with better access; efficient resource use, less pollution and waste; the restoration of natural systems; good housing and living environments; a healthy social ecology; sustainable economics; community participation and involvement; and preservation of local culture. [694]

There are a number of examples that illustrate different solutions for local transport management in tourism, indicating that it is possible to provide tourists with a chain of public transport options:

- **Copenhagen Free Bike Program (Denmark)**

  Between May and September, the city of Copenhagen offers visitors to use free bicycles all over the inner city. The 1,300 bicycles can be borrowed at 125 stations all over the inner city for a deposit of about € 3. [695]

- **NETS (Europe)**

  A Europe-wide Network for Soft Mobility in Tourism. [696]

- **City of Málaga Tourist Mobility Management Plan (Spain)**

  This new plan includes the implementation of the following services: design of a new website for tourists, new tourist bus service, tourist maps and leaflets, funicular to the Gibralfaro castle, and the creation of the Metropolitan Transport Authority (MTA). [697]

- **United Kingdom's National Cycling Network**

  The network offers over 10,000 miles of walking and cycle routes on traffic-free paths, quiet lanes and traffic-calmed roads. An up-to-date map can be downloaded from the web. [698]

Destination management can also include a closer cooperation with destination marketers. Marketing campaigns could, in the future, take issues such as energy use and GHG emissions into account. [699] For instance, Sweden currently seeks to establish a massive inflow of Chinese tourists, despite strong growth in incoming tourism from European countries. This will substantially increase national emissions in both Sweden and China. Conversely, Norway decided to not focus on Chinese markets, in order not to increase national emissions. To assess the consequences of shifts in marketing more strategically, eco-efficiency could be used as a technique to guide tourism promotion strategies. [700]

Box 31 Sustainable mobility in the Alpine Pearls of the European Alps

In 2006, 17 Alpine towns in five nations (Austria, France, Germany, Italy, Switzerland) founded the Alpine Pearls Association (APA), and membership has grown to 20 communities in 2007. The objective of the APA was to 'break away from conventional tourist mobility' and emphasize sustainable mobility getting to holiday destinations and once there to take action on climate change. Travellers are guaranteed mobility without the use of a personal motor vehicle or airplane. Through the APA, several pre-existing initiatives in each community were combined to offer the traveller a brand of destinations and tourism operators that are committed to sustainable mobility options that comply with the following criteria:

- **Super-regional mobility:** Accessibility to/from each Alpine Pearl is provided via train or bus at minimum four times per day.
- **On-Site mobility:** When at an Alpine Pearl, guests can expect a mobility system to provide connections to the most important local tourist attractions with a maximum waiting time of 30 minutes each day from 9 am to 8 pm.

Each of the Alpine Pearls provides its own sustainable mobility options. For example, in Werfenweng, Austria, guests can utilize a fleet of electric vehicles. The 'Alpine-Flyer' electric Swiss bike is available in six of the Alpine Pearls. The 'Alpine Pearl Rail Pass' is also now available from OBB in Austria to connect passengers between APA member communities. Arosa (Switzerland) and Werfenweng (Austria) also offer a 'Neutral-Climate Holiday' package, where the unavoidable emissions resulting from rail access and local transportation are calculated with assistance from APA and offset by emission reduction initiatives in another location. Guests receive a certificate guaranteeing that their holiday journey is completely climate neutral.

These sustainable mobility projects have been very successful as demonstrated by the changes in Werfenweng (Austria) since it introduced its car-free resort programme. From 1999 to 2004 Werfenweng has seen:

- 38% increase in overnight stays in the winter season;
- 101% increase in overnight stays within the special interest offer 'holidays from the car';
- 31% increase in overnight stays in the summer season;
- increase in train arrivals from 16 to 25%, resulting in the reduction of 375 tonnes of CO_2 per year;
- tripling of passengers for the Werfenweng 'Dial-a-ride' shuttletaxi.

12.1.5 Transport Policies

General policies relevant for tourism transport

There is a general lack of tourism transport policies that address the specific issue of climate change (see also IPCC WG 3, which identified the lack of political will to address transport emissions as a major obstacle). Transport policies are often generic and do not distinguish between various travel motives. For instance, freedom restrictions to travel could be understood as unfair, and transport policies should be designed in a way to consider this in order to be supported by the public. Policies typically focus on transport security and an integration of different modes of transport into a transport network with convenient transfers for the tourist. In contrast, destination-based transport policies often focus on congestion, parking issues and local air pollution.

Transport policies (and as part thereof tourism) often seek further economic development – often in alignment with tourism plans – and as a result conflict with environmental policies, in particular those on climate change.

There are several initiatives at the supranational policy level to make tourism transport more sustainable. The 'Biofuels Directive', for example, is a European Union directive for promoting the use of biofuels in EU transport. The directive entered into force in October 2001, and stipulates that national measures must be taken by countries across the EU aiming at replacing 5.75% of all transport fossil fuels with biofuels by 2010. Currently, petrol and diesel specifications are being reviewed in order to lower both environmental and health impact, and to take into account the new EU-wide targets on biofuels and greenhouse gas emissions reduction. The EU, along with Japan, already has the most stringent fuel efficiency standards in the world (more information can be found on EurActiv.com).

Market-based instruments

Fuel use of international aviation, together with bunker fuels for shipping, is currently not included under the Kyoto-protocol and in national greenhouse gas inventories, which represents an underestimate of country's emissions up to 10%. [701] Instead, Article 2, paragraph 2 of the Kyoto Protocol states that the responsibility for limiting or reducing GHG emissions from aviation falls to the Annex I Parties, working through the International Civil Aviation Organization (ICAO). ICAO's geographic and policy ambit reflects its membership of 190 states, well beyond the 37 ratifying Annex I countries or even the 167 which have ratified the Protocol. While focusing on airframe/engine technology, air traffic management and operational practices, ICAO has also investigated the use of 'market-based' measures such as taxes, charges and emissions trading. Such economic instruments would have effects beyond aviation and tourism. ICAO has effectively ruled out taxes and charges, as well as 'closed' (intra-aviation) emissions trading, and is now grappling with issues of scope in 'open' emissions trading, on which discussion at ICAO's Assembly Session in September 2007 was expected to be seminal.

At present, the most likely market instrument to be implemented is emission trading. This approach is supported in principle by a number of airlines and aviation organisations. Emission trading is generally seen as an option that is more flexible than that of taxation. The EU proposal (see Box 32) is an important step towards a worldwide cap and trade scheme that is likely to reduce demand through higher ticket prices and encourage airlines to press the aircraft and engine manufactures to develop more efficient aircraft.

Table 12.2 Comparison of market-based instruments to reduce greenhouse gas emissions from aviation

Type of levy	Operational issues	Financing (in the EU)	Effect on emissions	Legal aspects
Charge on ticket	Simple and possible to introduce in the short-term; airlines could be responsible for collecting the charge.	Assuming a charge of 5% on the airfare, this charge could raise about € 10–16 billion annually.	Probably little effect on demand given estimated price elasticities; no incentive for airlines to reduce emissions.	Legally feasible.
Fuel tax	A tax could be added as a fixed amount per lof fuel sold or as a percentage of current fuel price; petroleum companies could collect the tax.	Assuming a tax of € 0.32 per l of kerosene a total of about € 14 billion could be expected.	Incentive for emission reductions; research into fuel-efficient technologies and operations.	Problematic, especially concerning the many bilateral agreements including tax exemption for fuel.
Emission tax	Complicated, given the many factors that determine overall radiative forcing. Estimates of emissions possible when considering aircraft type, engines, LTOs, and routings.	Assuming emission charges per l of kerosene of € 0.12 for CO_2, € 0.12 for water vapour and € 0.6 for NOx, the total amount would be around € 14 billion.	An emission tax would have the greatest impact on emission reductions and provides an incentive for technological and operational improvements for airlines.	Likely to be legally feasible unless the tax is closely correlated to fuel usage, because this could be seen as a hidden tax on kerosene.
Emission trading	Integration with existing trading schemes, for example EU ETS.	Depending on market price for CO_2	Directly controlled through the cap in the case of a cap-and-trade scheme.	Likely to be legally feasible.

Source: Becken, S. and Hay, J. (2007) [703]

Other market-based instruments include policies to establish additional charges on tickets, fuel taxes and emission taxes. A charge on tickets is the most straightforward and simplest option to internalise the climate-change costs of aviation (see Table 12.2). However, if the charge is low to moderate, demand will possibly continue to grow, and a ticket charge would also not provide an incentive for airlines to reduce their emissions. If the tax is clearly coupled to the emissions of the flight, long-haul flights will be significantly affected, eventually reducing the growth of the number of long-haul trips and possibly increase the length of stay for these trips (if people go, they will do so for a longer period to save on the cost of the trip per day).

Fuel taxes could be added on top of fuel prices, which would be of particular relevance given the current state of non-taxation of fuels for aviation in contrast to fuel used by surface-bound means of transport. For instance, the current price of one litre of fuel for cars is roughly one Euro higher in the European Union than the price of one litre of kerosene. At present, kerosene sells at about € 0.31 per litre. This means that an increase by a factor of four for fuel costs would double ticket prices with major impacts on aviation volumes. Fuel taxes for aviation are difficult to implement legally, though, as there are a large number of bilateral agreements stating tax exemption for fuels. In contrast, emission charges target the source of the impact and theoretically it is possible to adjust the charge to the climate-effect of a particular flight. Legally, it is possible to introduce emission charges unless they are very closely correlated to fuel consumption. [702]

Irrespective of the policy instrument more research has to be carried out to determine the emissions of a particular flight, especially if non-carbon emissions were to be included. ICAO has started to develop a methodology for calculating emissions based on aircraft type, class of travel and route.

Box 32 Emission trading for aviation

Out of the various options to address emissions from aviation, emission trading is the only one that is in principle supported by a number of airlines and aviation organizations. Emission trading is favoured over the taxation of fuel or emissions, because it allows achieving emission reductions at the lowest cost, as well as putting caps on emission levels. The European Commission (EC) thus envisages including emissions from intra-European flights in the EU ETS from 2011 and all other aircraft flying into and out of the EU from 2012. However, this will mean to include aviation in the general trading system of the European Union, with the consequence that aviation will continue to grow. Several studies have shown air travel to be rather price-inelastic, [704, 705] and at prices of US$ 20 per ton of permit, ticket prices for aviation will become only marginally more expensive. For instance, a return-flight from the US to Europe (New York to Paris) would become US$ 24 more expensive. The aviation sector is thus likely to further expand in such a common trading system, while other sectors will have to achieve over proportionally large emission reductions.

Several publications have shown that emission reductions are cost-negative or – neutral, when companies implement measures to avoid low – or moderate amounts of greenhouse gas emissions. For instance, the IPCC WG3 Report [706] shows that emission reductions in the order of 15–30% are feasible at costs of up to US$ 20 per ton of CO_2-eq. However, further emission reductions become rapidly more expensive. Countries in the European Union are already struggling to achieve the 20% reduction goal agreed upon by 2020. As the 20% reduction goal only represents the first step in global emission reductions, with > 50% reductions needed by 2050, it is clear that there may be considerable problems in achieving further reductions in the medium-term future.

This has several implications with regard to the role of aviation. First, if aviation enters the EU ETS, pressure on other sectors to reduce emissions is likely to increase. This will have the consequence that economically feasible reductions (at < US$ 20 per ton of CO_2-eq.) will be more rapidly carried out in these sectors, and thus sooner lead to a situation where further reductions become more costly. For instance, there is already considerable debate by the Swedish industry that electricity will become more expensive because of aviation buying (scarce) emission rights. High electricity prices would in turn affect the costs of production. Note that the current trading system foresees only limited 'imports' of emission reductions generated through the CDM; i.e., reductions have to a large extent to be carried out within the European Union. Second, aviation is growing rapidly at the moment, with an increasing number of people in the European Union regularly using aircraft.

Such societal trends and the socio-cultural adaptation process going along with these are not easily reversed, and measures to regulate emissions from aviation could face growing resistance by part of the population in the future. In the light of this, it seems prudent to re-consider the implications of a common trading system.

An alternative is to include aviation in a trading scheme of its own. In such a system, aviation would have to reduce its own emission levels, and pressure on airlines would thus increase faster. The industry is currently opposed to such a system, as it is feared that this will limit the options for the aviation sector to grow and disrupt economic systems dependent on aviation. However, this problem could be dealt with by allowing moderate growth rates in the sector, which are reduced annually until emissions become constant (for instance, by 2015, when no further growth in global emissions of greenhouse gases is acceptable[707]). Economically, this would have the consequence that ticket prices will increase, as only a limited number of air miles can be sold. However, this would boost the profitability of the aviation sector, as prices for tickets can be increased despite stable costs of operating flights. At the same time, this will lead to a greater interest by the industry to invest in more fuel-efficient aircraft and to increase load factors.

12.2 Tourism Establishments

'Tourism establishments' include a variety of accommodation businesses, such as hotels, motels, bed and breakfast, camping grounds, holiday apartments, and second homes, as well as tourist attractions, such as entertainment facilities, historic buildings, recreational facilities, hospitality and information centres. The focus in the following will be on the commercial accommodation sector, which is of greater importance in terms of emissions than tourist attractions.

The accommodation sector represents, globally, approximately 21% of emissions from tourism (see previous Chapter on emissions). However, initiatives in this sector are important, as many hotels have considerable options to reduce energy use, which are usually economical. Initiatives such as the use of renewable energy or participation in certification schemes can have important repercussions for tourist perceptions of the importance of pro-environmental engagement in the tourism industry. The value of initiatives at the destination level thus also lies in their symbolic power for involving a larger number of tourists in environmentally proactive behaviour.

12.2.1 Technological Mitigation Options

Mitigation measures in tourism establishments focus largely on energy efficiency and renewable energy. The hotel sector is particularly well organised (especially the larger hotel chains) and there are a number of practical sources of information to help managers implement energy conservation and efficiency measures. One long-standing institution is the International Hotels Environment Initiative (IHEI), which was founded in 1992 to support and improve environmental performance by the hotel industry worldwide. IHEI provides benchmarking tools and publishes a quarterly magazine, the Green Hotelier. A similarly useful website is the Australian 'Twinshare: Tourism Accommodation and Environment'.

In the following we will discuss energy conservation and efficiency measures in buildings, and provide an overview of renewable energy sources for tourist accommodation.

> "The first step [for energy saving programs] is to build consumption history so you can see how you use energy. Understand what your costs are and where they are coming from."
>
> Dan Gilligan, *Vice President of Utilities and Administrative Service, Accor*[708]

Energy conservation and efficiency in buildings

Energy use in the accommodation sector is usually a result of heating and cooling; i.e., hot water supply, central heating, cooling for fridges and freezers, air conditioning, and lighting. In warm holiday destinations, the single largest energy end-use is air conditioning. To address those key end-use areas, mitigation measures can be carried out in the following areas:

Room temperature

The key is to keep temperatures in guestrooms at comfortable levels, ideally between 20–25° C. For instance, the Hilton Seychelles has experimented with room temperatures, and the management reports that 25° C are accepted without any complaints by guests. Building design, including positioning, material and insulation can provide an important precondition for maintaining temperatures in the desired range and considerably reduce overall energy use (Figure 12.4). In a comparison of Scandic and Hilton hotels the differences in energy use between hotels may primarily be a result of hotel standard and management, with a higher standard leading to higher resource consumption. The study also shows that there are considerable options to reduce energy use through pro-environmental management, which often lead to cost savings. [709]

Figure 12.4 Air conditioning unit outside a tourist bungalow in Fiji *

Photo credit: Becken, S.

* The manager reported that because of the design (natural ventilation through windows) and the setting (ample of vegetation to provide shade), tourists only rarely use the air conditioning.

Technical options to reduce energy use include for instance thermostats, combined with a system to heat or cool rooms only shortly before they are used. Regarding air conditioning and heating, it is crucial to have these in the right location to avoid inefficient use, or infiltration of hot air into cooled space. Measures to increase efficiencies can be simple. For instance, the London Marriott County Hall in the United Kingdom reduced its energy use in rooms by 37%. This was achieved by cleaning filters in the air-conditioning units, as well as the coils. A side-effect was that optimal room temperatures were reached faster. In addition, changes were made to the air conditioning and heating running times in banquet rooms, resulting in significant energy savings. It is also possible to introduce systems to shut down air conditioning automatically, for instance, when balcony doors are opened. Finally, the Mariott's air conditioning system was adjusted according to the season.

Restaurants

Many hotels have restaurants that can make substantial contributions to sustainability. Besides adapting similar measures for mitigation as the hotel, restaurants can, through their choice of foods, heavily influence the carbon-intensity of meals served. Food now accounts for approximately one third of emissions caused by households in industrialized countries, and is thus an important factor in reducing energy use. Generally, locally produced food will have a considerably smaller energy footprint. This is particularly relevant in small tropical islands, where food may often be imported by air. Using local resources, for instance by serving mostly local seafood instead of imported meat dishes, is one such measure. Restaurants can also favour organic or certified raw materials and products, and avoid food that is particularly harmful to the environment, such as shrimps produced in converted mangrove areas. Environmentally oriented restaurants in Europe have also started to serve increasing shares of vegetables, as meat is far more carbon intense.

Water temperature

Guest showers, pools, and especially laundry operations can account for about half of a hotel's energy bill. Most common measures to reduce energy use for water heating include setting water temperatures at no more than 60° C, installing low-flow shower heads and using energy-efficient equipment, for example for laundry. All over the tropics, it is feasible to use solar heating systems, which have been proven to work efficiently and securely.

The Orchid in Mumbai uses economisers in the boiler to recover the heat from the hot exit gas, which is used for preheating the water fed to the boiler. Similarly, the Wellington YHA installed a heat exchanger that recovers heat from shower waste pipes and transfers the waste heat into the incoming cold water, which reduces costs for hot showers by 50%.

Heating costs for swimming pools can also add substantially to a hotel's energy bill. Various technologies are available to reduce these costs, including solar water heaters, heat pumps and pool covers. A heat pump as opposed to traditional heating systems, such as electric boilers or condensing boilers, could save up to 52% of energy use. The investment in a heat pump would be paid back in about 2 years, making heat pumps an interesting alternative both environmentally and financially. [710]

Cooling (food storage)

Energy can be wasted when cooling systems are creating temperatures colder than needed. Refrigerators and freezers operate most efficiently when the refrigerator is set at 3.2° C and the freezer is set between –18° and –15° C. There are a number of zero-cost measures to reduce the need for cooling, including:

- allowing hot food to cool before storing it in refrigerators and freezers;
- not overfilling refrigerators, as best cooling occurs when air can circulate throughout;
- regular checking and cleaning of fans, condensers and compressors;
- ensuring doors fit and close properly, and the seals are in good condition;
- ensuring refrigerator compressor belts maintain proper tension;
- defrosting freezers frequently since frost build-ups reduce efficiency.

Lighting

There are some basic measures to reduce energy needs for lighting. In the temperate and northern zones, the most cost-effective measure is to make best use of daylight (for instance by trimming trees and in the overall siting and design of hotels). Other low-cost measures include energy-saving lighting systems and occupancy sensors installed in common areas and guest rooms. The technology of energy efficient light bulbs has improved so that compact fluorescent lamps and circline fluorescent lamps now closely match the colour of incandescent lighting. An energy-efficient light bulb lasts about ten times longer than conventional lamps and staff spend less time changing bulbs. Many hotels now operate room cards for guest rooms to turn off lights (and other appliances) when leaving the room.

Energy efficiency of tourist attractions

Most of the energy-saving measures outlined for accommodation businesses apply equally for other tourism businesses that operate buildings. Theme parks or large entertainment centres are a good example. Most tourist attractions and activity operators operate at least an office building, in which energy conservation and efficiency measures are relevant.

Some tourist activities require special infrastructure in addition to buildings. Energy demand is often high. A good example is the ski industry, which not only relies on energy for lift operations and trail preparation, but also increasingly for snow-making systems and on-mountain entertainment.

Box 33 Mitigation initiatives in the North American ski industry

As part of the 'Keep Winter Cool' program established by the National Ski Areas Association (NSAA), ski areas in the United States have undertaken a wide range of energy efficiency and renewable energy initiatives to reduce the GHG emissions related to their operations and serve as a model for other tourism sectors.

At the operator level, the Aspen Ski Company (ASC) (Colorado, USA) is an acknowledged international leader in greenhouse gas emission reductions and was the first resort operator to join the Chicago Climate Exchange (in 2001) and thereby legally committing itself to annual accounting of GHG emissions and a 10% emission reduction by 2010 (based on a 1999 baseline year). To accomplish this objective ASC has undertaken multiple initiatives, including: building the largest solar photovoltaic array in the ski industry, constructing an onsite micro-hydroelectric plant (generating 250,000 kWh annually), converting all of its snow-grooming machines to biodiesel, building two of the earliest buildings certified by the US Green Building Council's 'Leadership in Energy and Environmental Design' Program, and most recently purchasing 100% of its electricity use from wind power generators.

More broadly, the NSAA launched its 'Green Power Program' in 2006 to promote investment in renewable power by the ski industry. A total of 58 ski resorts now purchase renewable energy (primarily wind) for all or part of their operational energy use. Impressively, 28 of these resorts purchase 100% of their energy needs from renewable sources (through renewable energy credits where local grid sources are not available). The NSAA estimates that these 28 ski resorts purchased 292 million kWh of green energy in 2006-2007, avoiding over 193,000 tonnes of CO_2 emissions. [711]

Another example is golf tourism. Modern golf courses use energy in a wide range of facilities: in the clubhouse (offices, meeting rooms, bar, restaurant, kitchens, locker rooms, pro shop) and on the golf course (use of green-keeping machinery, pumping irrigation water, operation of maintenance facilities). The world rules and development body and organizer of 'The Open Championship', [712] has developed a four-point plan to energy conservation:

1. **Decide who will be responsible:** note examples of energy wastage, read meters and check fuel bills, encourage others to use energy more efficiently, regularly report findings back to senior management.
2. **Establish the facts:** any signs of exceptional consumption, how costs are changing over the years, seasonal patterns to energy consumption.
3. **Compare your performance:** make some comparisons internally and with other, similar golf clubs, and between years, set priorities and targets for improvement.
4. **Use less energy:** the goal is to eliminate waste, including boiler rooms, offices, function rooms, kitchen, cellar, maintenance facility, and irrigation pump house.

Renewable energy sources

A number of renewable energy sources are relevant for tourism. These are wind, photovoltaic, solar thermal, geothermal, biomass and waste. [713, 714] Several studies have explored the extent to which renewable energy sources can be used for tourism, in particular in island destinations where energy supply based on fossil fuels is expensive and at risk of supply interruptions. These studies come to the conclusion that the use of renewable energy sources is generally economical and technically feasible. [715, 716]

Wind energy is of interest in areas with average wind speeds of more than 5–5.5 metres per second. [717] There are different systems for wind energy, ranging from small scale to medium scale (100–700 kW) and large scale (up to 5 MW output). Tourism businesses require small applications, unless a region invests collectively in larger units. The capital costs of wind power are generally smaller than those of solar power. While windmills produce low-carbon electricity and cause no other air pollution, they are sometimes criticised for other environmental impacts, for example noise or visual impacts. However, in some areas, wind parks have also become tourist attractions. Wind energy has the disadvantage that it needs to be backed up with other energy sources in periods of insufficient wind speeds.

Solar energy can be used in three ways: to heat space, generate hot water, or to produce electricity. Solar thermal systems are probably the most commonly used ones in tourism. Depending on the climate, solar water heaters can meet at least half of the hot water requirements of an accommodation establishment over the year. Additional heating might be required on cloudy days, at times when demand for hot water is high, or in winter. The amortization horizon for solar energy panels depends on the climate and can be between 2 years in tropical destinations and 10 years in higher latitudes.

Another way of using solar energy is photovoltaic; that is solar radiation transformed into electricity by means of a photovoltaic (PV) cell. PV systems are simple to operate and therefore attractive for a range of tourism applications. PVs have low operating maintenance costs and are reliable in terms of energy production. PV cells can be used at most locations, but they must be positioned to capture maximum sunlight. A PV system needs a component for energy storage, usually batteries. [718] A back-up diesel-powered generator can be necessary in some locations; however, it might also be possible to combine PV with, for instance, wind power. PV systems are in the range of 1–50 kW; one-kilowatt rooftop cells can be an interesting option for tourist bungalows, for example to provide electricity for lighting and smaller appliances (e.g., radios). Investment horizons for PV systems without diesel generator may be in the order of less than 5 years. [719] The costs of PV cells are decreasing all the time, making them increasingly competitive with diesel generators. This is of particular relevance in remote areas without connection to electricity grids.

Box 34: Nukubati Island Resort, Fiji [720]

A good example of a business that has placed a lot of effort into the development of green approaches to business is Nukubati Island resort in Fiji. The resort has implemented a series of environmental systems on the island, including:

- Nukubati produces its own electricity with one of the largest solar power plants in the South Pacific islands; from an array of 300 solar panels and four wind generators, Nukubati generate 10 kW electricity output from sun and wind;
- fresh water is collected, rainwater filtered and UV treated;
- hot water is produced from ten solar water heaters;
- sewage is tertiary treated using natural bio-cycle systems with grey water being used for irrigation;
- all organic waste is composted for the gardens and other waste is recycled;
- Nukubati grows its own organic vegetables and fruits, using tropical permaculture techniques.

Figure 12.5 Solar panels on Nukubati Island

Photo credit: Nukubati Island [721]

12.2.2 Integrated Emission Management

Integrated emission management in a tourism establishment goes beyond the use of technology to reduce energy use and includes a wide range of measures:

- the implementation of environmental management systems that include management, technology, and behavioural changes;
- eco-labelling or certification;
- supply chain management and strategic partnerships with other, carbon-efficient operations.

Box 35 Scottish Seabird Centre

The Scottish Seabird Centre is a community inspired project that opened to the public in 2000. [722] It has achieved the 'Gold Level' in the Green Business Tourism Scheme (GBTS). Since opening, the centre has grown to be a world leader in the real-time remote observation of wildlife in its natural habitat without disturbance. The centre was designed and built on strong ecological principles. Materials were locally sourced where possible and environmentally friendly products used in its construction and furbishment.

Examples of specific initiatives include:

- recycling waste (for example bottles, cooking oil, paper);
- food and drink for the café are sourced from local producers and suppliers;
- using solar systems to power the Bass Rock and Isle of May cameras;
- encouraging use of public transport to the centre through the provision of joint travel and admission package with ScotRail.

An Environmental Management System (EMS) is a comprehensive and formal organizational approach designed to achieve environmental care in all aspects of operations. It typically involves the development of an environmental policy for the tourism business, monitoring of impacts (such as emissions), environmental reporting (e.g., in the form of 'triple bottom line' reporting) and certification. Only very few tourism businesses have specific climate change policies (as part of their EMS). The Aspen Skiing Company (see also Box 33) developed a policy in 2001 to (1) acknowledge that climate change is of serious concern to the ski industry and to the environment; and (2) that a proactive approach is the most sensible method of addressing climate change. More importantly, the Aspen Skiing Company established a climate change action plan, committing to the following:

- use of green development principles in new Aspen Skiing Company developments;
- energy efficiency in old buildings through economically viable retrofits;
- continued support of mass transportation and local employee housing;
- annual accounting of greenhouse gas emissions;
- a 10% reduction in greenhouse gas emissions by 2010 based on a 1999 baseline.

As part of wider environmental management, many (typically larger) tourism establishments now use the ISO14001 environmental management standard. The management standard helps to understand, monitor and reduce environmental impacts. Green Globe 21 is an environmental management standard developed specifically for the travel and tourism industry, but it has not managed to reach the market (see Table 12.3 below).

There are also a substantial number of ecolabels, codes of conduct, sustainability reporting schemes, awards, and benchmarking programs in the tourism industry. Font (2002) identified over 100 ecolabels for tourism, hospitality and ecotourism worldwide, while in a more general study, the World Tourism Organization (2002) identified 104 ecolabels, awards and self-commitments. Certifications can aid consumers in sustainable decision-making, and have important roles in marketing. Currently, there are over 60 programs worldwide setting standards and verifying them, with an average of about 50 certified tourism firms per program. [723] A general problem with certifications is that they are based on a wide range of criteria, with only some of these addressing energy use or emissions. Another general issue is the relatively low take-up and recognition of these schemes among the consumers. [724] With regard to climate change mitigation, there is thus considerable potential to improve ecolabels for tourism. As an example, Table 12.3 provides an overview of certifications in Sweden with regard to the area of application, the criteria used and the number of businesses in each programme.

While certifications can contribute to the marketing of destinations and travel products, it is interesting to note that most of the certifications found in Sweden are focusing on quality, rather than environmental issues more generally. Energy use in particular is only part of few certifications, with on-site energy use being the focus of assessments.

Table 12.3 Tourism certifications in Sweden, 2005

Country/ region	**Certification**	**Area of application**	**Criteria**			**No. of businesses in the programme**
			Quality	**Environment**	**Energy use (at destination)**	
Sweden	Bo på Lantgård (Stay on a Farm)	Farm accommodation	x	(x)		428
Sweden	Godkänd Gård för Hästturism (Certified Horse Farm)	Horse farms	x	(x)		40
Southeastern Sweden	Det Naturliga Fisket (Natural Fishing)	Fishing arrangements/ accommodation	x	(x)		35
Sweden	Naturlig Laddning (Natural Charge)	Nature-based activities	x	x		12
Sweden	Naturens bästa (Nature's Best)	Ecotourism operations	x	x	x	220[(a)]

Country/ region	Certification	Area of application	Criteria			No. of businesses in the programme
			Quality	Environment	Energy use (at destination)	
Denmark, Sweden, Greenland, Estonia, France, Lithuania	The Green Key	Accommodation		x	x	254
Sweden, Norway, Finland, Iceland	Svanen (Nordic Swan)	Accommodation		x		111
Europe	EU Flower	Accommodation		x	x	36
Europe	Blue Flag	Beaches/marinas	x	x		3,107
Worldwide	Green Globe 21	Airlines, airports, attractions, car hire, caravan parks, convention centres, cruise boats, exhibition halls, golf courses, hotels, marinas, micro businesses, railways, restaurants, tour operators, cities, destinations, protected areas, resorts		x	x	113

(x): soft criteria (indirectly considered)

(a) number of certified arrangements offered by 70 tour operators

Source: Gössling, S. (2006)

Environmental management, certification and ecolabelling can be a useful basis for managing a businesses' supply chain and developing strategic partnerships.* This means that a tourism business looks beyond the boundaries of its own establishment. While this is often done for economic reasons, environmental benefits can be achieved as well. Such partnerships could, for example, involve cooperation with other, energy efficient businesses. An eco-tourism tour operator will choose to work with – ideally certified – accommodation providers and local attractions. This will enhance the credibility of their own product and also reduce overall carbon emissions. Partnerships are also common between attractions and transport providers. A number of tourist destinations now offer integrated tickets for attractions and public transport systems. For example, the 'Barcelona Card' is a transport and attraction discount card that is issued by the Barcelona Tourism Association. Similarly, the FIFA Soccer World Cup held in Germany in 2006 offered free public transport for ticket-holders on the day of the match. Events held in the Telstra Stadium in Sydney offer similar arrangements.

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* See for example Centre for Environmental Leadership and Tour Operators Initiative (2004).

12.2.3 Policies for Tourism Establishments and Destinations

National policies

Tourism establishments are often too small to be specifically considered in energy or climate change policies. Similarly, their emissions are too small to participate effectively in carbon trading. This leaves tourism businesses with few options to participate proactively in government schemes, as other industries might do. Notwithstanding this, tourism stakeholders have the option to be partners in local sustainable development initiatives, such as Agenda 21. The municipality of Calvia in Majorca, for example, has used its Local Agenda 21 to spearhead planning for a more sustainable tourism – focussing on the needs of the local people and future markets. A total of 639 cities are currently part of the ICLEI (Local Governments for Sustainability) network, a worldwide initiative embracing national and regional government organizations with a commitment to sustainable development. [725]

There are a number of policies that seek to improve the energy performance of buildings in the commercial sector that are relevant to tourism. These have been reviewed by the IPCC. [726] Policies typically refer to legislation such as building codes, mandatory energy labelling, and appliance standards. In addition to regulation there are a number of fiscal policies to address energy use and greenhouse gas emissions. One example is the taxation of fuel, as is commonly done in European countries. Governments also provide incentives such as subsidies or grants, or 'green loans' to facilitate technological investments. The Canadian Government supports the design process of commercial buildings through their 'Commercial Building Incentive Program', similar to 'California's Savings By Design' programme and Germany's 'SolarBau'.

It is important that tourism businesses and their associations engage with climate change policies to negotiate agreements that benefit their sector. The' Climate Change Levy' in the UK, for example, is a levy on some types of energy used by businesses, such as gas and electricity. Many businesses in the food and drink industry are part of 'Climate Change Agreements', which can rebate up to 80% of the levy. From April 2007, the levy will start increasing in line with inflation, providing an added incentive to consider measures to reduce energy use. Voluntary action is an important pathway to reducing emissions from tourism and there are numerous examples, especially from the hotel sector. Certification and eco-labelling are part of voluntary initiatives and have already been discussed above.

Non-commercial accommodation, including, for instance, second homes, poses specific policy problems since it is characterised by lower energy efficiencies than in permanent housing, combined with low occupation rates which renders improvement measures economically less interesting.

Governments can lead by example, too. 'Parks Canada', which welcomes about 16 million visitors each year, for example, have reduced their greenhouse gas emissions substantially as a result of changes in their vehicle fleets, investment into solar pilot projects and retrofitting of historical site buildings. In 2006, they managed to decrease their GHG emissions below their target for 2010.

International policies

The Clean Development Mechanism (CDM) is an international policy instrument developed as part of the Kyoto Protocol. The CDM allows developed countries (Annex I Parties) to invest in GHG emission reduction projects in developing countries (non-Annex I Parties) that benefit from such activities. A CDM project activity needs to be 'additional'; this means that GHG emissions need to be reduced below those that would have occurred in the absence of the CDM project activity. Afforestation and reforestation projects are also eligible under the CDM.

The United Nations Framework Convention on Climate Change (UNFCCC) reports that there are 684 (31 May 2007) registered CDM projects. Most of them are large projects in the area of refrigerant producing factories and biomass energy. There is only one tourism-related project, the ITC Sonar Bangla in Calcutta India. This hotel is the first in the world to obtain Certified Emission Reductions (CERs) under the CDM from its emission reduction initiatives. Carbon dioxide emission reductions have been achieved through energy conservation initiatives such as waste heat recovery, improved pumping systems and better efficiencies in the air conditioning system. This was equivalent to a reduction of the hotel's total annual energy bill by 19%. While this is an impressive example showing the huge potential for tourism operations to get involved in carbon trading, the procedures are however tedious and often go beyond the means of small businesses.

12.3 The Role of Tour Operators and Other Organisations

National tourism industry associations, grouping the medium and small size businesses, can have a role in influencing or applying national policies. In the highly fragmented tourism sector tour operators can play a key role in influencing a range of small tourism facilities and services they own or sub-contract. The Tour Operators' Initiative (supported by UNWTO, UNEP and UNESCO) has developed a series of guidelines for environmental management of tourism establishment, including energy saving measures, and also developed a series of destination partnership initiatives.

Tour operators play a role in climate change mitigation as they bundle products to packages that are purchased by tourists. While one could argue that tourism is largely demand-driven (i.e., tourists determine what is provided through their purchasing behaviour), there is also a dimension of supplier influence, whereby tourists purchase the products they are offered. To some extent tour operators can influence demand for less carbon intensive packages by creating attractive products that meet tourists' needs and desires. Such products could contain rail travel to the destination (instead of short-haul air), cycle options whilst at the destination and the hire of an energy efficient vehicle. Other options for tour operators are to increase length of stay, which would effectively reduce the carbon footprint per tourist day. It has to be noted that tour operators already seek to increase average length of stay, for example through measures such as 'buy 6 nights, stay another night for free'.

There are numerous examples of tour operators that incorporate alternative transport arrangements into their packages. German tour operator Studiosus, for example, offers 'Anreise mit der Bahn' (travel by train). Other organisations are also seeking to provide energy-efficient transport solutions to tourists. The Deutsche Verkehrsclub (VCD), for example, worked with 10 German holiday destinations to provide 'new paths to nature' by developing and marketing car-free packages for visitors. Similar initiatives have been undertaken by the Swiss Alpine Club and the German Forum Anders Reisen.

12.4 Tourist Behaviour

Though it is clear that the industry shapes demand through marketing, tourists still have relative autonomy in the choice of tourist products. It is likely that a greater awareness of the dangers of climate change will affect tourist attitudes (some of these changes can in fact already be seen) and lead to changes in travel behaviour.

Tourists have thus an important role in creating business interest in restructuring towards a sustainable tourism system by choosing destinations at shorter distances from their homes, choosing environmentally friendly means of transport, demanding more environmentally adequate infrastructure, by favouring destinations that seek to be sustainable, by choosing accommodation that is certified, or eating in restaurants providing local and/or organic food. Tourists can also ask to be transported in new, fuel-efficient aircraft, or demand the use of biofuels, both of which can put pressure on companies to improve their work towards sustainable tourism.

> "Customers are seeking a quality hotel at a competitive price, while increasingly demanding ethical and environmental business practices which make them feel good about their hotel choice."
>
> Andrew Cosslett, *Chief Executive Officer of Inter-Continental Hotels Group* [727]

12.4.1 Sustainable Demand and Consumer Choices

To reduce their carbon footprint tourists have a number of options. First, they can decide to replace a long-distance holiday with a short-haul one. This has been actively encouraged in some countries. For example, the President of the German Federal Environment Agency urged consumers to do so, on the eve of Berlin's ITB in March 2007: "Anyone who travels to South Asia by plane should be aware that he is producing over six tons of carbon dioxide."

Reducing the demand for aviation-based transport poses a great dilemma for tourism, especially considering equity issues in the context of international development and poverty reduction efforts. Much of the recent growth in tourism can be attributed to the increased accessibility of air travel to a larger part of the population. There is, however, some evidence that a minor share of 'hypermobile' travellers account for the majority of the overall distances travelled. [728] This is both a challenge and an opportunity, as addressing the travel patterns of these hypermobile travellers could lead to substantial reductions in emissions. However, little is currently known about these travellers in terms of their travel motivations and their willingness to reduce travel or to switch to other means of transport.

The second option for tourists is to choose an airline for its performance in fuel efficiency, environmental initiatives and direct routing. The more stops during the journey (i.e., take-offs) the larger the carbon footprint.

Third, tourists can consider how much luggage they want to take on their trip, particularly on long-haul flights. Scandinavian Airlines has just increased passenger baggage allowances to 40 kg, but environmentally responsible travellers should rather attempt to reduce the weight of their baggage. On a flight from Europe to Australia, each kg of additional baggage carried will add an estimated 2 kg of CO_2 emissions. Obviously, this also goes for tax-free purchases in airports or on aircraft. A bottle of wine bought in New Zealand and transported to Europe, for instance, will demand its own weight in fuel use to be carried along.

Fourth, for shorter distances tourists can replace air travel with energy efficient land transport, for example train systems. A trip from southern to northern Sweden (1,000 km), for instance, will result in emissions of less than 10 grams of CO_2 per passenger if made by train, as Swedish Railways use exclusively renewable power generated from wind and water. An aircraft will emit almost 150 kg of CO_2 per passenger on the same journey. [729]

Finally, tourists have the choice to minimise their transport emissions at the destination. Options include the use of public land transport, renting fuel efficiency vehicles, walking and cycling, switching off equipment in hotel rooms and supporting green businesses.

When tourists use their own vehicle to or at the destination, fuel efficiency and emissions are determined to a large extent by driving behaviour. For example, 'aggressive driving' as compared with 'restrained driving' increases specific fuel consumption by about 30%. The use of air-conditioning increases the fuel bill by 10–15%, and an extra load of 100 kg increases fuel consumption by another 7–8%. [730] Changing driving behaviour was found to be among the most promising measures to reduce passenger transportation emissions in Canada. [731]

12.4.2 Carbon Offsetting

The term 'carbon compensation' or 'offsetting' means that an amount of GHG emissions equal to that caused by a certain activity; i.e., a flight, will be reduced elsewhere. Carbon offsetting is growing rapidly, and promoted by many actors, from Al Gore's film "An Inconvenient Truth" to influential guidebooks such as Lonely Planet and Rough Guide. Tourists willing to compensate their travel emissions can calculate these with the help of an online calculator. Tourists can then choose to invest either in energy-efficiency measures (e.g., low-energy light bulbs), energy renewal (e.g., hydro-turbines), or carbon sequestration (usually forestry projects).

There is still a lot of confusion among tourists about what carbon offsetting is, [732] and there is also evidence that particularly hypermobile travellers, who account for the major share of the distances travelled and emissions caused, are not ready to support voluntary carbon offsets. [733, 734] There is also a risk that carbon offsetting, which has been initiated as a voluntary form of carbon reductions, is now becoming the means used by the industry to 'reduce' emissions. This effectively means that producer responsibility is turned into customer responsibility, which may be problematic if no action to reduce fuel use is taken by the airline. As such, carbon offsetting can be seen as a controversial solution to climate protection, because it potentially diverts from the real causes of the problems and therefore bypasses the structural and technological changes that need to be made to achieve long-term GHG reductions. There is also a moral or guilt dimension to carbon offsetting – redemption through payment. Thus, tourists can travel on Air Canada, for example, and pay C$ 12.80 for the 800 kilograms of CO_2 that they will have released into the atmosphere between Vancouver and Montreal.

The usefulness of forests as sinks in particular is debated for a number of reasons, including the vast areas needed for forestry schemes, the risk of forest fires, pests and climate change as well as social and other factors that may affect the permanency of the forests. Furthermore, space for offsetting competes with space for biofuels, so to some extent, a choice has to be made between these. Concerns also relate to the difficulty of measuring carbon uptake, sinks as being a short-term solution, the insecurity of projects, and the long-term costs of administration/monitoring. Moreover, in tree-planting schemes the initial rates of sequestration are low and, therefore, it can be years before travel emissions are actually offset. Notwithstanding these caveats, the enhancement of carbon sinks through forestry is recognised in the Kyoto Protocol (Article 3) as a mitigation measure.

The second option of offsetting is by investing in measures for energy efficiency elsewhere or in the future (for example in developing countries by using the money to replace a planned coal electricity plant by one driven by gas or including carbon sequestration). This would support the wider goal of tourism as a means to alleviating poverty and can spread the use of renewable technology in these countries. However, substantial criticism has been forwarded against offsetting projects within the CDM, both with regard to their efficiency and sustainable development benefits.

Carbon offsetting is only one of the available mechanisms to mitigate aviation's impacts on climate. An integrated strategy for the mitigation of aviation's impact on climate change should include a number of mechanisms:

- fuel reduction through improved operations and air traffic management;
- demand management;
- research on the use of alternative fuels and engine's efficiency;
- market mechanisms (taxation);
- emission-charges;
- voluntary initiatives.

Another issue regarding carbon offsetting is related to the choice of an offsetting service. Travellers need clear guidelines on how they should choose the best available carbon offsetting service. Although transparency is the main guiding principle for such selection, there is a need for clear criteria and guidelines that will allow the comparison and evaluation of the effectiveness of various carbon offsetting services. These guidelines could be further linked to a set of global principles for sustainable tourism and criteria for sustainable tourism certification programmes.

12.4.3 Long-haul Travel Reductions and Poverty Alleviation

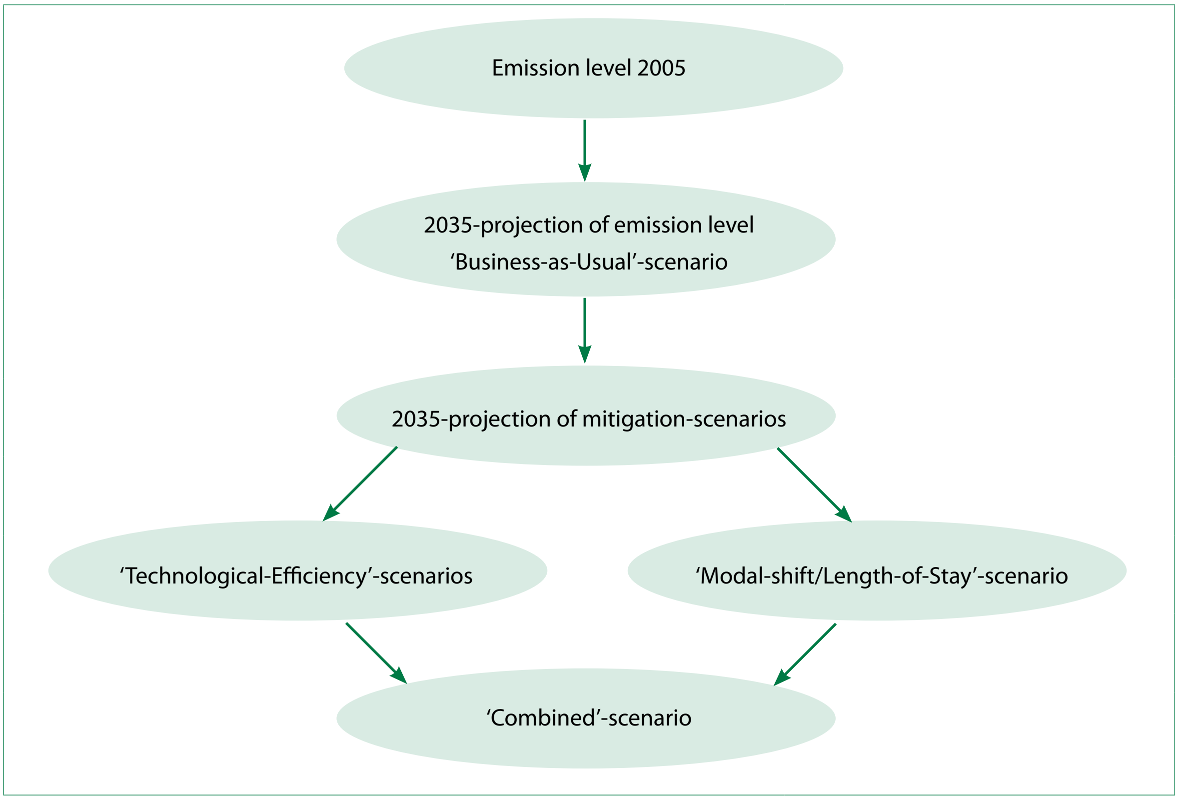
The analysis in Chapter 11 found that a globally averaged tourist journey is estimated to generate 0.25 t of CO_2 emissions. A small share of tourist trips, however, emits much more than this: while the aviation based trips account for 17% of all tourism trips, they cause about 40 % of CO_2 emissions from tourism. Long-haul travel by air between the five UNWTO world tourism regions represents only 2.2% of all tourist trips, international tourist trips (overnight) by coach and rail, which accounts for an estimated 16% of international tourist trips, stands for only 1% of CO_2 emissions by all international tourist trips (transport only). These results show that mitigation initiatives in the tourism sector will possibly focus on the impact of some particular forms of tourism (i.e., particularly those connected with air travel) if substantial reductions in CO_2 emissions are to be achieved. As section 11.1.6 shows that inter-regional (long-haul) trips from high income to developing countries comprise 4.9% of all tourism air trips and 15.6% of all air transport emissions (excluding same-day tourism). Long haul-trips between developing regions comprises only 0.6% of trips and 1.8% of transport emissions (excluding same-day tourism).

Changes in global tourist flows, however, have to be considered in the context of equity and development of more remote or disadvantaged destinations. In recognition of tourism's role in development and in application of the recommendations of the 2002 Johannesburg Summit on Sustainable Development, the UNWTO,for example, launched an initiative called ST–EP (Sustainable Tourism for the Elimination of Poverty) in 2003. The two goals of climate change mitigation and poverty alleviation have to be addressed in a balanced way, ensuring that development objectives are not jeopardised. Long-haul flights cause high emissions, but only a minor share of the toal air travel is directed to poor regions. Considering that tourism contributes significantly to the economy of developing countries, especially LDCs and SIDS, the implementation of mitigation measures in these countries should be supported by international development funds and programmes.

12.5 Tourism Mitigation Scenarios

This Chapter has identified many examples of how to reduce the contribution from tourism to climate change, including reducing energy consumption, increasing energy efficiency, increasing the use of renewable or carbon-neutral energy sources, and sequestering CO_2 emissions. The global tourism CO_2 emissions and radiative forcing model, developed by the experts (see Chapter 11), is used here to explore how the range of mitigation strategies could be used to estimate reductions of the future CO_2 emissions and RF from the tourism sector (see figure 12.6).

Figure 12.6 Overview of scenario development



To explore these 'tourism-mitigation-scenarios', the assumptions of the 'business-as-usual' emissions scenario for 2035 that was developed in Chapter 11 are altered to model the potential affect of various mitigation strategies. The purpose is not to provide a political blueprint of measures for a low emission future, but to show the potential responses of the tourism system if certain types of efficiency gains are pursued on a widespread basis and certain types of changes in demand patterns potentially occur. The assumptions of the two mitigation scenarios developed* are outlined below and the resulting GHG emissions are compared with the 'business-as-usual' scenario for 2035.

'Technical-efficiency' scenario

- Reduction in aviation energy consumption per pkm of 50% versus 32% in the 'business-as-usual' scenario;
- additional 2% per year reduction in car transport emissions per pkm over the 'business-as-usual' scenario;
- additional 2% per year reduction in other transport emissions per pkm over the 'business-as-usual' scenario;
- additional 2% per year reduction in accommodation emissions per guest night over the 'business-as-usual' scenario;
- additional 2% per year reduction in activities emissions per trip over the 'business-as-usual' scenario;

'Modal shift/length-of-stay' (LOS) scenario

- No further growth in aviation number of trips and pkm;**
- growth in rail/coach of 2.4% to 5% per year to keep growth in the number of trips constant with the 'business-as-usual' scenario;
- 0.5% per year increase in average LOS instead of a 0.5% reduction per year in the 'business-as-usual' scenario.

The 'technical-efficiency' scenario reduced CO_2 emissions by 38% (Figure 12.7) and RF by 40% versus the 'business-as-usual' scenario in 2035. This scenario did not however achieve absolute reductions in emissions nor in RF versus the 2005 baseline, largely because of the large growth in the number of trips over this timeframe. Emissions of CO_2 were 44% lower in the 'Modal-Shift -Increased LOS Scenario' than the 'business-as-usual' scenario for 2035, but also did not achieve absolute reductions in 2005 baseline emissions (Figure 12.7). However, this scenario does achieve an absolute reduction of RF by 5% with respect to RF in 2005. Notably, when the two scenarios were combined, CO_2 emissions were reduced 68% (equal to 16% below the 2005 baseline – Figure 12.7) and RF reduced by 85%. Several important points emerge from this analysis:

- Increasing LOS is an economically efficient way to save a significant amount of emissions, while retaining the total number of guest nights. Social policies that would contribute to this change in current LOS trends is an important area of further analysis.

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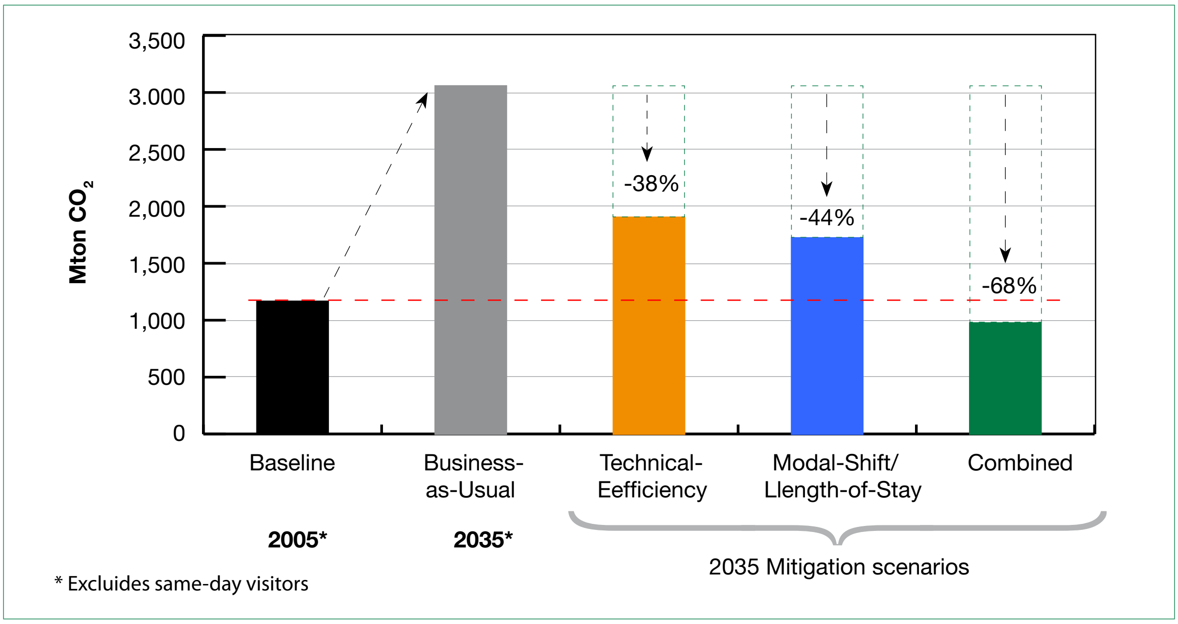
* Many other mitigation scenarios with different assumptions are possible; a total 70 were analyzed with the emissions model.

** The number of passenger kilometres is kept constant, using average trip distance as found in the 'business-as-usual' scenario, thus also keeping the number of trips by air transport constant. However, it is possible to keep reach the same emissions reduction with some growth in the number of trips by air transport when the average distance is reduced (i.e. less long-haul and more medium haul)

- Reducing energy use by combinations of modal shift, shift to shorter haul destinations and increased LOS is more effective in reducing CO_2 emissions (–44%) than additional technological energy efficiency improvements alone (–38%).
- Limiting growth of car transport and a modal shift towards rail/coach has a limited impact on CO_2 emissions (–3% if domestic car trips in developed countries is limited to zero growth; –7% if growth in all car trips is limited to zero).
- Aviation efficiency and growth reduction has important impacts on emission reductions (–14% if aviation fuel efficiency is increased to the theoretical limits, and up to –43% if pkm are restricted to current levels). Thus aviation policies are likely to play a crucial role in mitigating tourist emissions.
- 'Aggressive' efficiency measures in accommodations and activities can reduce CO_2 emissions by 14%.
- Only the combination of emission reduction strategies delivered absolute reductions in CO_2 emissions (and RF) in concordance with the goals of the international community for avoiding dangerous climate change and recent discussions of long-term emission reduction targets at the "Vienna Climate Change Talks". In all other mitigation scenarios evaluated, other economic sectors (e.g., agriculture, manufacturing) will have to take a larger share of the mitigation burden as emissions from tourism continued to increase above 2005 baseline levels.

Figure 12.7 Scenarios of CO_2 mitigation potential from global tourism in 2035



* Excluides same-day visitors

12.6 Conclusion

This Chapter has discussed a wide range of mitigation options for tourism within the aviation and other transport systems, tourism establishments, tour operators and tourists. Mitigation measures range from low-cost initiatives (e.g., using energy-efficient lighting in hotels, monitor energy use) to those that require more effort and investment, for example purchasing more fuel-efficient vehicles, designing a sustainable transport system at a destination, changing transport mode choices or travel patterns. It becomes clear that a combination of measures will be required to reduce the carbon footprint of tourism. This means a wide number of stakeholders need to be involved – airlines, vehicle- and aircraft manufacturers, transport companies, tour operators and travel agents, hotels-resorts, attractions, international organisations, governments at all levels, and tourists themselves – in a suite of activities to reduce emissions, while maintaining the opportunity for tourism development. To achieve this it is important that far more tourism actors become engaged in moving towards mitigate emissions and reduce radiative forcing than is presently the case. So far only relatively few leaders in tourism are actively seeking to reduce their emissions. Voluntary initiatives by a significant percentage of global tourism businesses could have a key role in moving towards sustainability, however, given the uncertainty regarding the effectiveness of voluntary initiatives, a combination of voluntary sector-wide initiatives and consistent government policy and regulatory measures will be needed to generate the far-reaching change required.

In this context it is important to note that there are large differences regarding the effectiveness of various emission reduction initiatives. While there are many options to reduce emissions, the analysis in Chapter 11 and the mitigation scenarios in Section 12.5 suggest that the greatest potential is related to air travel. Reducing growth in the number air transport pkm will achieve more to reduce tourism's contribution to climate change than most other emission reduction measures taken together. As indicated, changes in air travel patterns need to be balanced against other development objectives; however there is considerable potential in many nations for promoting tourism development based on domestic tourism and visitors from neighbouring countries, with relatively low CO_2 emissions per trip.

This Chapter also identified a number of knowledge gaps. Most importantly, there is currently no alternative technology to move to non-fossil-fuel aircraft. Current investments in traditional aircraft mean that the tourism industry will be 'locked into' this technology (and accordingly emissions) for at least a few more decades. In other sectors, such as surface transport and tourism establishments, the non-fossil fuel technology is more advanced and improvements depend more on a successful (and cost-effective) implementation of technologies. This is largely determined by policies (that hinder or encourage such shifts) and by behaviours of the main stakeholders in tourism, including managers who decide to invest in sustainable alternatives and tourists who use these.