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D2.1 Potential transfer of passenger demand to personal aviation by 2020

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Dissemination		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	**X**
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Table of contents

Executive summary

This report is the deliverable report made in the context of the second work-package of the EPATS project.
The WP 2's has four objectives:

- Defining air transport efficiency and its measures;
- Analysing passengers' mobility in Europe when focusing on connections where personal aviation could potentially operate;
- Estimating the potential transfer of passenger demand to personal aviation by 2020;
- Identifying the needs of further work that should be done to be able to go deeper in the estimation of EPATS potential market in Europe.

The analysis of the air transport efficiency lead to the conclusion that the main natural determinants of personal transportation system efficiency are:

- Traveling time as an effect of a mode speed, infrastructure, traffic management system and accessibility
- Energy used (fuel) on the realization of one passenger kilometer at given speed
- Resources used for the mode of transport and infrastructure production on one passenger kilometer
- Impacts on ecology

We suggest the following definition for air transport efficiency: *At the system level Air Transport Efficiency is defined as energy consumption or costs needed to shift one passenger (or kg) on representative (average) origin to destination Great Circle Distance in time according to a fixed plan and complying specifications requirements, including safety and environmental costs.*

The mobility analysis made at a EU 15 level highlights that the long-distance journeys characteristics change according to the customer profile: business and leisure traveller do not travel the same way (difference in terms of transport mode, duration, traveller features (age, gender, etc.). Characteristics of long-distance mobility therefore vary a lot according to the trip purpose.

We identify that **15 223 connections** between 28 countries can be considered as **EPATS potential connections.** All together these potential connections represent **24%** of the total existing NUTS 2 connections in Europe.

The developed estimation method is based on the minimization of the generalized cost that consists in linking the indifference curves to the expected results i.e. to the potential transfer of passenger-km. We consider to perform estimations in the context of ASSESS scenarios that have been developed in order to evaluate the effects of the White Paper measures.

Estimations of the potential transfer of traffic to EPATS are obtained for Europe, France and Poland:

1. **EUROPE**: the total transfer of traffic from road and air transport modes to EPATS would reach 43 million flights in Europe in 2020, made by around 90 000 personal aircraft. At least 50% of these EPATS aircraft would be Piston aircraft.

In total, we estimate that around:

- 23 million flights will be performed with Piston aircraft at Flight level 250
- 15 to 16 million flights will be performed with Turboprop aircraft at Flight level 250
- 3.7 to 6.3 million flights will be performed with Jet aircraft at Flight level 350

2. **FRANCE**: the total transfer of traffic from road and air transport modes to EPATS would reach 4.7 million flights in 2020 with 8 600 aircraft (81% of piston aircraft, 17% of turboprop aircraft and 2% of jet aircraft). Estimations are performed on 302 French domestic connections.
   In total, we estimate that in France around:
   - 2.6 million flights will be performed with Piston aircraft at Flight level 250
   - 1.9 to 2 million flights will be performed with Turboprop aircraft at Flight level 250
   - 44 000 to 196 000 flights will be performed with Jet aircraft at Flight level 350

3. **POLAND**: the total transfer of traffic from road and air transport modes to EPATS would reach 4.3 million flights in 2020 with 7000 aircraft (Table 4 11) (96% of Piston aircraft and 4% of turboprop aircraft). Estimations are performed on 70 Polish domestic connections.
   In total, we estimate that in Poland around:
   - 3 million flights will be performed with Piston aircraft at Flight level 250
   - 1 million flights will be performed with Turboprop aircraft at Flight level 250

The analysis of impacts of increases in the EPATS cost on these estimations estimations, shows the very high sensitivity of the EPATS traffic to cost increases reaching 30%. The impacts on the EPATS traffic would be particularly important in Poland since the number of flights would decrease by 95%, while this reduction is around 65% in Europe or France. Impacts on the fleet of personal aircraft needed to satisfy this potential demand would then be very strong since the EPATS fleet would decrease from 72% in Europe to 80% in France and 97% in Poland.

The main difficulties encountered during the study relate to the lack of available data in all European countries in terms of traffic flows or trips and travellers' features, and also relate to problems of data homogeneity between countries. Following these difficulties we identify two domains in which there would be a need of further works and researches: European data on mobility and the method of estimation of EPATS traffic.
These suggested further works and researches are the following:

- Creating a European Centre for Personal Interregional Transport as a common research platform of the EU Members
- Developing researches on EPATS interactive transport system
- Building an European mobility database with EPATS transport subsystem
- Developing close cooperation with European programmes (ESPON 2013, SESAR)
- Refining the generalised cost formula when including qualitative factors so as to better characterize travellers behaviours.
- Performing a deep analysis on the most accurate aircraft type according to the traffic volume and characteristics to refine the fleet estimation per aircraft type.
- Making estimations of the potential EPATS traffic from each European country to obtain the total traffic at the whole European level.

List of figures and tables

List of tables

List of figures

1. Introduction

1.1. Context

In modern society, the need to travel within Europe is more and more important, and is expected to increase. The extension of the European Union to 27 members amplifies this phenomenon. However, current transport modes have limitations and suffer already from congestion in some places: most large airports are congested or could quickly reach their maximal capacity. Conversely, other areas, especially in Eastern Europe, are hardly accessible.

Moreover, society is evolving : passengers are becoming more exigent in terms of time and cost, but their behaviour is also changing : a phenomenon of individualisation is taking place little by little, meaning that people want to have a choice . Future mobility therefore cannot be entirely satisfied by current transport systems, such as hubs, railways or highways.

A new transport mode is thus needed, and from this perspective, a new concept, the Personal Aviation, has been proposed. It would consist in realizing long-distance trips in a short time at an acceptable cost, thanks to the use of small aircraft (jet, turboprop, pistons) departing from small airports. These aircraft, operating in all weather conditions, could deserve any kind of location, but their interest would be overall to serve inaccessible areas. The concept of personal aviation implies the development of a system. This system is called “EPATS”: European Personal Air Transportation System which is a complex collection of systems, procedures, facilities, aircraft and people, working together. EPATS would be developed especially in regions where the airlines are extremely little present and where high-speed trains do not work, owing to the low flow of passengers.

At first, EPATS will help to meet the needs of a society that is more and more mobile and demanding, by increasing passenger choice. Then, EPATS aims at improving the accessibility of some areas in Europe and at attenuating the disparities relative to networks development. This system proposes an alternative mode to road transport by private car. But EPATS is also a means to make a stronger aeronautical Europe by developing technologies needed for this kind of aircraft and by strengthening general aviation. Lastly, EPATS should increase the operational capacity and the efficiency of air transport system

1.2. Purpose and scope of the document

This report is the deliverable report made in the context of the second work-package of the EPATS project.
The WP 2’s has four objectives:

- Defining air transport efficiency;
- Analysing passengers’ mobility in Europe when focusing on connections where personal aviation could potentially operate;
- Estimating the potential transfer of passenger demand to personal aviation by 2020;
- Identifying the needs of further work that should be done to be able to go deeper in the estimation of EPATS potential market in Europe.

This report is therefore broken down into sections as follows :

- Section 2 presents the air transport efficiency and its measures
- Section 3 deals with mobility in European countries

- Section 4 estimates the potential transfer of traffic to EPATS in 2020
- Section 5 identifies the needs of further works and researches

2. Air transport efficiency and its measures

2.1. Introduction

In ACARE Strategic Research Agenda Efficient Air Transport is defined as: "*the movement of aircraft, of all types, and their passengers, through European airports and sky, in a timely and economic manner, without undue constraints on their preferred flight trajectories (aircraft), journeys (passengers) or departure and arrival times*" and the main Vision 2020 Goals are: three times more aircraft movements, punctuality (delays less than 15 min), time spent in airports – no more than 15 min, five-fold reduction in the average accidents rate [1].
This definition of efficiency is limited to the Air Traffic Management level.
At the air travel industry level efficiency is addressed to capital productivity and is measured in two ways [3]:

- The simplest measure is the average aggregate load factor of the airline. This can be taken to measure the approximate capital productivity of the airline Aggregate load factor are defined as the percentage share of seats occupied per year in total aircraft seat capacity on route served by the carrier.
- A more adequate method is to evaluate efficiency by analyzing and comparing the outputs of the decision unit to its inputs. Each output and each input is assigned a weight and the ratio of weighted outputs to weighted inputs yields a global measure of efficiency in given environmental conditions. Outputs include total passengers transported and total passenger-kilometers. Inputs include total personnel, capacity, fleet, fuel and average stage length.

At the route level, standard measures of efficiency are load factors and fares. Load factors express the efficiency in the use of aircrafts on each route. Empty seats depend on the structure of the fleet (average size and age of planes), on the economies of scale, passenger flow density, stage length, and on policy and market influences shaping the efficiency of carriers.
The efficiency in the use of airline capital increase with average aircraft size and the size of market [3]. That explains the reasons behind the Hub & Spoke system and large airliners development at the expense of direct point-to-point connections and low passengers flows small aircraft service**.**

From the point of view of vehicle efficiency, the fundamental efficiency quantities of any vehicle are its velocity, payload and energy consumption. These quantities are used to define generic vehicular efficiency that applies to all vehicles.
At the level of European Union and respective Member States, the air transport efficiency evaluation cannot be limited to the level of Air Traffic Management or airline economic efficiency only . The evaluation has to take under consideration social aims, which are targeted by air transport and which were formulated in numerous documents concerning European Union transport policy. They especially concern: securing coherent and sustainable transport development, slowing the dynamics of car transport development down in favor of more environmental friendly modes, extending daily radius of population activity.
The natural measures of transport efficiency in this context at the country level are:

- **Origin-Destination time of travel** (as a result of mode speed, network availability and traffic management system)
- **Energy (fuel) consumption** at the level of system (required for 1 passenger-kilometer in given conditions)

- **Material use** (per 1 passenger-kilometer)
- **Externalities – impact on environment** (in terms of 1 passenger-kilometer)
- **Affordability and Accessibility**

2.2. Time efficiency

We consider a time effective mode of transport, appropriate for certain groups of population if time of travel is the shortest among other modes.

We call time saved by one traveler in terms of O-D travel realization a unitary time efficiency of transport system “m” for “i to j” itinerary in comparison to other available transport systems. Travel time consists of unproductive transport time (including node access, waiting for transport and compulsory rest during travel) and efficient time used for business trip objectives. For this analysis, we assume, typical business trips start during morning hours and trip objectives realization lasts 6 hours, because trip objectives and their time of realization may vary. Global time efficiency of a new transport system introduction to “i to j” itinerary is measured by aggregating time savings of all passengers traveling using those itineraries per a unit of time (assumed 1 year). Thus, the efficiency depends on which itinerary the system is introduced to and what the flow of passengers is. The transport time between all regional (16 NUTS-2) capitals using all available modes (except for coach) of transportation and hypothetical EPATS aircraft were analyzed to estimate time efficiency of the EPATS. The time data came from train and air transport schedule and the Michelin internet website (http://www.viamichelin.com) for car travel. The least time consuming mode was found for every itinerary (examples: image 1, 2). Potential average time saving generated by EPATS introduction for every itinerary was calculated (image 5).

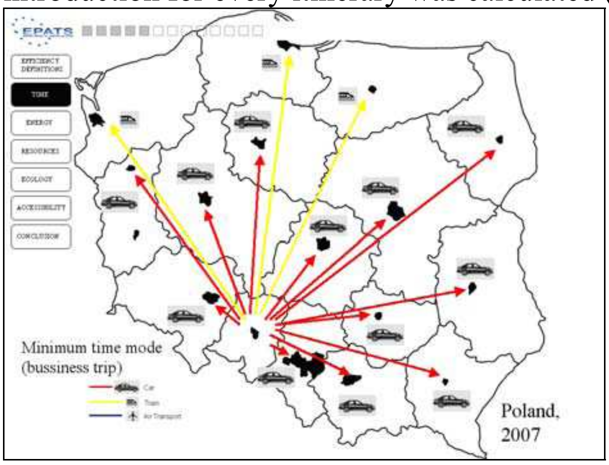


Figure 2-1 : Least time modes on itineraries originating from Rzeszów

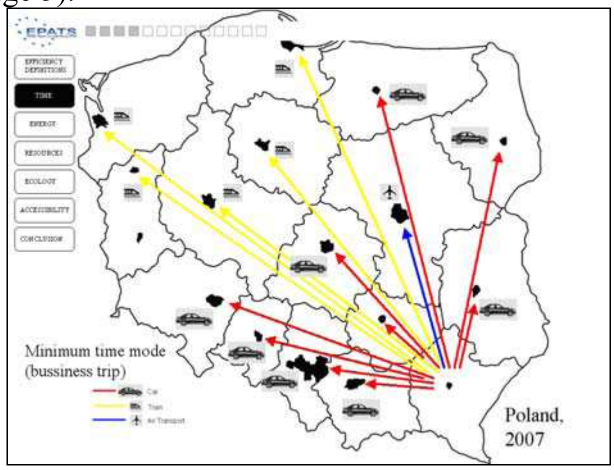


Figure 2-2 : Least time modes on itineraries originating from Opole

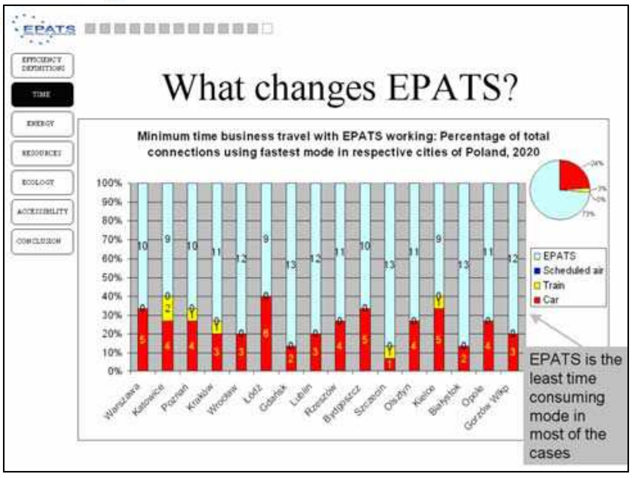


Figure 2-3 : Share of the least time consuming modes among all regions

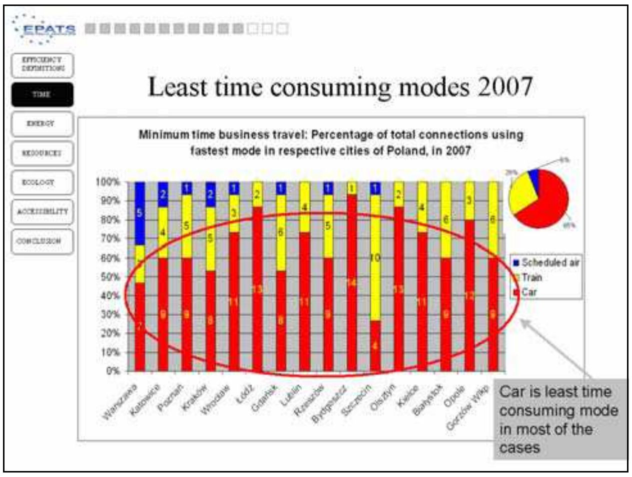


Figure 2-4 : Share of the least time consuming modes among all regions if the EPATS is working

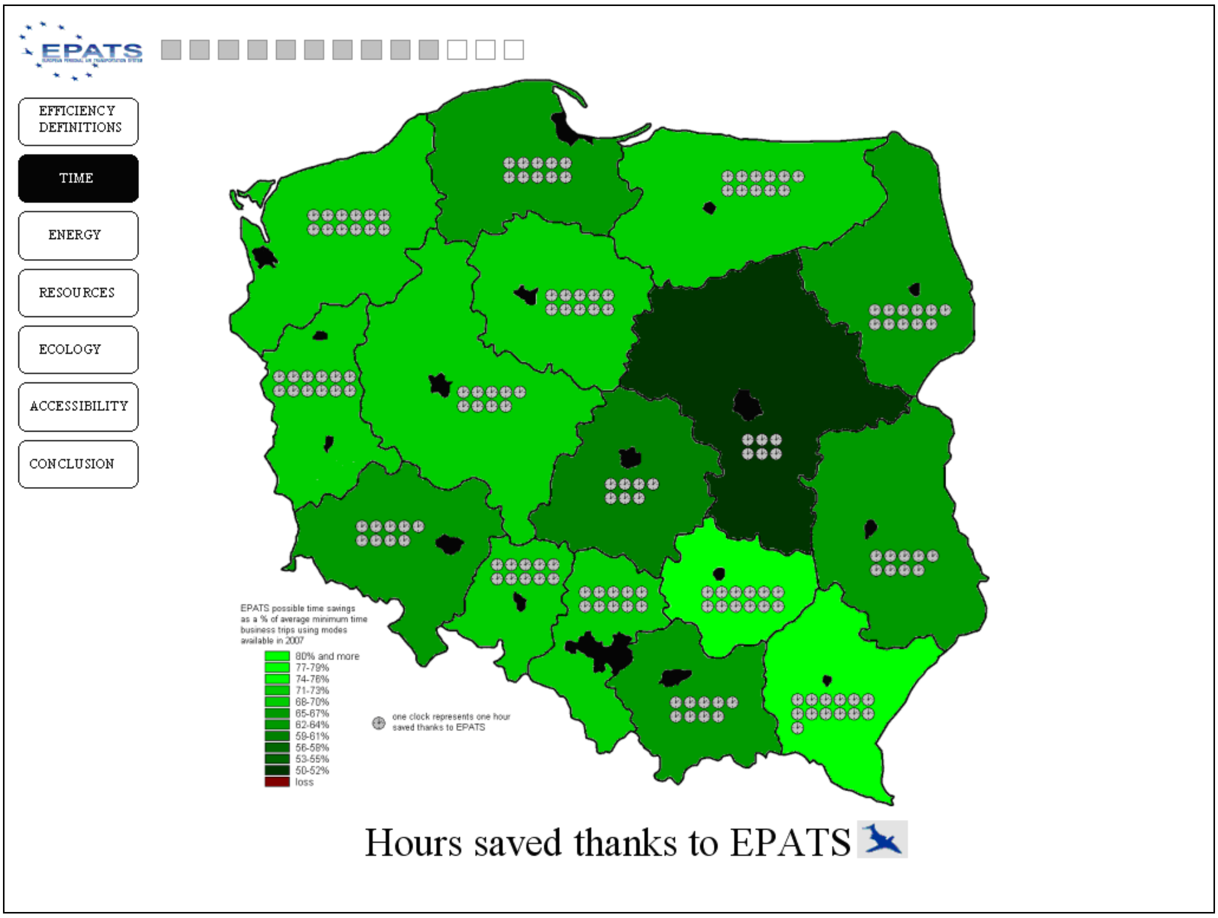


Figure 2-5 : Average time saved during one business trip from one region of Poland to all of the rest after EPATS implementation.

The time saved due to EPATS introduction was calculated using Polish Institute of Tourism (PIoT http://www.intur.com.pl/) data concerning number of business trips in Poland.

According to the PIoT sources, 14 % of short term domestic travels in 2005 were of business purpose (2,212 mln travelers)[1].
Average time savings per region is estimated at c.a. 10 hours per business travel, therefore **the global time efficiency of EPATS system in Poland is c.a. 30 million hours**

2.3. Energy efficiency

The words "energy efficiency" are in common use qualitatively, but are difficult to define or even to conceptualize. An engineer may define energy efficiency in a very restrictive equipment sense, whereas an environmentalist may have a more broad view of energy efficiency. Increases in energy efficiency take place when either energy inputs are reduced for a given level of service or there are increased or enhanced services for a given amount of energy inputs.
Energy use in the transportation sector is primarily for passenger travel and freight movements and is measured as Specific Fuel Consumption (SFC). The energy input is fuel consumption the given service is passenger transportation from origin to destination in given time and conditions.
In aviation, we can distinguish the following units of fuel consumption: hourly consumption, consumption per kilometer or passenger-kilometer and per unit of effective power, calculated as a product of number of transported passengers and speed.
Fuel consumption and theses units values depend on conditions and reference levels, for which they were chosen.
We can list the following levels of reference:

- aircraft technical level, at which various conditions of fuel consumption can be distinguished, especially: flight speed and level condition, longest range condition or during standard mission (according to the requirements), etc. These values are determined by calculations and analysis and are included in the set of aircraft characteristics, given in aircraft manual.
- air subsystem level which includes aircraft of a given airline, airports, air network and air traffic management, where average fuel consumption is determined on real routes and in real conditions taken under consideration including e.g.: waiting, route change, aircraft load, network geometry, etc.
- air transport system level which includes all airlines and all airports, air network and air traffic management system. Fuel consumption at this level is statistically determined and includes aircraft fleet as well as surface facilities and surface transport
- transport system level which includes consumption of fuel used for airport access and gress operations and airport fuel and material logistics

The example of fuel consumption at air transport system and its comparison to car transport system is given below on the graph:

[1] Polish Central Statistical Office provides different data , saying about c.a. 1% of total travels as business purpose travels.

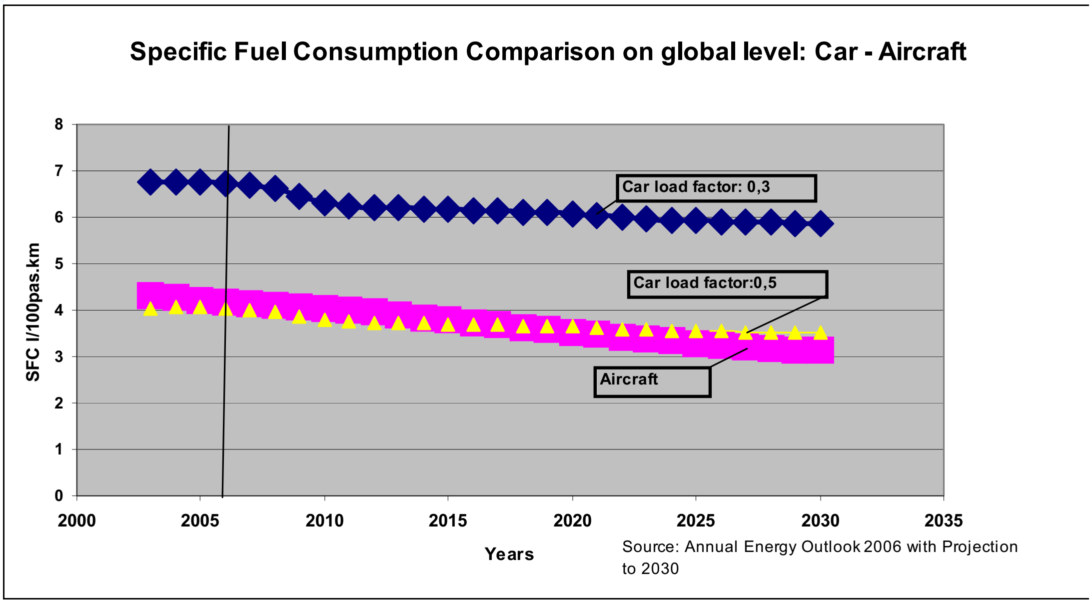


Figure 2-6 : Specific fuel consumption comparison on global level : car - Aircraft

Fundamental differences among the mentioned reference levels can be seen on the example of ATR-42, used by Polish Airlines on regional routes (see figure). The statistical specific fuel consumption per unit of this aircraft in real conditions, on distances of 300 km is about 7 liters of kerosene per 100 passenger-kilometers, while this value at block speed in standard conditions is about 3 liters per 100 pkm, that is two times less. It proves that the aircraft technical characteristics are far different from these, reached in the system. It is important not only in terms of fuel consumption, but also speed.

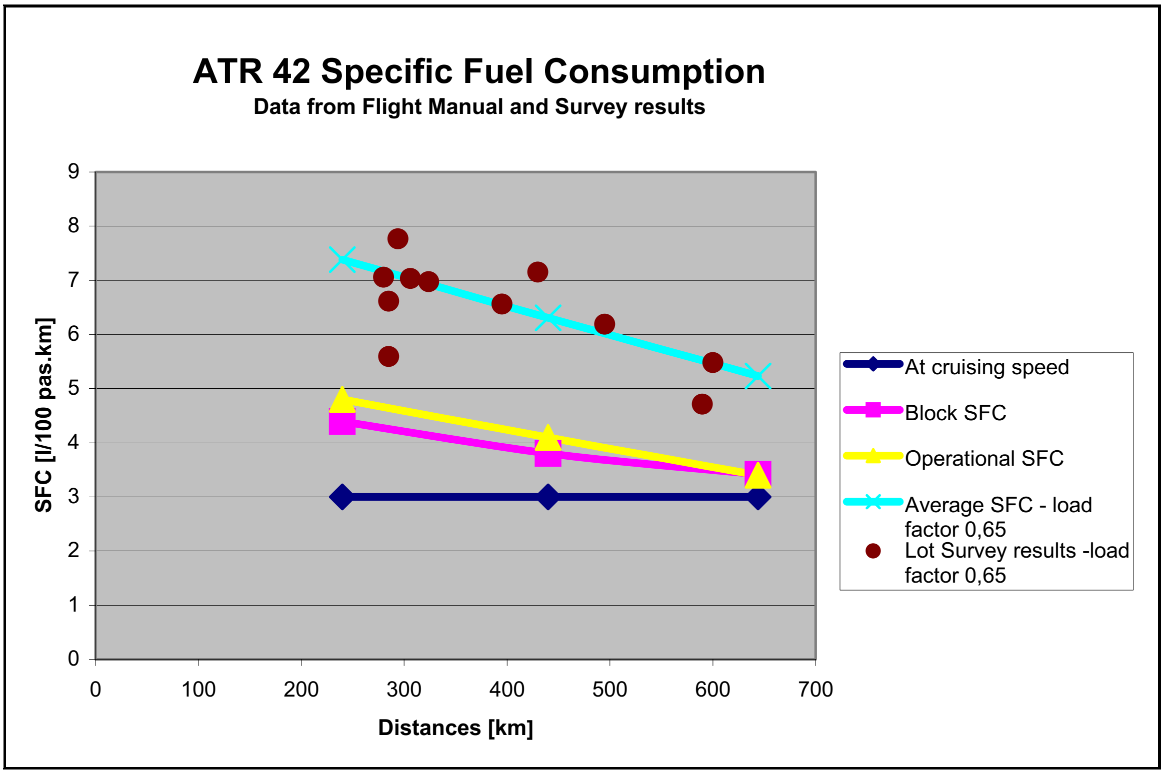


Figure 2-7 : ATR 42 Specific fuel consumption

Main factors of fuel consumption increase in air transport system are: empty seats, waiting for start and landing, route extension due to network characteristics, route change due to traffic, etc. The more complete use of airspace and airport, the higher the loses. Increasing number of communication airports and making air traffic management more efficient leads to significant decrease in fuel consumption in air transport. The similar effect is generated by fitting network to directions of O-D(Origin-Destination) travel, simultaneously adjusting aircraft size to passenger flow density.

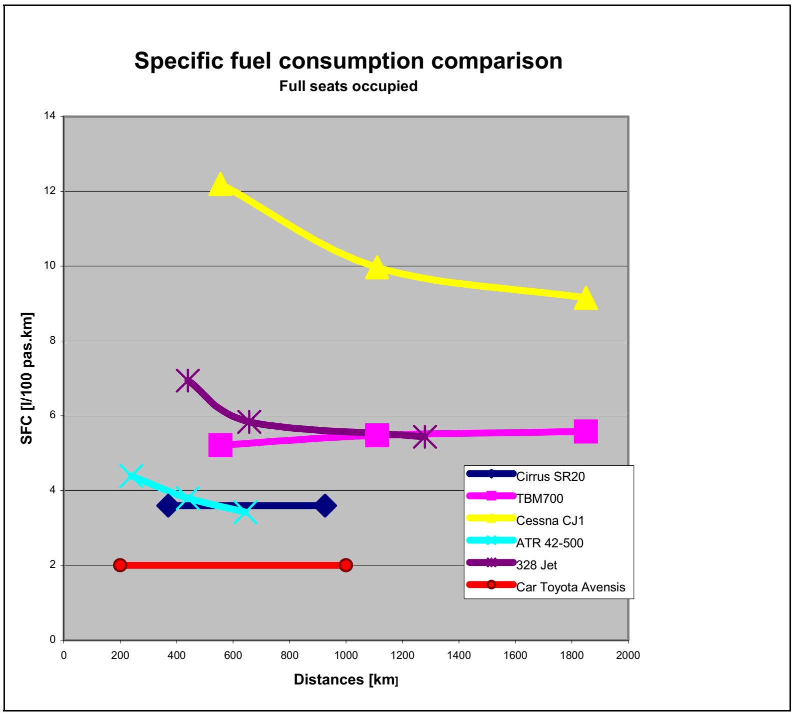


Figure 2-8 : Specific fuel consumption comparison (Full seats occupied)

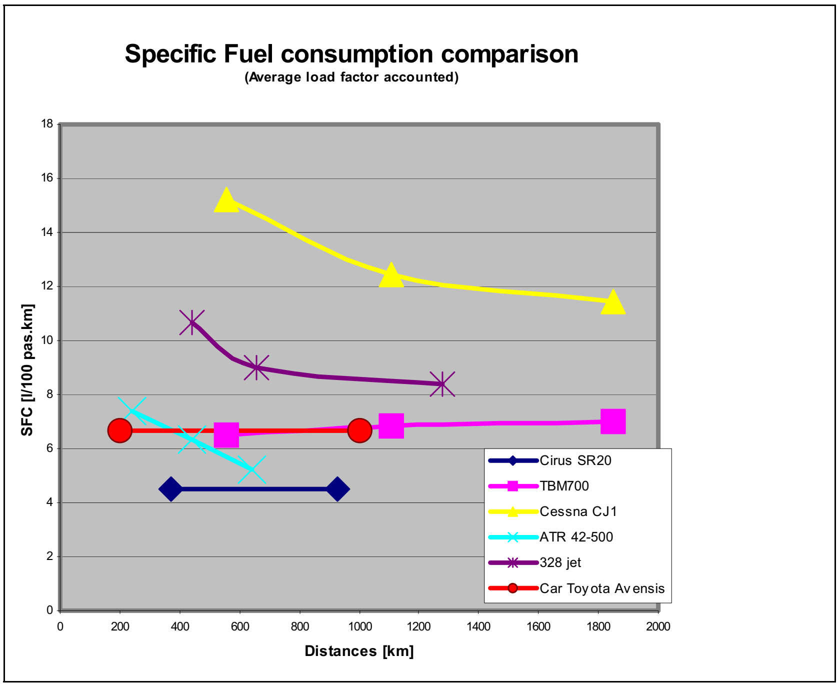
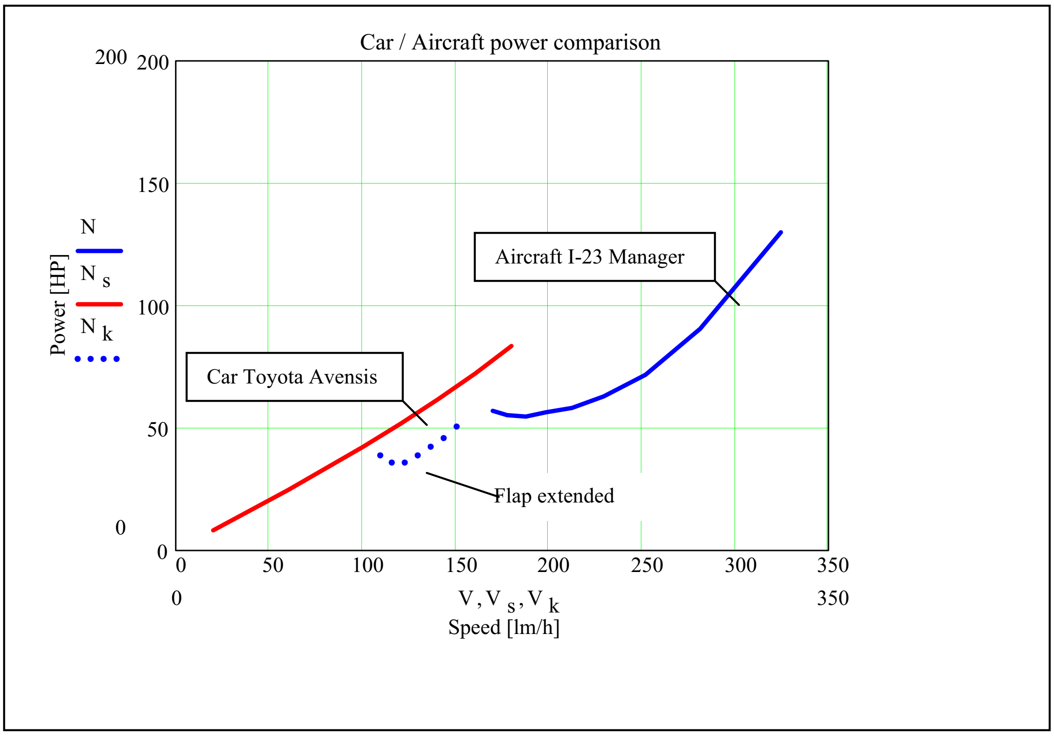
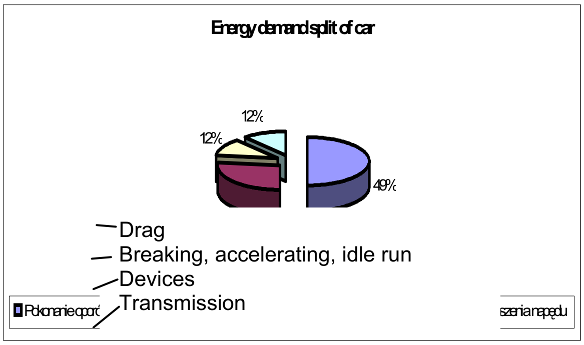


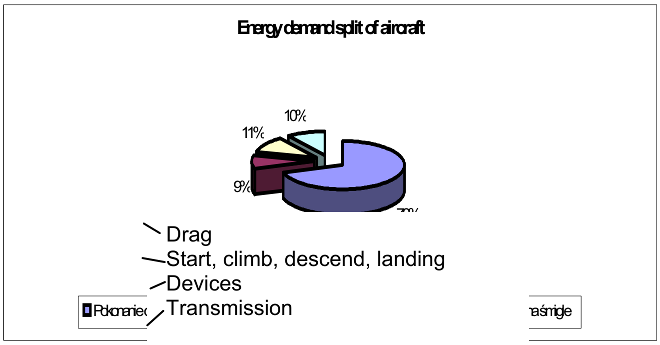
Figure 2-9 : Specific fuel consumption comparison (Average load factor)

Comparison of unit fuel consumption, in standard conditions, of aircraft of different size and with different propulsion depending on different route distances were shown at the graph. When all seats are occupied, on routes no longer then 800 km, a unitary use of fuel by 4-seat Cirrus, at 300 km/h is similar to the one of ATR-42 at block speed of 350 km/h. When considering real load factors, the small aircraft shows better characteristics. The faster, 8-seat TBM 700 indicates higher SFC by 40%, when 6-seat Cessna CJ1 jet has 2,5 times higher SFC.

When car statistical load factor is on average 1,2 persons per vehicle, its SFC on one passenger is on average 6,6 liters/100 km, what is, in comparison to 4-seat aircraft, higher by 50%. This value, at last, reaches 2 liters per 100 passenger-km and is smaller from the one of aircraft. It is important to note, that the comparison of fuel consumption per unit of transport (passenger x kilometer) of two vehicles of very different speeds is not aligned to the definition of energy efficiency and lead to confusion. According to the definition of energy efficiency of transport mode, the energy put in the transport realization should be referred to the energy required for this transport realization, i.e. to 1 pas.km/hour or pas.speed. In reality, even when load factor is 1, the energy efficiency of car is much lower than aircraft. At an average speed of 80km/h, the SFC per 1 pas.km/hour is 0,025l/pas.km/h, when for aircraft at an average speed of 300 km/h it is, respectively, 0,01 litres/pas.km/h. There are two, important reasons for that. Car power need is higher at higher speeds, than the need of the aircraft (higher resistance), energy loses for idle gear and for breaking and accelerating are important in total need of power of car. Figures clearly show it.


Car / Aircraft power comparison
Power [HP]
N
N s
N k
Aircraft I-23 Manager
Car Toyota Avensis
Flap extended
0
50
100
150
200
0
50
100
150
200
250
300
350
V , V s , V k
Speed [lm/h]


Energy demand split of car
12%
12%
49%
Drag
Breaking, accelerating, idle run
Devices
Transmission


Energy demand split of aircraft
10%
11%
9%
Drag
Start, climb, descend, landing
Devices
Transmission

Transport energy efficiency differences of car and aircraft will deepen in favor of aircraft. Assuming a similar development of car and plane propulsion towards more energy saving and ecological solutions, the differences will deepen due to changes in energy demand. Energy loses of car transport caused by road traffic, car mobility resistance and load factor will not be significantly changed and the congestion growth trend will remain disadvantageous. It is opposite in the air transport. There are still large reserves in energy demand at aircraft technical level (aerodynamics perfect ness increase, better material and technology use, lower weight), as well as at the system level (better use of airport network, new air traffic management systems implementation). It is estimated that a unitary need for energy in EPATS system may be decreased in comparison to the present state in aviation by about 30%.

It is worth mentioning, that the trend in air transport, focusing on hub-and-spoke system, good to serve large flow of passengers, by large aircraft does not favor energy saving, what is proved by the large disparities between unitary fuel consumption at the level of aircraft and the system.
In air transport, transport system energy efficiency should be treated with a great care. It significantly impacts on liquid fuels reserves depletion, air pollution and transport costs.
Air network efficiency and air traffic management system, although hard to examine, apart from delay indicator should be measured by energy loses indicators.

Since 1970 the specific fuel consumption of the European passenger fleet has already been cut by 70%. It is intended that this trend should continue. There are a lot of opportunities of reducing further specific fuel consumption - i.e. the amount of fuel necessary to transport one passenger over a certain distance in given time. Further reductions in the specific fuel consumption of aircraft can be achieved not only through advanced engines, improving aircraft aerodynamics. introducing lighter materials, replacing heavy system components with lighter ones, but also by improving ATM – ATC technology, using direct link between nearest local airports and operating the most accommodated capacity of aircraft fleet.

Energy consumption statistics for modern civil aircraft show that air travel is not only a fast but also a fuel-efficient form of transport. The specific fuel consumption of some airliners at cruising speed is now below 3,5 litres of kerosene per 100 passenger-kilometer.

On average, for a long-distance journey, a mean class car with average consumption 8 litres per 100 km and average occupancy 1,3 persons per car will have a specific fuel consumption of 6,15 litres per 100 passenger-km. According to these figures, long-distance car travel requires a higher specific fuel quantity of 25 % more than a propeller aircraft. Only if a minimum of three people is traveling in one car, do they consume less fuel per capita than in an aircraft. Even then, the time, cost and accessibility factors in reaching many destinations are points in favour of air travel.

At one time extraction costs and availability of aviation fuel had little impact on the evolution of the air transportation industry. Today, fuel conservation in aviation is one of the most critical concerns to air transportation
By the early 1970s it had become increasingly evident that the era of plentiful, inexpensive petroleum-based fuel was ending. The fuel cost was becoming more significant in air transport economies. The forecast of jet fuel prices on the current dollars scale are expected to follow the trends of the previous years, indicating a four percent increase per year over 12 years. In order

to achieve improved system efficiency a key requirement is an improved capability to accommodate fuel efficient aircraft operations.
The ideal aircraft would be economical to buy, maintain, have a high cruising speed, short take-off and landing distance, long range (adequate to demand), and be fuel efficient. It's highly unlikely for an aircraft to have all of these characteristics but it is possible to retain the most important for the market The goal in aircraft design is to achieve a rational balance between vehicle performance in combination with affordability.

2.4. Materials effectiveness

We understand material efficiency of a transport mode at the vehicle level as a degree of material use, needed to transport passengers – we assume, that it is relation of useful vehicle weight to total weight (take-off weight). At the level of transport system, we assume, that the weight of material, needed to transport 1 passenger-kilometer in full life cycle is measured in kg/pas.km.
Material efficiency was calculated basing on statistical data of aircraft MTOW from 1300 to 28 000 kg and for an average personal car of 1700 kg.

Calculation assumptions:
- Life cycle of aircraft: 20 years, of car: 10 years
- Flight hours yearly of 9-seat aircraft for air-taxi and charter: 600 h, for more than 10-seat aircraft: 1800 h yearly
- Speeds were taken from characteristics
- Load factor of car: 0,3, of aircraft: 0,65
- Average car yearly volume of kilometers: 10 000 km.

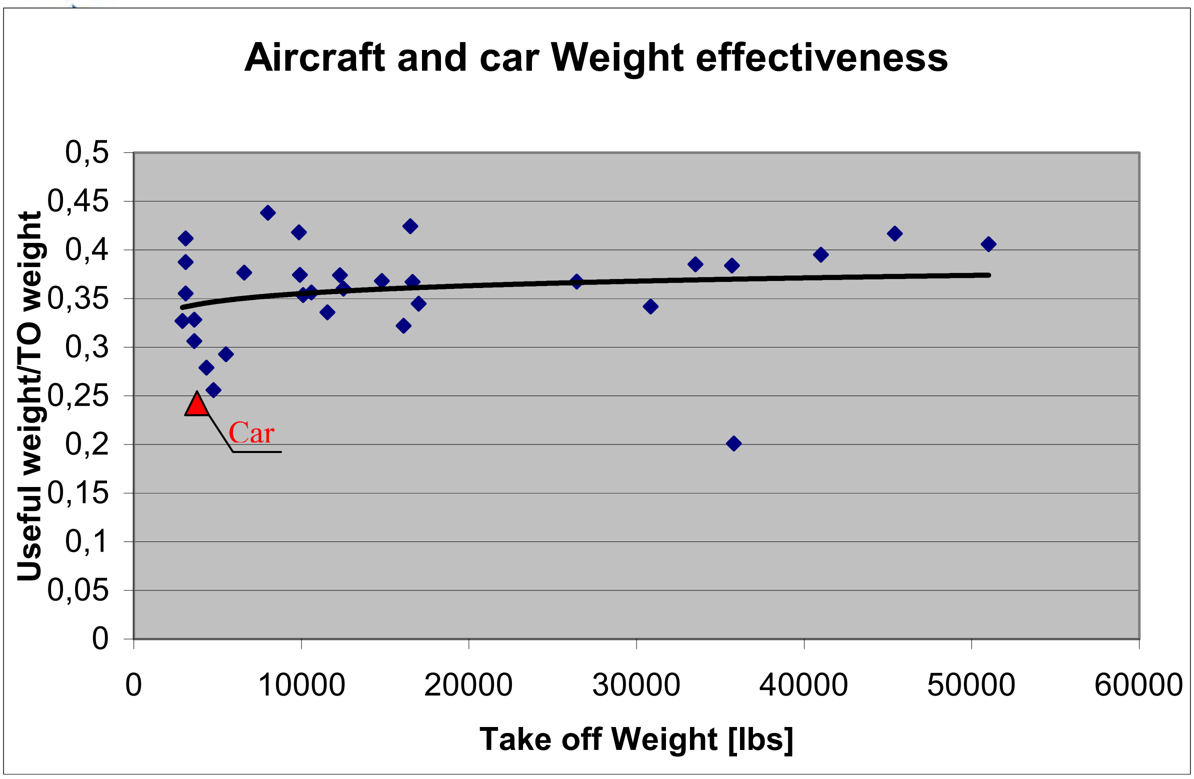


Figure 2-12: Aircraft and car weight effectiveness

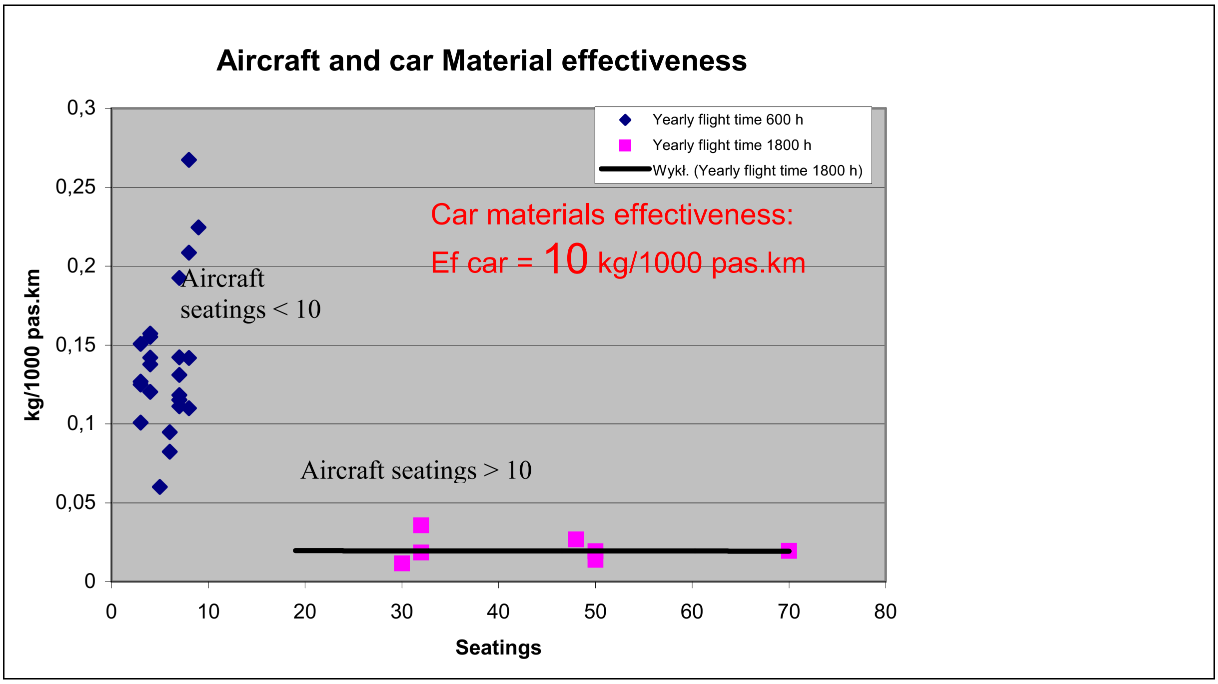


Figure 2-13: Aircraft and car material effectiveness

Material effectiveness is calculated according to the following relations:

Effectiveness = vehicle weight / (life cycle x yearly flight hours x travel speed x number of seats x load factor)

The differences in material efficiency among smaller and Langer aircraft comes from different assumptions of yearly flight hours, what is supported by their purpose – small aircraft are mainly used as air-taxis, larger – for regular flights. Average, absolute values are: 0,14 for small and 0,025 kg per 1000 passenger-kilometers for larger. The differences are slight and in comparison to the one of car can be omitted (car: 10 kg per 1000 pas.km, that is 2 ranks higher). If we total the material use with land consumed by roads, highways, parking places and other materials used for motorization infrastructure, then we clearly see, how great benefits is brought by passenger air transport, if we consider land use.

2.5. Impact on environment by costs externalities measurements

The impact of air transportation on environment is carry out through costs externalities evaluation.

The sources of data presented below are:

Sources:

[10].“The Social Costs of Intercity Passenger Transportation: A Review and Comparison of Air and Highway” by David M. Levinson

[11]. Efficient Vehicles Versus Efficient Transportation - Comparing Transportation Energy Conservation Strategies By Todd Litman *Victoria Transport Policy Institute* 6 May 2005

[12].„Sector Operation Program. Transport for years 2004-2006”. Polish Infrastructure Ministry

[13] Values assumed for the aeroplanes are based on the comparative analyses, taking mainly into account the difference in: fatalities rate and crash externalities, traffic congestion, street parking, local air pollution, roadway costs and traffic services.

		EXTERNAL COSTS OF TRANSPORTATION						
		in US dollars per passengers kilometers travelled						
	Vehicles	**average Car 1**		**Car 2**		**Aircraft 2**	**Car 3**	**EPATS 4**
		$/vkt	**$/pkt ***	**$/vkt**	**$/pkt**	**$/pkt**	**$/pkt**	**$/pkm**
Users costs	Vehicle ownership	0,15	0,1					
	Vehicle operation	0,09	0,06					
	Off-street parking	0,036	0,024					
	Users costs	**0,276**	**0,184**			**tbd**	**0,3**	**tbd**
Externalities	Traffic congestion	0,03	0,0200	0,0069	0,0046	0,0017		0,0005
	Local air pollution	0,024	0,0160	0,0056	0,003733	0,0009		0,0003

	Crash externalities	0,024	0,0160	0,03	0,02	0,0005		0,001
	Fuel externalities	0,024	0,0160					
	Roadway costs	0,01	0,0067					
	Traffic services	0,007	0,0047					
	Barrier effect	0,007	0,0047					
	Noise pollution	0,0065	0,0043	0,0068	0,004533	0,0043		0,002
	Total externalities	**0,1325**	**0,0883**	**0,0493**	**0,032867**	**0,0074**	**0,06**	**0,0038**

Total costs	**0,4085**	**0,2723**

- 2004 Dollar per passenger kilometer traveled assuming 1,5 passengers by car

Data taken into account in furthers analysis

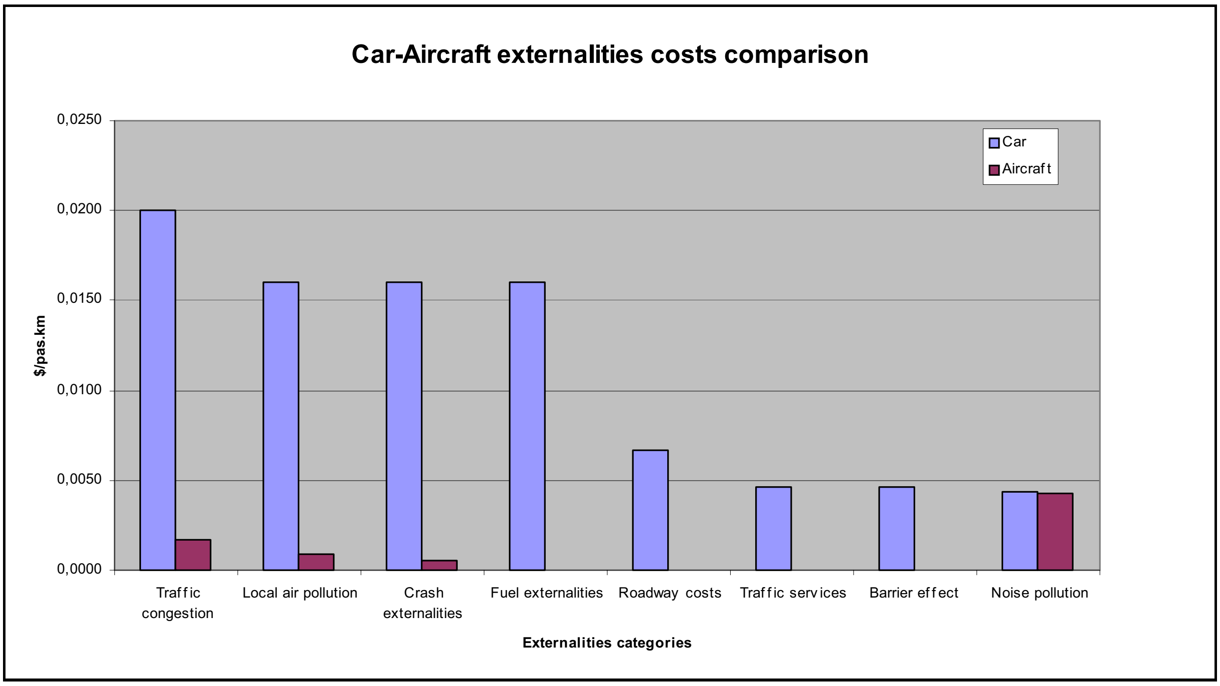


Figure 2-14 : Car-Aircraft externalities costs comparison

2.6. Affordability and accessibility

To high speed mode of transport in interregional trips (500 - 2000 km) (inter eu-25 and national),
we consider that the mode of transport is **accessible** if the access time to transportation system node is less than 1 hour and we consider the mode of transport is **affordable** if the cost of travel does not exceed the cost of transport by car + time value + accommodation costs for a one way distance of 1000 km

For these assumptions we evaluate the affordability and accessibility (the share of people) of current high speed mode of transport and EPATS 2020

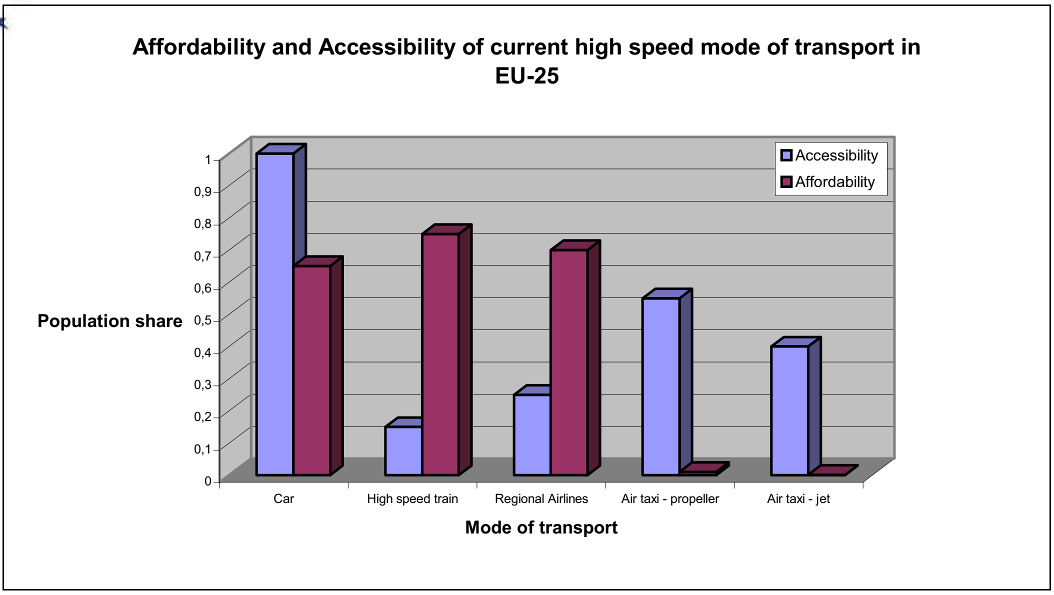


Figure 2-15 : Affordability and accessibility of current high-speed mode of transport in EU-25

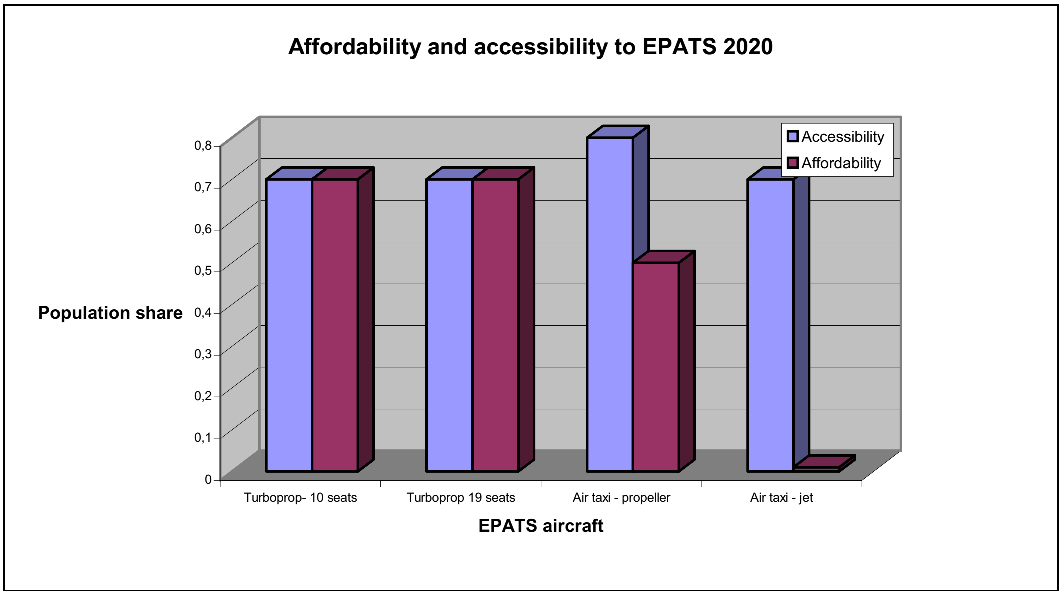


Figure 2-16 : Affordability and accessibility to EPATS 2020

For air transport accessibility can be also presented as the average distance to the nearest airport from where the flight is possible. The figure below shows the distance to different class of airport for a given percent of population.

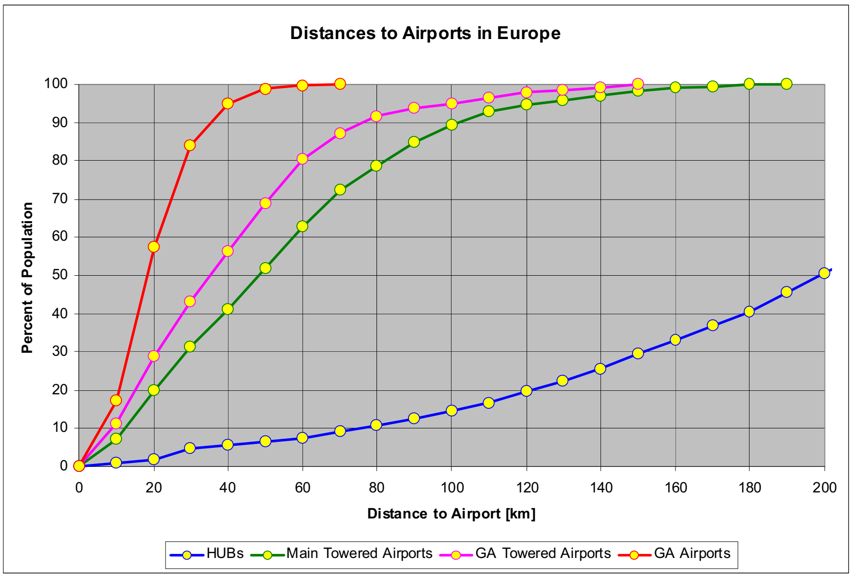


Figure 2-17 : Distances to airports in Europe

Some results of transport mode distribution analysis, based on minimization of generalized cots, are presented below. They shows the affordability of 3 different modes of transport (car, piston and jet aircraft) via travel Great Circle Distance and passenger value of time

MODAL SPLIT VIA DISTANCE AND TIME VALUE

Inverse Cummulati Frequency %	Time value [Euro/h]	One way travel Great Circle Distance [km]							
		200	300	500	700	900	1100	1300	1500
80	3	Car	Car	Car	Car	Car	Car	Car	Car
60	5	Car	Car	ACP-1	ACP-1	ACP-1	ACP-1	ACJ-1	ACJ-1
40	8	Car	ACP-1	ACP-1	ACP-1	ACP-1	ACP-1	ACJ-1	ACJ-1
20	13	Car	ACP-1	ACP-1	ACP-1	ACP-1	ACJ-1	ACJ-1	ACJ-1
10	18	Car	ACP-1	ACP-1	ACP-1	ACP-1	ACJ-1	ACJ-1	ACJ-1
5	22	Car	ACP-1	ACP-1	ACP-1	ACP-1	ACJ-1	ACJ-1	ACJ-1
1	33	Car	ACP-1	ACP-1	ACP-1	ACP-1	ACJ-1	ACJ-1	ACJ-1
0,1	64	ACP-1	ACP-1	ACP-1	ACP-1	ACP-1	ACJ-1	ACJ-1	ACJ-1
0,01	80	ACP-1	ACP-1	ACP-1	ACP-1	ACJ-1	ACJ-1	ACJ-1	ACJ-1

Car	Car, Average travel speed = 80 km/h, Operating Costs = 0,5 E/km
ACP-1	4 seat Piston Aircraft, Vcr = 320 km/h, Operating Costs = 350 E/h
ACJ-1	5 seats Jet Aircraft, Vcr = 700 km/h, Operating Costs = 1050 E/h

Many inter-city connection analysis shows that door-to-door travel time in Europe can benefit from a different approach to air travel.

The planned implementation of Interactive Transportation Network reinforces the affordability and accessibility of EPATS presented above

2.7. Recapitulation

1. When we are dealing with efficiency, definition and measurement level must be given
2. Levels of measurement influence efficiency evaluation significantly.
3. The shorter distances and larger aircraft, the wider differences.
4. Despite the fact, that larger aircraft have better weight ratio and energy consumption characteristics, it is small aircraft, which provide higher efficiency in particular situations.
5. Mode efficiency should be measured at the national/European economy level considering social efficiency.
6. Air transport is safer, environmentally friendlier and more energy and resource efficient than car.
7. The greatest disadvantage of contemporary modes of high-speed transport (scheduled air, hi-speed train) are infrastructure development limitations, low nodes accessibility causing unbalanced regional development as a side effect.
8. The EPATS keeping all advantages of air transport enables negative externalities limitation and contributes to a more cohesive territorial development of EU-27.

2.8. Conclusions

Main natural determinants of personal transportation system efficiency are:

- Traveling time as an effect of a mode speed, infrastructure, traffic management system and accessibility
- Energy used (fuel) on the realization of one passenger kilometer at given speed
- Resources used for the mode of transport and infrastructure production on one passenger kilometer
- Impacts on ecology

The global determinant including all factors expressed in monetary form is the generalized cost of transport of one passenger-kilometer.
These quantities will be used to evaluate the effectiveness of EPATS and to compare its to others transportation modes

General Definition of Air Transport Efficiency – suggestion:

At the system level Air Transport Efficiency is defined as energy consumption or costs needed to shift one passenger (or kg) on representative (average) origin to destination Great Circle Distance in time according to a fixed plan and complying specifications requirements, including safety and environmental costs.

The main Vision 2020 Goal for EPATS is to reduce energy consumption and costs to the Car level.

3. Mobility in European countries

The objective of this section is to analyse the main characteristics of the mobility in Europe when particularly focusing on the mobility features on the connections where personal aviation could potentially operate. Besides this general analysis of mobility in Europe we also focus on the mobility analysis in two particular countries: France and Poland.

Both indeed belong to the countries with the highest traffic level in old European countries and new European countries. With 5.2 billions of passengers in 2000 (on trips over 100 km) France belongs to the top 4 of old European countries while with 1.4 billions of passengers (Figure 3-1), Poland is the new European country with the highest traffic level in 2000 (Figure 3-2). Both countries are therefore particularly interesting to be analysed in terms of mobility features as representative of old and new European countries.

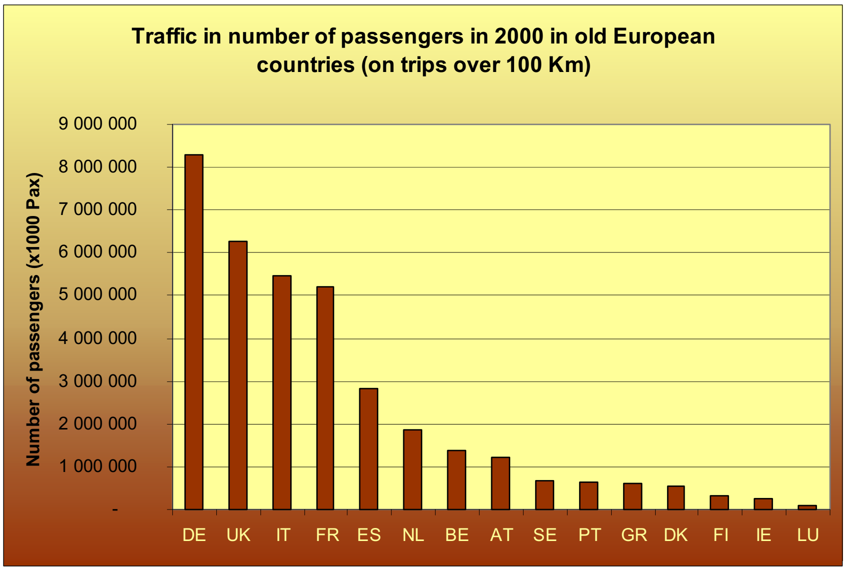


Figure 3-1 : Traffic in number of passengers in 2000 in old European countries (Source ESPON)

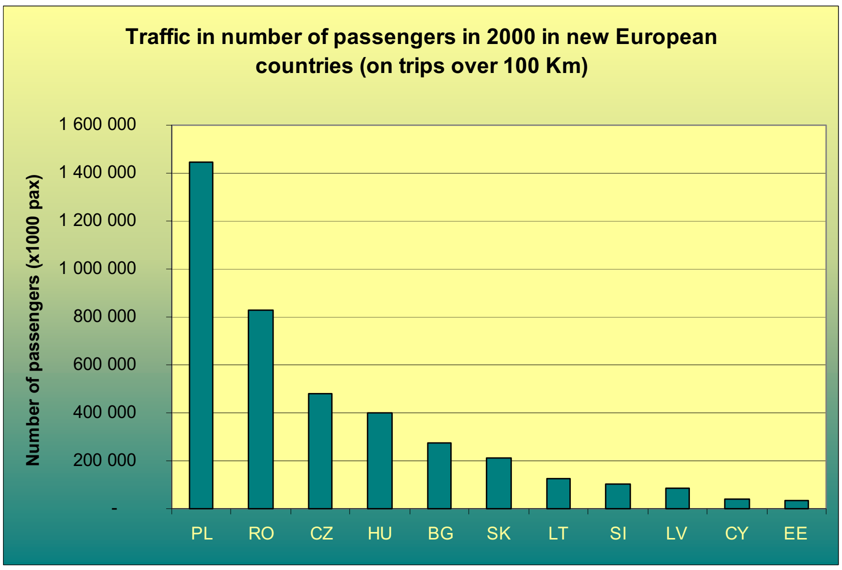


Figure 3-2 : Traffic in number of passengers in 2000 in new European countries

(Source ESPON)

3.1. European mobility overview

3.1.1. Traffic and Evolution

Data on passenger transport in EU-25 has become increasingly available since 1995. Before this date, we do not have enough information for the whole countries. The analysis first of all focuses on the traffic evolution in EU 15 only, to have a large overview on transport activity in Europe since 1970. In a second step the analysis outlines the recent evolution of traffic in EU 25 and provides an insight of the current situation in transport.

3.1.1.1. Traffic evolution in EU-15 from 1970 to 2001

During the period 1970 – 2001, passenger transport in European Union 15 has more than doubled : it has been multiplied by 2,28, going from 2 117 billions to 4 834 billions passenger-km[2]. This corresponds to an average annual growth of 2,7 %. Transport growth was particularly strong at the beginning of the period, as shown in Table 3-1 (+ 3,4 % per year from 1970 to 1980), but since the 1990's, the annual growth has slowed down and does not exceeded 1,8% per year.

Average annual growth rate (%)	Mode of transport					Total
Period	Car	Bus - Coach	Tram -Metro	Railway	Air	All
1970 – 1980	3,7	2,6	0,3	1,3	8,4	3,4
1980 – 1990	3,4	0,6	1,8	0,8	7,8	3,0
1990 – 2001	1,7	1,1	1,2	1,2	5,6	1,8
1970 – 2001	**2,9**	**1,4**	**1,1**	**1,1**	**7,2**	**2,7**

Table 3-1 : Passenger Traffic Growth by transport mode in EU 15 between 1970 and 2001

(Source : European Commission Ref 15)

However the growth in passenger traffic significantly differs between transport modes. Figure 3-3 points out this gap between modes: the growth of air traffic in passenger kilometres (intra EU 15 + domestics) was significantly stronger than that of the other modes between 1970 and 2001. Indeed, air transport increased by 766 % over the period, while transport modes such as bus / coach, Tram / metro and Railway hardly grew by 50 %. At the same time, the level of car traffic was multiplied by more than two between 1970 and 2001, in terms of passenger km. Besides, the annual growth in car traffic (+ 2.9 % per year) is quite close to that of transport in general. This growth of individual road transport, particularly strong between 1970 and 1990, is mainly due to an increase in the level of motorization.

More precisely we observe two different trend in terms of growth rates evolutions: while the dynamic growth of the air market decreased over the period (5,7 % traffic growth per year between 1990 and 2001, versus 8,4 % between 1970 and 1980), the growth rates of rail transport, particularly low between 1980 and 1990, increased over the last 10 years because of the development of the high speed rail network.

[2] Passenger-km = unit of passenger traffic. It represents the movement of one passenger over one kilometre.

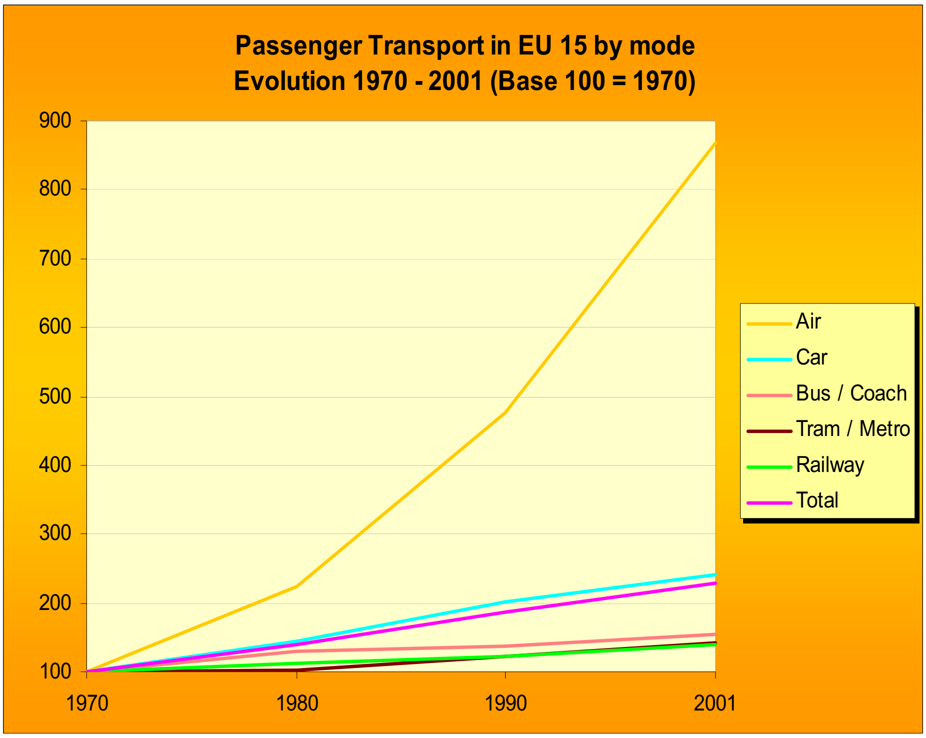


Figure 3-3 : Evolution of passenger transport by mode in EU 15 between 1970 and 2001

(Source : European Commission Ref 15)

This growth difference between modes generated an evolution in modal split. Figure 3-4 shows that the shares of air and road traffic in the total passenger km traffic continually increased since 1970 : car transport was and is dominant over the other modes, with a market share of 73,8 % in 1970, reaching more than 78 % in 2001. The rise in the air transport market share is even more outstanding : it rose from 1,6 % to 5,9 %. Conversely, the market shares of Bus / Coach, Tram / Metro and Railway widely fell from 23 % to 16 %.

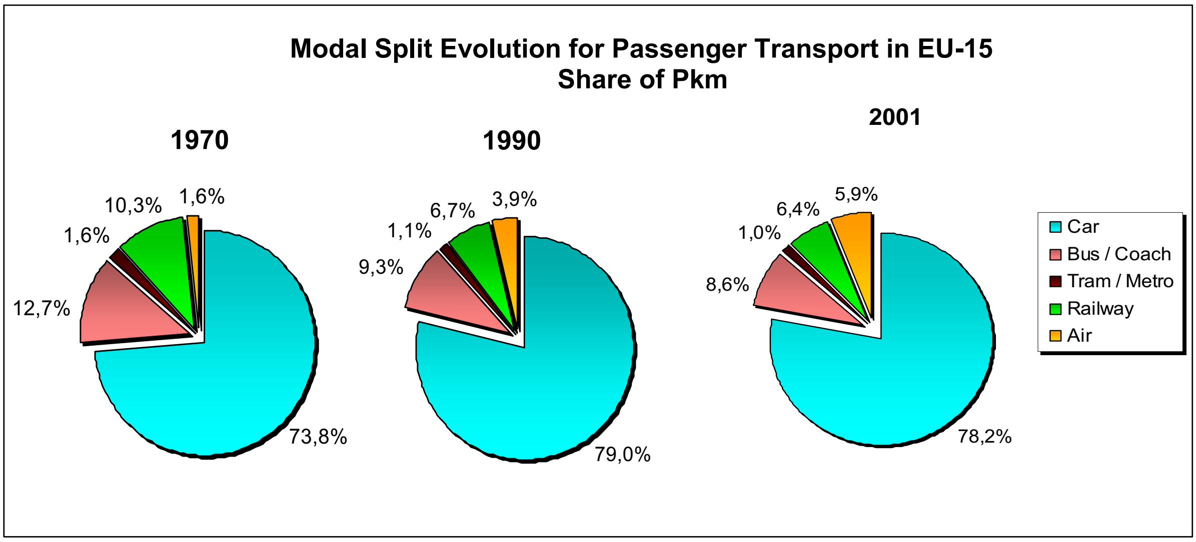


Figure 3-4 : Modal Split Evolution for passenger transport in EU 15

(Source : European Commission Ref 15)

3.1.1.2. *Traffic in EU-25*

A very large share of traffic is concentrated in European Union 15, which accounts for 81 % of the total population in EU 25 (source: DG Tren). However this share tends to decrease, as shown in Figure 3-5: in 1995, EU 15 citizens made 88% of the total EU 25 traffic in passenger km, versus 85 % in 2001. Because of new member country development, we can reasonably assume a continuation of this trend from 2005.

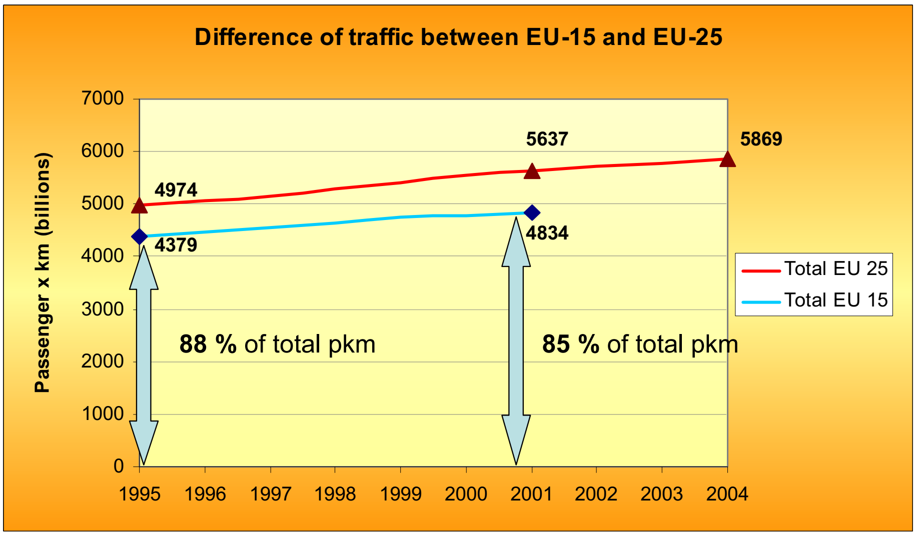


Figure 3-5 : Difference of traffic between EU 15 and EU 25

(Source :Ref 14)

Now, let's have a look at the current situation of transport in European Union 25.
Over the period 1995 – 2004, we observe the same general trend as for the EU 15 in the late 90's: the yearly average growth rate in passenger traffic in EU 25 is 1,9 % (vs. 1.8% in EU 15). Moreover, the modal split for EU 25 in 2004 is close to the modal split of EU 15 in 2001. Indeed as shown in Figure 3-6, the individual road transport is preponderant with a market share of 76 % (vs 78% in EU 15 in 2001). Air transport market share reaches 9 % (vs. 6% in EU 15 in 2001), and transport by rail only 6 % (same share than in EU 15 in 2001). The market share of other modes (metro, bus, coach and tram) is about 10 %.

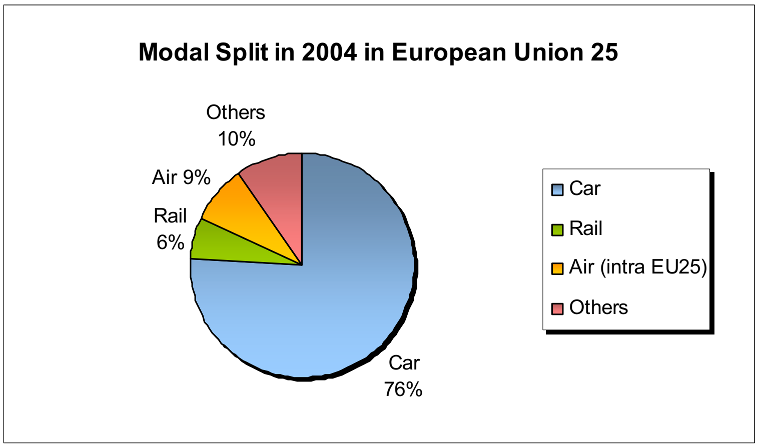


Figure 3-6 : Modal Split in EU 25 passenger transport in 2004

(Source :**Ref 14**)

Finally, the traffic reaches 5689 billions of passenger-km in EU 25 in 2004, which corresponds to 12 370 pkm per capita each year.

However, characteristics of this mobility can change according to the trip distance. That is why it is important to differentiate two types of trips:

- **Short-distance trips** that concerns trips with a travel distance less than 100 km. They can correspond to trips linked to daily activities such as work, education or shopping but can also be more occasional trips;
- **Long-distance trips** concerns trips with a travelled distance above 100 km. They can be realized within a weekly, seasonal or annual activity : holidays, professional meeting, visiting family, etc.

In the scope of EPATS, only the long-distance passenger traffic is pertinent. That is why we focus our analysis on long distance mobility.

3.1.2. Long-distance journeys

After this large overview of passenger transport in Europe, we can now study in detail the features of long distance trips. Due to the lack of mobility statistics at a EU 25 level this long-distance mobility overview is mostly made at a EU 15 level.

The main source providing useful information for the analysis of the long-term mobility is DATELINE. Dateline is a European Project that realized a survey in all the EU 15 states about long-distance travel within Europe and that created a important database relative to the characteristics of the European long-distance journeys. The survey was carried out in 2001 – 2002.

When performing this mobility overview it would be particularly interesting to make comparison in terms of traffic features between EU 15 and France and Poland that are both countries that we consider in the estimation of the EPATS potential market. Unfortunately the DATELINE database does not contain information for Polish travel, which makes comparison impossible. This long-distance mobility overview therefore mainly focuses on EU 15 and French travellers and is completed with Polish data each time it is available.

When dealing with long-distance journeys it appears necessary to consider two kinds of journeys:

- Business Journey
- Leisure Journey

Indeed, leisure and business journeys have their own specificities and concern persons with different goals and budget.
They are defined as follows :

- **Business Journey** = journey realized for business purpose (professional conference, congress, meeting...). This definition does not include commuting journeys or professional travel (e.g. flight attendants, pilots, truck drivers, sea captains etc.). Business journeys represent about 20 % of the whole long distance journeys (Source Dateline).

- **Leisure Journey** = journey realized in all other cases, for instance to visit friends or relatives, for holidays, sport, shopping, etc.

The analysis of long-distance mobility provides elements on the share that long distance trips represent in the total number of trips, but also on the characteristics of these long distance trips in terms of modal split, distance, duration, number of people travelling together and also the share of journeys abroad.

3.1.2.1. Share of long-distance journeys

"Long distance journeys" is the segment of mobility which increased the most during the last half century. Many determinants such as the rapid development of air transport or the increasing level of motorization, but also the development of tourism contributed largely to the strong growth of long distance mobility : in France, the long distance traffic increased by 108 % between 1973 and 1993 (corresponding to an annual growth of 3,6 %), while short distance traffic only increased by 66 % (source : INRETS Ref 19). Despite fast growth, long distance traffic only represents 40 % of the total travelled passenger x pkm (source : INRETS Ref 19).

According to the Dateline survey, the rate of European people travelling at least once in 2001 on long-distance reaches 70 %. More precisely, 69 % of the European citizens made at least one leisure journey. Besides, only 5% of the European citizens made at least one trip for business purpose in 2001. In France, the departure rate is slightly higher, as shown in the following table:

Departure rate in 2001	Europe	France
all reasons	70 %	77 %
leisure journeys	69 %	76 %
business journeys	5 %	11 %

Table 3-2 : Departure rate in 2001 in Europe and France

(Source : Dateline)

In addition, each French inhabitant makes on average 3,8 long distance journeys yearly, from Dateline : 3 journeys for Leisure reasons, and 0,8 for Business reasons. Unfortunately, we are not able to determine this average number of journeys for Europe, but we can assume that it does not differ too much from French results.

3.1.2.2. Long distance features

- **Modal Split of journeys**

Train, car and aircraft are the three main transport modes used by Europeans on long-distance journeys. The analysis of the modal split between these three modes clearly shows the preponderance of the individual road transport mode since 71% of the traffic of EU 25 long-distance travellers (in number of passengers) is performed by car. Train is the second most used transport mode with a 19% share. The preponderance of the individual road transport mode is moreover higher in France and Poland (Figure 3-7). Another important difference in modal split

between EU 25 and France or Poland is the traffic share of air transport. Indeed this transport only represents 3% of the domestic French traffic and 1% of the domestic Polish traffic.

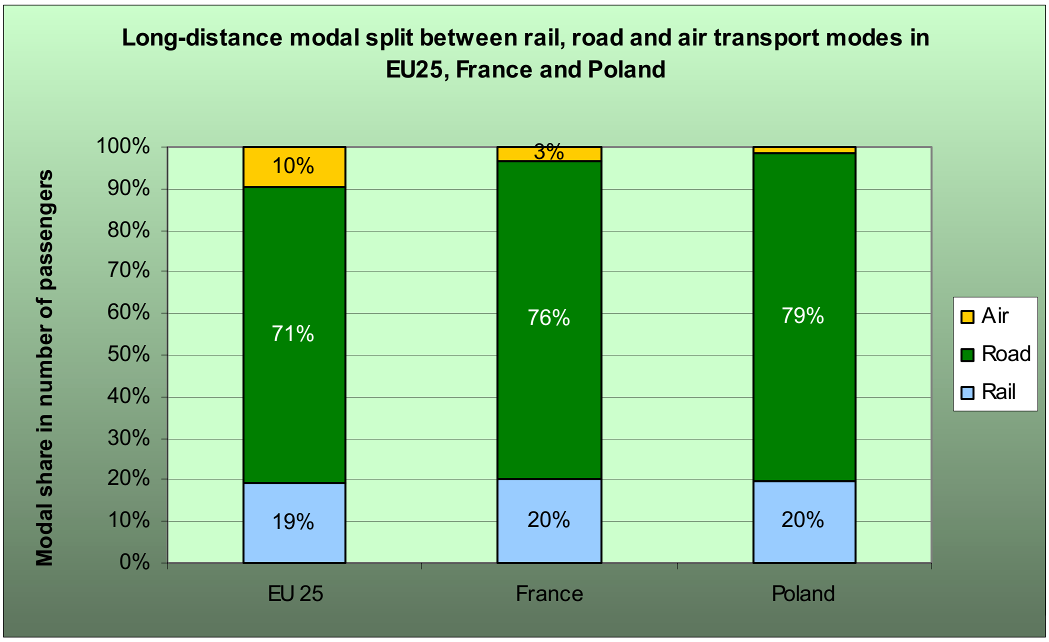


Figure 3-7 : Long-distance modal split between rail, road and air transport modes in EU25, France and Poland

(Source ESPON)

The lower use of the air transport mode in France compared to EU 25 is particularly marked for journeys exceeding 1000 Km. Indeed while representing 64% of the traffic over 1000 km in EU 25, the air transport mode is only used in 31% of the domestic journeys exceeding 1000 Km in France (Figure 3-9). On the other hand, the low share of the air transport mode in domestic Polish journeys can be explained by the non existence of domestic journeys exceeding 800 Km. Until 800 Km the modal share of air transport is quite close to the corresponding modal share in EU 25 or France (Figure 3-9).

Another main difference between EU 25 and French behaviours also arises on distances exceeding 1000 Km where French travellers tend to use, to a larger extent, individual road transport modes than Europeans (Figure 3-9).

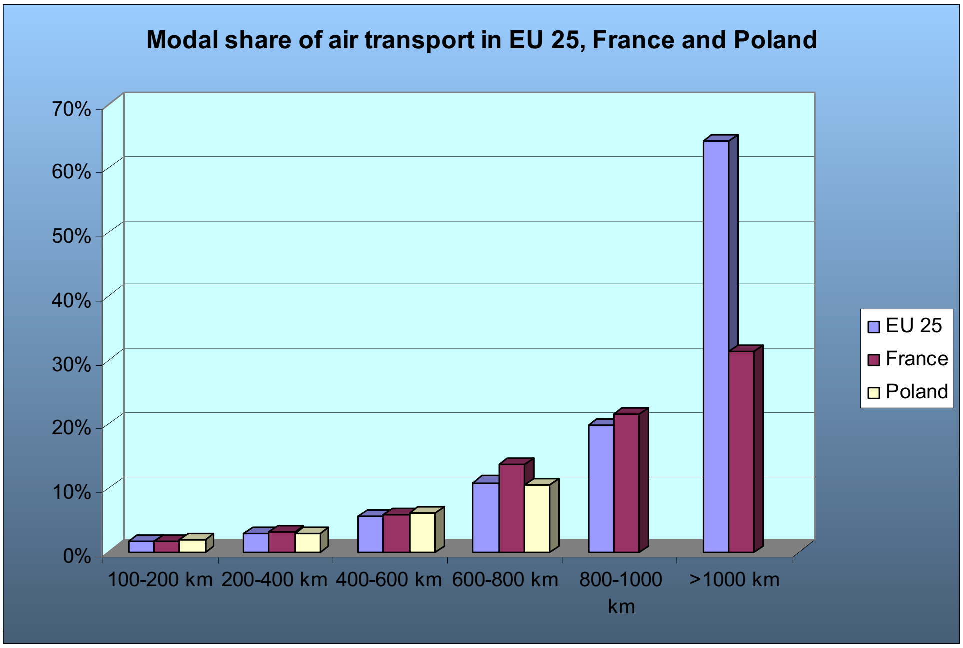


Figure 3-8 : Modal share of air transport in EU 25, France and Poland (Source ESPON)

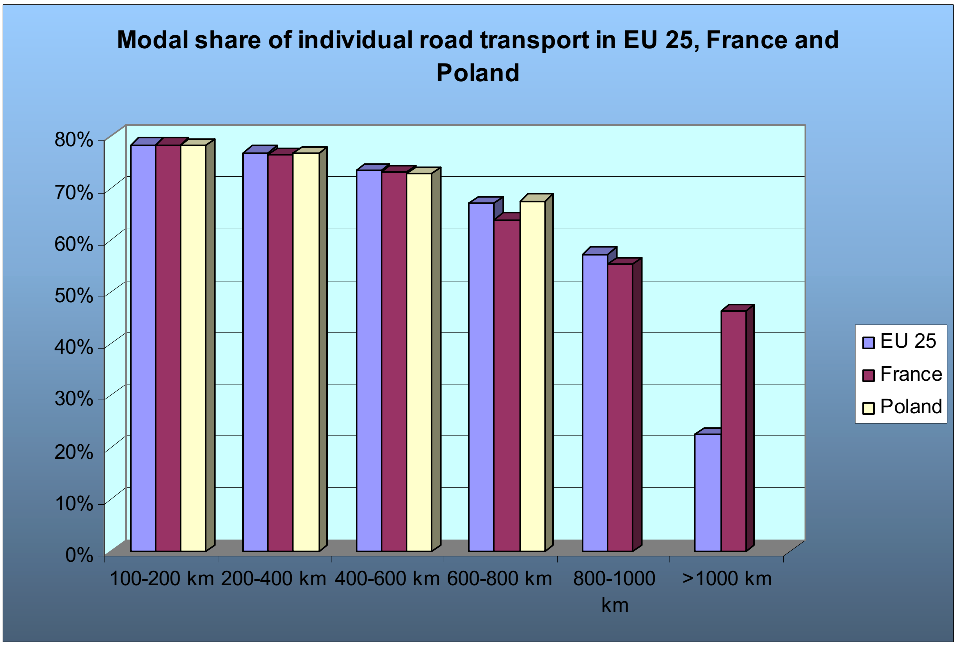


Figure 3-9 : Modal split of individual road transport in EU 25, France and Poland (Source ESPON)

However, these general modal splits can vary a lot according to the purpose of the trip that is why it is particularly interesting to go deeper in the analysis when differentiating business from leisure trip purposes. The following graphs show the modes distribution by travelled distance category. The travelled distance corresponds to the distance of a one way trip.

⇨ **Business Journeys**

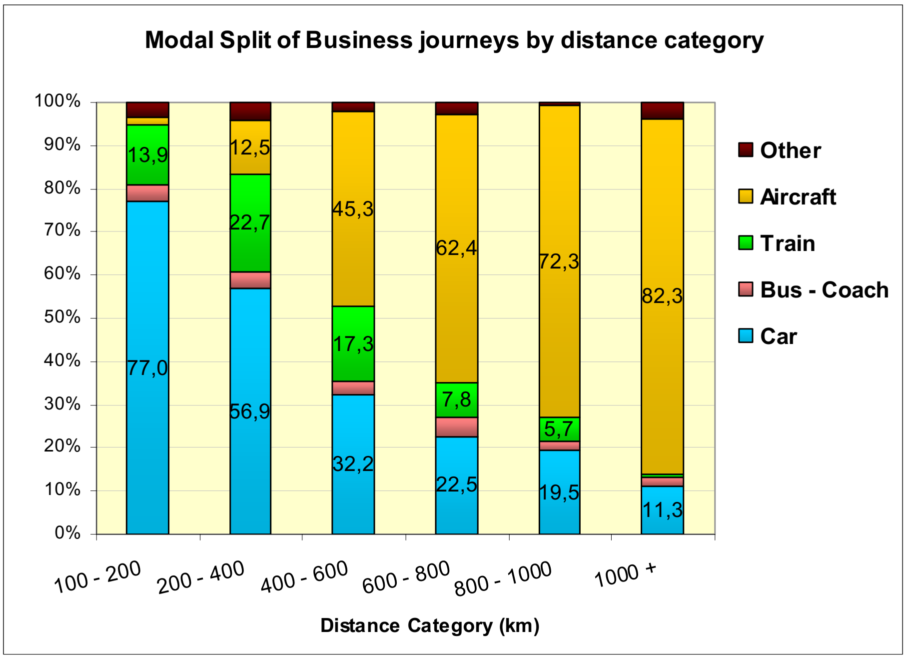


Figure 3-10 : Business Journeys - Modal Split by distance category in Europe

(Source : Dateline)

In business travels the individual car dominates the other modes on short distances, i.e. distances comprised between 100 and 400 km. Above this limit of 400 km, businessmen widely prefer aircraft, because of their higher speed which wastes less time. Train is interesting to a lesser extent for medium distances (200 – 600 km). The other modes (Bus, coach, ship, ..) are hardly used by the business passengers, due to their low speed and their lack of convenience.

A similar analysis on the behaviour of French travellers in long-distance trips tends to show significant differences with the European behaviour. This difference mainly comes from the larger use of rail transport by French people than by typical European people, what can be explained by the large French high-speed rail network. However, we have to be careful when considering Figure 3-11 since the sample of French business travellers extracted from DATELINE is very small which means that shares of modal traffic may not be representative of the real modal split of French business travellers.

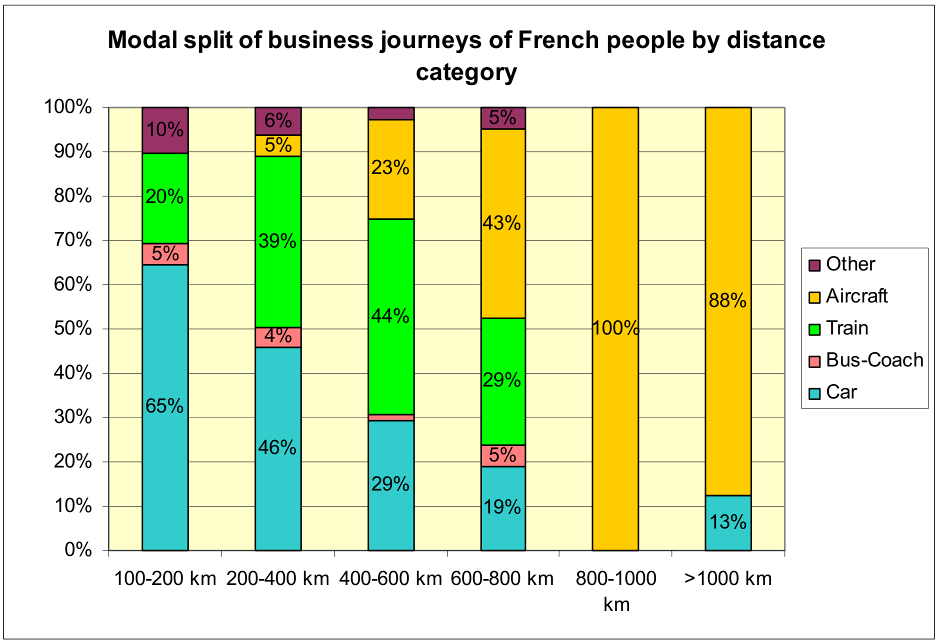


Figure 3-11 : Modal split of business journeys of French people by distance category (Source : Dateline)

⇨ Leisure Journeys

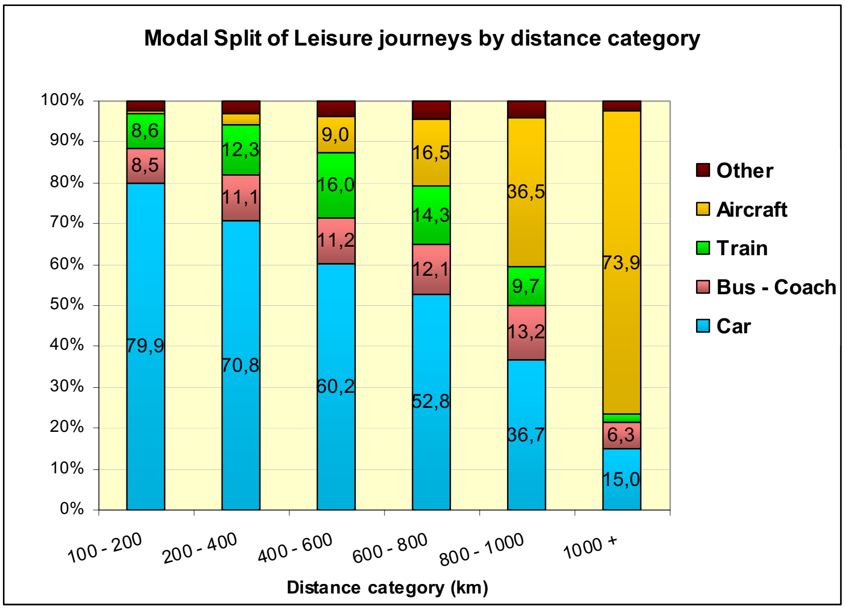


Figure 3-12 : Leisure Journeys - Modal Split by distance category in Europe (Source : Dateline)

The modal split of leisure journeys mainly differs from business journeys due to the preponderance of the car in main distance categories. The high flexibility of a car compared to the other transport modes explains this predominance up to 800 km. From this distance air

transport takes over. As opposed to business travellers, leisure travellers do not hesitate to use transport by coach and bus because of their low price. Finally, the train is mainly used on distances comprised between 200 and 800 km.

As in case of business travel, the main differences in modal split between European and French people mainly comes from the larger importance of rail transport mode. However it is important to note that this higher modal share of rail is not at the expense of the individual road transport. Indeed the traffic share of cars is always higher for French travellers than on average in Europe. On the other hand French travellers are less inclined to use the air transport mode for leisure purposes than European travellers.

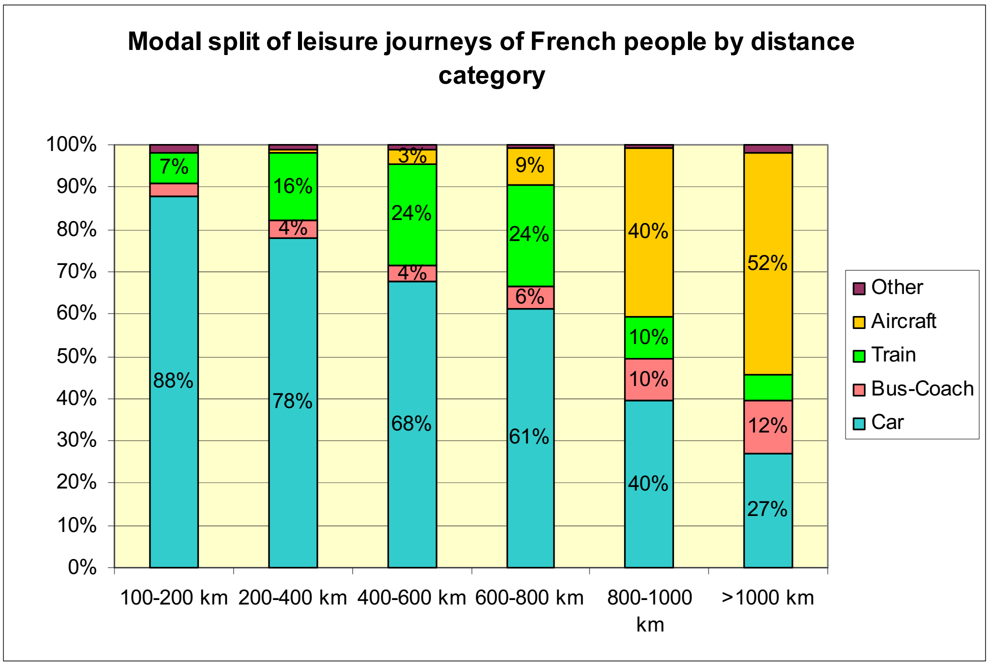


Figure 3-13 : Modal split of leisure journeys of French people by distance category

(Source : Dateline)

All these graphs therefore show the difference of behaviour between business and leisure passengers, and outline the fact that business travellers care about time much more than other travellers.

➢ Travelled distance

Whether it is for business or leisure travel, about three journeys in four are realized at less than 400 km from home (Figure 8). Then, the percentage of journeys by distance category clearly decreases. Lastly, journeys above 1000 km represent 5 to 7 % of the long distance journeys made by European travellers. This graph therefore points out the preponderance of trips below 400 km, and also shows that business and leisure journeys are distributed in the same way.

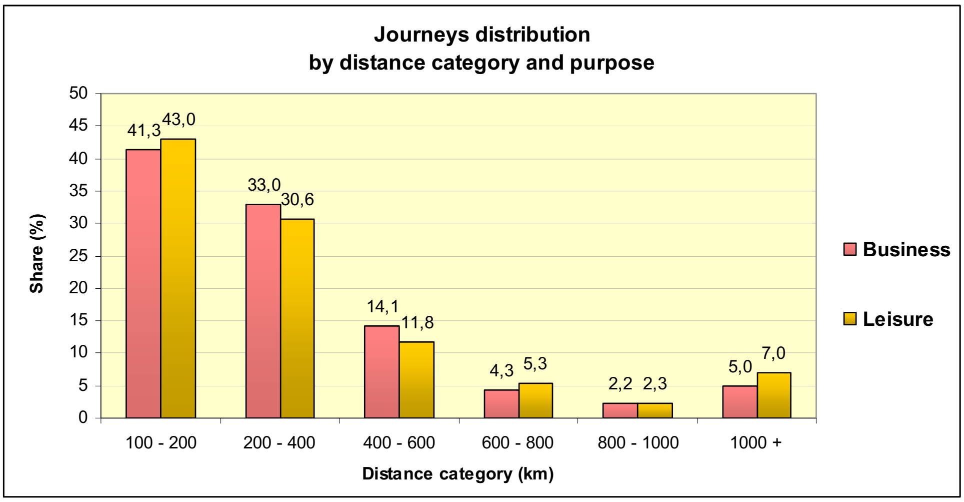


Figure 3-14 : Journey distribution of European travellers by distance category and by purpose

(Source : Dateline)

When comparing the French travelling behaviour with the European one we observe that French tend to travel less for leisure purposes between 100 and 200 km than Europeans while they travel more on the other distance categories (Figure 3-15). Conversely, French tend to travel more for business purposes on very short distances (100-200 Km) and less on longer distances than Europeans.

In addition, we can also note that the average distance of French trips has been increasing for more than 20 years : average distance of 346 km in 1982 and of 406 km in 1994. (Source INRETS Ref 20)

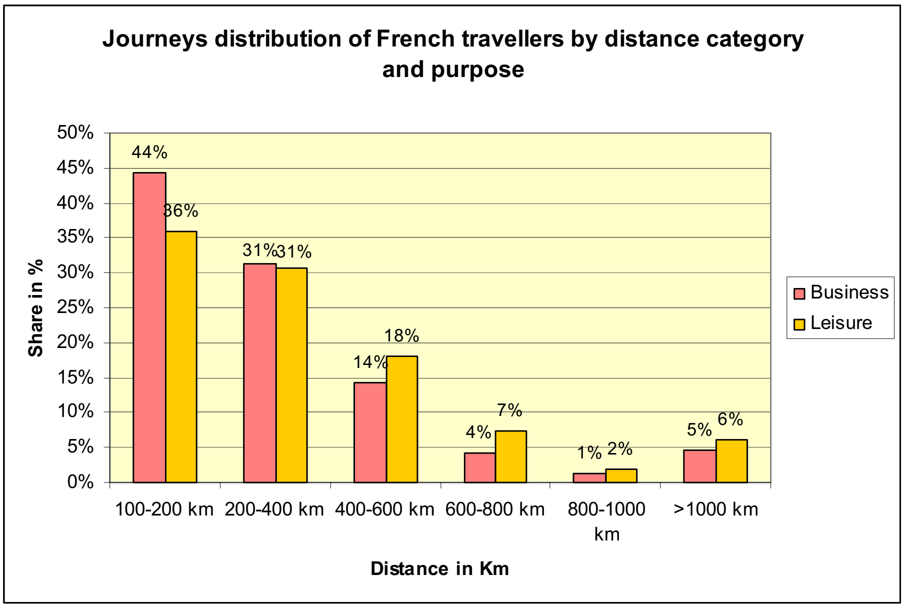


Figure 3-15 : Journey distribution of French travellers by distance category and by purpose

(Source : Dateline)

As the Europeans and the French ones, the distribution of the number of trips made by Polish decreases until 700 Km (Figure 3-16). The main difference comes from the lower share of trips between 100 and 200 km compared to the cases of France and Europe. Indeed they only represent 32% of the trips (as well for leisure as business purposes) while this share exceeds 40% for Europe.

Another particularity of Polish trips lies with the very low number of business trips made by Polish travellers.

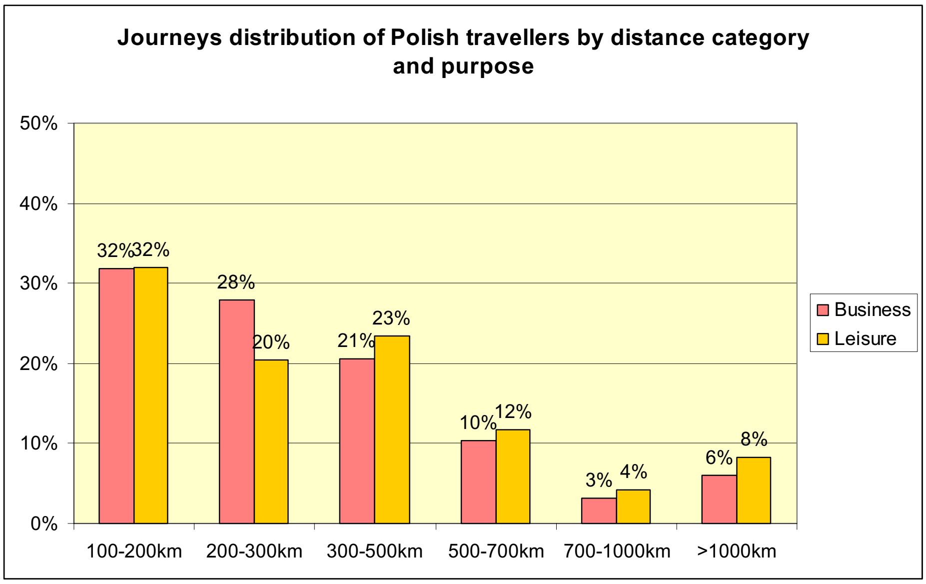


Figure 3-16Journeys distribution of Polish travellers by distance category and purpose

(Source Buczak Ref 1)

- **<u>Travel Duration</u>**

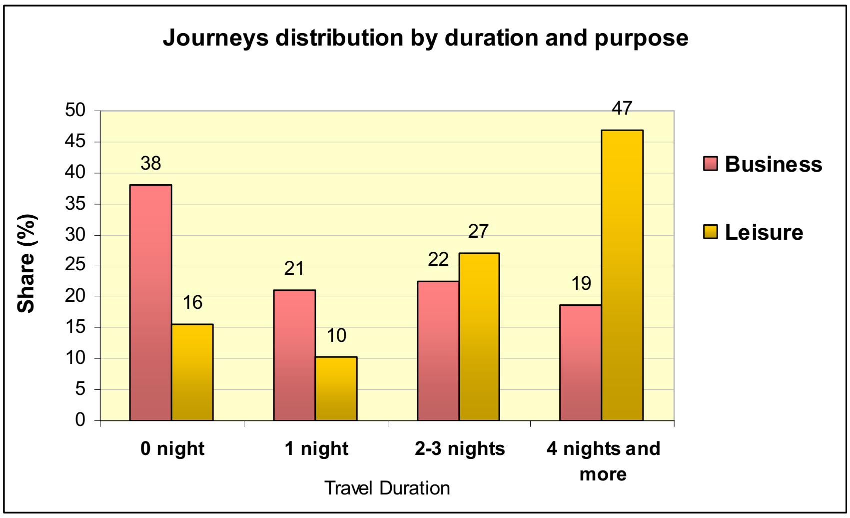
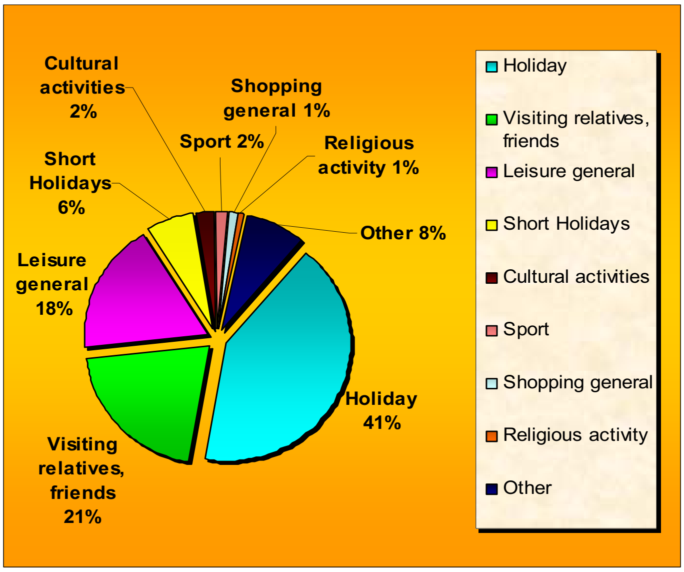


Figure 3-17 : Journey distribution by duration and by purpose

(Source : Dateline)

Figure 3-17 shows that journeys distributions by duration evolve in opposite direction according to the journey purpose: businessmen prefer journeys with short duration, and more particularly journeys undertaken in the day (38 % of all journeys). Conversely, leisure travellers realize only 16 % of journeys in the day, and even less journeys with only one night. They like long trips better. Besides, they especially enjoy travels with a duration of at least 4 nights : almost one leisure journey in two lasts 4 nights or more. This trend in the distribution of journeys according to the duration is similar in 2001 for French travellers (source DATELINE) than for European ones. However, the duration of leisure travels (lasting at least one night) tends to decrease for a few years (Cf. Annex 1). Moreover, the number of long trips (> 3 nights) in 2005 has considerably fallen in respect to 2004 : - 3.1 %, while short trips have decreased by 1.9 % (Cf. Annex 1).

This distribution is easily understandable when referring to the different purposes of leisure journeys : Figure 3-18 outlines the importance of Holiday journeys (= journeys undertaken for the purpose of a holiday and including at least four overnight stays). They represent 41 % of all leisure journeys :



Notes :

- Holiday ≥ 4 nights
- Short Holidays ≤ 3 nights
- Leisure General : short excursions such as going one day to sea or mountain, or going to an attraction park …
- “Other” journeys :personal services, medical care, education, bring or pick up people …

Figure 3-18 : Leisure journeys distribution by purpose

(Source : Dateline)

Two other purposes also stand out : visiting friends or family (21%) and general leisure (18%).

➢ Average number of co-travellers per journey

Little information on the number of persons travelling together is available. A European study (Ref 12) relative to the features of long-distance travel only provides such information for some European countries in 1999. This study shows large differences from one country to another. For instance Danish people, who are relatively autonomous and independent, travel alone in 40% of the cases. Conversely, Spanish and Austrian prefer travelling in groups of at least 3 people. (source European Commission Ref 12).

➢ **Share of journeys abroad**

According to Dateline, among the leisure journeys, 24 % take place abroad. However, this share differs noticeably between European countries, as shown in Table 3-3 :

Home country	AU	**BE**	DA	EI	FI	**FR**	GM	**GR**	IT	**LU**	NL	PO	**SP**	SW	**SZ**	UK
Share of journeys abroad	41,7	**70,8**	43,2	50,1	16,9	**13,0**	35,8	**6,2**	21,1	**100,0**	50,9	12,4	**7,6**	26,6	**57,8**	29,4

Table 3-3 : Share of long distance journeys abroad in European countries

(Source : Dateline)

Note : The countries with the highest rate of journeys abroad are stressed in red, whereas journeys with the lowest rate are in blue.

The smallest countries (Luxembourg, Belgium and Switzerland) appear as the countries the most mobile abroad. Conversely, in the largest countries such as Spain, Greece or France citizens prefer staying in their home country and undertake few trips to foreign countries. This is mainly due to two factors: the size of the country and its diversity (sea, mountains, etc.).

3.1.3. Conclusion on the European mobility overview

Beside highlighting the strong global traffic increase over the past decades (especially in air transportation) and the preponderant share of long-distance trips (>100 Km) that represent 70% of the total European traffic, the overview of the European mobility also particularly stresses the differences in the characteristics of these long-distance trips according to the trip purpose.

The analysis indeed shows that leisure and business trips only present similarities in terms of journey distribution according to the traveled distance. As well for leisure as business purposes, around 74% of the trips are made between 100 and 400 Km.

The other trip characteristics are generally significantly different according to the leisure or business purpose:

- If the use of the air transport mode always increases with the travelled distance, the boundary distance from which the air transport market share exceeds 50% is significantly lower in case of leisure trip. This boundary is indeed 600 Km for business trips and 1000 Km for leisure trips.

- The trip duration is often shorter for business purposes. For instance the share of trips with at least 4 nights duration is 2.5 times higher in the case of leisure trips.

- Both trip purposes also significantly differ in terms of the age of the travellers since the share of travellers over 65 and below 25 is 3.5 times higher when the people travel for leisure purposes.

- The gender distribution also varies a lot between trip purpose since male travellers represent 76% of business travellers vs. 57% of leisure travellers.

The characteristics of the long-distance trips made by French people are very close to the general European characteristics. The main differences concern the modal split:

- the larger use of road transport mode on distance exceeding 1000 Km by French than by European travellers

- the larger use of the rail transport mode than European due to the important French high-speed rail network.

Comparisons between Europe and Poland appear to be very difficult to make due to the lack of data on the features of the Polish mobility. The analysis however manages to show the very low market share of air transport in Poland since only 1% of Polish travellers use this transport mode. In addition trips for business purposes only represent 1% of the total trips made by Polish travellers.

More generally, detailed data on long-distance trips made to and from all the 27 European countries is lacking . This lack of data is therefore an incontrovertible obstacle to the realisation of a total mobility analysis at a EU27 level.

3.2. Main factors influencing mobility

As we showed in section 2, the mobility features can change a lot according to countries, trip purpose, etc. More generally speaking the mobility is driven by numerous determinants that can be sorted into three categories :

- The demographic determinants : what are the characteristics of the traveller, in term of age, gender, occupation, localization, .. ?
- The socio economic determinants: GDP, households level of income, etc.
- The transport supply = what is proposed to the traveller : infrastructure / service (price, speed, quality, etc.) …

3.2.1. Demographic determinants

The goal is to identify and analyse demographic and socio-economic determinants by leaning on the observations at a micro level. Thus, three main factors, Demography, Economy and Localisation, are investigated thanks to the study of the travellers' characteristics. In this section, we mainly base on the French surveys and we principally use as mobility indicators the departure rate, the number of journeys per year and the duration of the travel, by population group. These indicators are shown in Annex 2. Leisure travel is overall concerned.

The demographic growth is naturally a factor of mobility. In the future, the demographic growth is expected to be much lower than in the past. Thus, there is reason to believe that it will generate a slowdown of the transport demand growth.

The features themselves of the demography are also important.

3.2.1.1. Gender

When considering EU 15 we observe a significant difference in travelling volume between genders since 60% of the total journeys are made by men. Moreover this share tends to stay constant whatever the considered distance class .

Nevertheless, behaviours are different in France, since the traffic volume is equally distributed between men and women, i.e. women tend to make the same yearly number of long-distance trips as men.

The higher number of journeys made by male travellers in EU 15 is also confirmed when differentiating the journeys according to their duration. The share of female travellers indeed increases with the journey duration (Figure 3-19). This trend is particularly marked for French travellers since while only around 40% of the journeys undertaken in the day or journeys with one night are made by women, this percentage is around 50% for other journey durations. This lower share of short duration journeys made by women can be mainly explained by the significant lower share of women travelling for leisure purposes compared to men (Figure 3-20), since we already showed that business trips often have short durations.

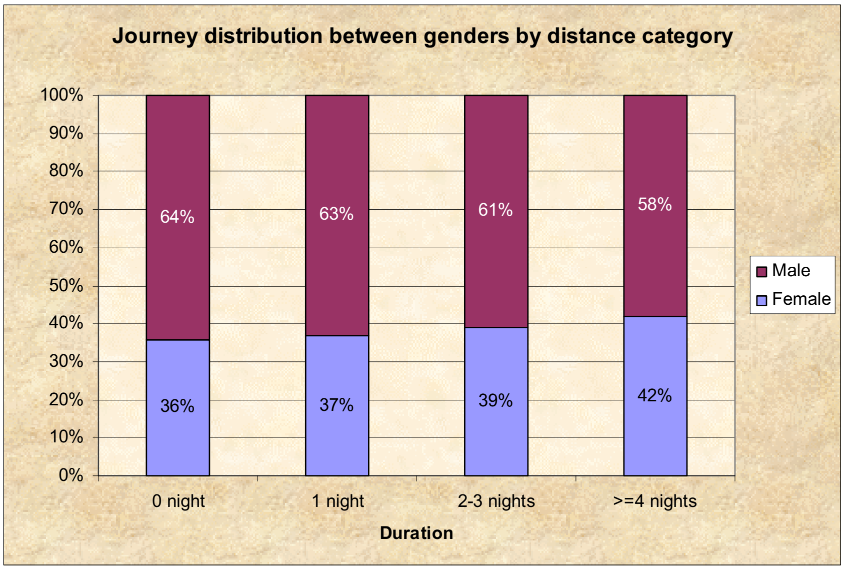


Figure 3-19 : Journey distribution between genders by journey duration

(Source Dateline)

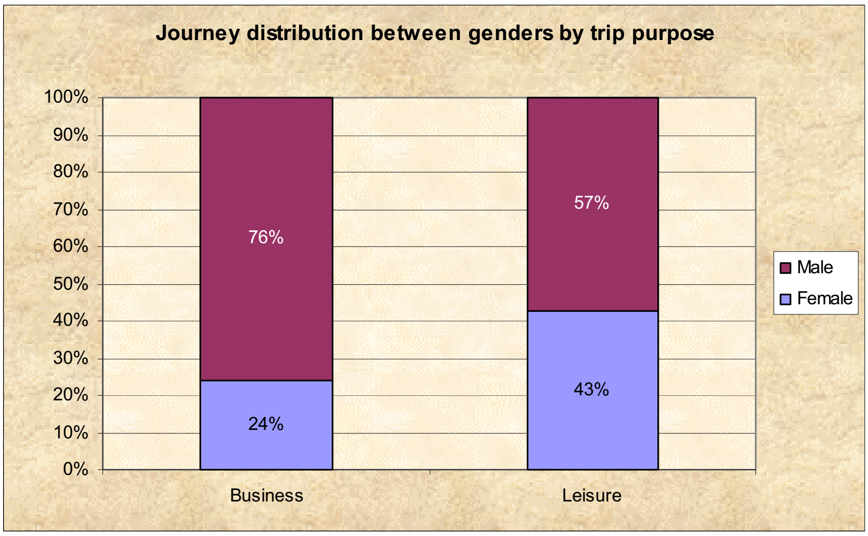


Figure 3-20 : Journey distribution between genders by journey purpose

(Source Dateline)

3.2.1.2. Age

When basing the analysis on the Dateline database we clearly observe that most mobile European people are between 25 and 64 years old. These travellers indeed make 93% of the business journeys and 76% of the leisure journeys.

This trend is confirmed in France by an INRETS study (Ref 19) comparing the holiday departure rates of French people. Young people (less than 30) and people aged 70 and over have the lowest departure rates. In addition, as shown in

ANNEX 2, the number of long distance journeys and the travel duration is growing with the age, with exception of the group "70 and over ". The high level of mobility of the 60 – 70 group is not surprising : it corresponds to the advancement of the retirement age. These people have no occupation and their good health enables them to move. , the number of long distance journeys and the travel duration is growing with the age, with exception of the group "70 and over ". The high level of mobility of the 60 – 70 group is not surprising : it corresponds to the advancement of the retirement age. These people have no occupation and their good health enables them to move.

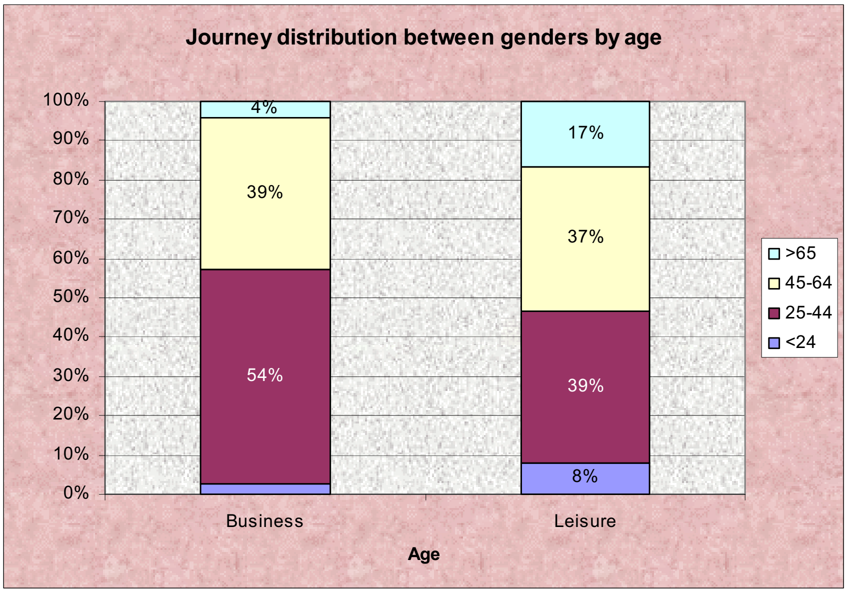


Figure 3-21 : Distribution of the journeys according to the age of European travellers (Source Dateline)

3.2.2. Socio-economic determinants

Mobility growth is strongly linked to GDP growth, but for a few years, decoupling between both growths tends to appear, as shown in Figure 3-22. Decoupling corresponds to the difference between GDP and passenger transport growth. However, this decoupling has not exceeded 0.5% per year. Much more data would therefore be needed to approve this trend.

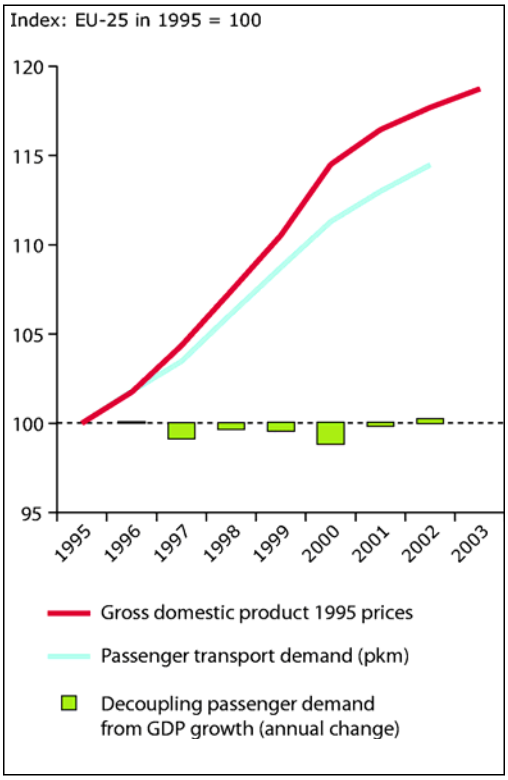


Figure 3-22 : GDP and passenger transport growth

Source: *Eurostat and DG TREN, European Commission*

At a "micro" scale, the impact of economy on mobility is illustrated by the behaviour of people according to their type of occupation and to their income of course (cf. Annex 2)

3.2.2.1. Occupation

The fact of having an occupation supports mobility: 80 % of working people realizes leisure journeys, whereas only 65 % of people that have never worked participate each year to leisure journeys.

The category of occupation is also a determining factor. Managers and intellectual professions are the most mobile categories, with a rate of departure comprising between 87 and 93 %. The income and the cultural level indeed favour the need and the capacity to travel. But some constraints linked to the type of occupation (farmer, craftsmen, owner of a shop) also explain the fact that some categories can not travel as they want.

Lastly, we can notice that the employed in the public sector travel more than in the private sector. It results partially from the higher number of free days in public sector.

3.2.2.2. Location

The home location is also an important factor in the transport demand. Indeed, the level of mobility (departure, frequency) increases with the size of the agglomeration. (Cf.

ANNEX 2). Several reasons for this phenomenon : firstly, big cities represent stress, pollution, proximity, etc. People living all the year in city need generally to rest in quieter places (sea, mountain, countryside…). It also corresponds to a need of nature. Secondly, the transport system is more developed in and around the cities than in the countryside: airports are closer; High-Speed Train connects easily large cities, whereas small cities have only traditional trains. Thirdly, we can assume a higher level of income in big cities, which could as well justify their higher mobility.

3.2.2.3. Income

Mobility grows with the level of income: travel (journeys + accommodation) are expensive, thus money is an important parameter in the choice to realize a travel.
Calculations made from Annex 2 show that the 34 % of the richest of the population undertake 50 % of the journeys.
Hence, one of the main determinants influencing transport mode choice while planning a journey is the level of wealth and individual income of travelers. The value of time, comfort needs and accommodation costs depend on this basis. These factors, expressed in monetary units, play important role in travel costs calculation, and their level depends, also, on chosen mode. His or her low income and low value of time determines a traveler for rational choice of less expensive mode, that cruises at lower speeds. The more one earns the faster and the more expensive vehicle is more advantageous solution. Staying aligned with these rules, the income distribution should be known when planning a transportation system. The more detailed information, the greater possibility to satisfy the needs.

Available data

The internet data search for European detailed income information revealed that the United Nations Economic Commission for Europe[3] is the only free of charge, income data provider. The data is quite old (year 2000) and considers means of gross monthly wages[4]. Some of the information had to be extracted form other sources to fill the UNECE data list gaps.[5]

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[3] http://w3.unece.org/pxweb/DATABASE/STAT/2-ME/3-MELF/3-MELF.asp
Wages and salaries are defined as the total remuneration, in cash or in kind, payable to all persons counted on the payroll, in return for work done during the accounting period. In the ECESDB the data refer to Average monthly gross wage. Average monthly gross wage covers all earned incomes (basic wages and salaries, payments additional to wage or salary, direct remuneration and bonuses, payments for days not worked, remuneration for being on call to work, and other wage or salary components) all charged to be paid to employees for the related period. The data are based usually on a sample surveys - monthly, quarterly and annual. Information on compilation methods and practices in individual countries can be found in the IMFs Special Data Dissemination Standards (SDDS) available on the Internet at http://dsbb.imf.org/Applications/web/sddshome/ (IMFs Special Data Dissemination Standards (SDDS)).

[4] Gross Average Monthly Wages for: Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom are derived by dividing Average Gross Annual Earnings in Industry and Services (Of full-time employees in enterprises with 10 or more employees) by 12.
Gross earnings are remuneration (wages and salaries) in cash paid directly to the employee, before any deductions for income tax and social security contributions paid by the employee. Data is presented for full-time employees in industry and services.

[5] OECD, Economic Outlook No 77, June 2005 and Taxing Wages (2004).

	Indicator name:	GDP per capita	Population	Acitive population	Work activity	Monthly gross wage	Yearly average gross wage
	Unit:	US$ PPP	in millions			US$ currrent exchange rate	US$ current exchange rate
	Source:	UNEC for Europe	[GDP / GDP per capita]	UNEC for Europe, but missing values are the European average	[Active population / Population]	UNEC for Europe	[Monthly gross wage * 12], but for *USA, AT and IE - *OECD 2004 data*
	Year	2000	2000	2000	2000	2000	2000*
0	EU-27		482,42	205,81			
1	BE	26 653	10,25	4,09	0,40	2 430	29 154
2	CZ	14 812	10,27	4,64	0,45	353	4 232
3	DK	28 818	5,34	*2,33*		3 145	37 739
4	DE	25 553	82,19	*35,94*		2 865	34 382
5	EE	9 622	1,37	0,57	0,42	289	3 470
6	EL	16 635	10,92	3,95	0,36	1 130	13 562
7	ES	21 079	40,26	*17,61*		1 338	16 061
8	FR	25 927	60,71	23,42	0,39	2 051	24 611
9	IE	28 844	3,80	1,50	0,39		*34 250*
10	IT	25 880	56,94	*24,90*		1 535	18 418
11	CY	18 811	0,69	0,30	0,43	1 254	15 049
12	LV	8 078	2,37	0,95	0,40	247	2 958
13	LT	8 678	3,50	1,52	0,43	243	2 912
14	LU	50 727	0,44	*0,19*		2 754	33 053
15	HU	12 431	10,12	*4,43*		311	3 727
16	MT	17 864	0,39	*0,17*		964	11 566
17	NL	28 377	15,92	*6,96*		2 449	29 390
18	AT	28 714	8,01	3,78	0,47		*31 307*
19	PL	10 676	38,26	14,53	0,38	436	5 228
20	PT	18 372	10,23	*4,47*		969	11 627
21	SI	14 321	1,99	0,77	0,39	861	10 330
22	SK	10 836	5,40	2,00	0,37	248	2 980
23	FI	26 087	5,18	2,33	0,45	2 104	25 243
24	SE	27 175	8,87	3,73	0,42	2 428	29 132
25	UK	25 729	58,89	27,83	0,47	2 893	34 712
26	BG	6 250	8,00	2,86	0,36	112	1 345
27	HR	9 338	4,38	1,57	0,36	588	7 060
28	RO	5 762	22,12	10,06	0,45	131	1 570
30	IS	29 177	0,28	*0,12*		2 890	34 678
31	NO	36 573	4,49	2,27	0,50	2 779	33 353
32	CH	30 361	7,21	*3,15*		3 354	40 246
	EU27+HR+3		498,79	212,92			
	average EU+				0,44		
	US	34 759	282,43	135,21	0,48		*34 934*

Table 3-4 European average gross wages. [Source: UNECE]

"EU+" means all countries providing data concerning active population except for the USA

The outcome distribution approximations

When calculations of all distributions for each countries are done thank to the method described in Annex 8, the average European gross wage distribution is compared to the one of the USA. The results, shown below, indicate that the USA has more population earning higher wages than the average of 27 Member States of European Union, but it may be caused by different year of the EU and the US income data (2000 and 2004) The estimated distributions approximations are taken in consideration for further works.

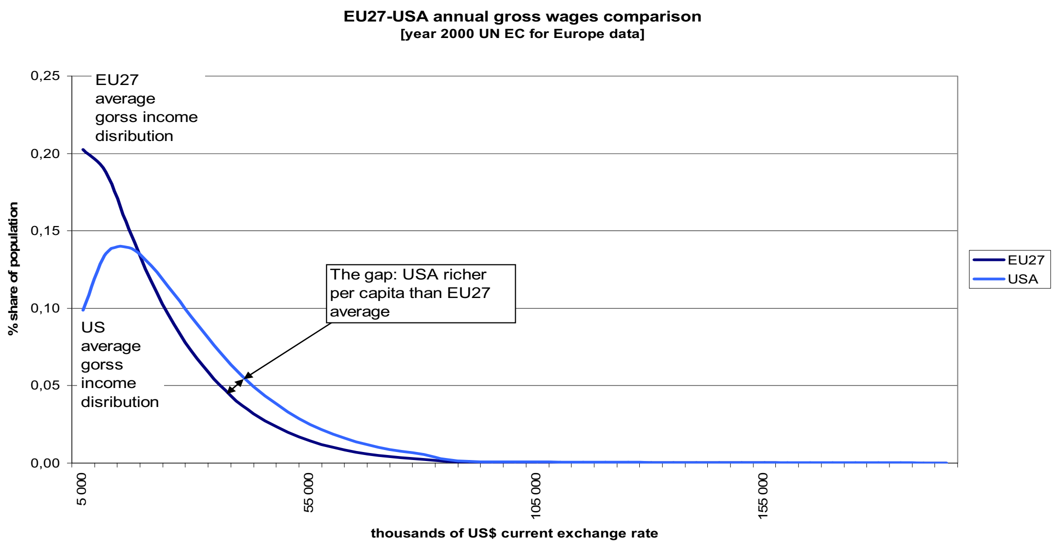


Figure 3-23 : Comparison of EU27 and USA gross wages distributions using exponential function and Pareto power law theory.

[thousands of US$ current exchange rate, annual gross income]		share of population (EU27 = 1)	USA
or less	7,5	0,202388	0,098669
7,501	12,5	0,187806	0,135351
12,501	17,5	0,151097	0,139253
17,501	22,5	0,117478	0,127348
22,501	27,5	0,089719	0,109183
27,501	32,5	0,067651	0,089864
32,501	37,5	0,050353	0,071909
37,501	42,5	0,037121	0,056367
42,501	47,5	0,027227	0,043494
47,501	52,5	0,019847	0,033147
52,501	57,5	0,01429	0,025008
57,501	62,5	0,010126	0,018712
62,501	67,5	0,00701	0,013904
67,501	72,5	0,005092	0,01027
72,501	77,5	0,003507	0,007547
77,501	82,5	0,002438	0,005522
82,501	87,5	0,001188	0,00249
87,501	92,5	0,000733	0,001176
92,501	97,5	0,000615	0,001005
97,501	102,5	0,000529	0,000867
102,501	107,5	0,000459	0,000753
107,501	112,5	0,000401	0,000659
112,501	117,5	0,000353	0,00058
117,501	122,5	0,000312	0,000513
122,501	127,5	0,000277	0,000456
127,501	132,5	0,000247	0,000408
132,501	137,5	0,000222	0,000366
137,501	142,5	0,000199	0,00033
142,501	147,5	0,00018	0,000298
147,501	152,5	0,000163	0,000271
152,501	157,5	0,000149	0,000247
157,501	162,5	0,000136	0,000225
162,501	167,5	0,000124	0,000206
167,501	172,5	0,000114	0,000189
172,501	177,5	0,000105	0,000174
177,501	182,5	9,67E-05	0,000161
182,501	187,5	8,94E-05	0,000149
187,501	192,5	8,28E-05	0,000138
192,501	and more	7,68E-05	0,000128
TOTAL income		1	1

Table 3-5 : European and US average gross wages distributions.

3.2.3. Transport infrastructure in Europe

The transport infrastructure is an essential parameter in mobility for several reasons : firstly it impacts on the decision to travel or not (the phase of generation is directly concerned). Secondly, supply has effects on the choice of the transport mode (i.e. on the phase of modal split).

The existence and development of such infrastructure are strongly linked with transport policies. That is why it is particularly interesting to deal with such European policies when focusing on transport infrastructure.

3.2.3.1. Transport policy objectives

The European transport policy has developed considerably over the last fifteen years. The border opening allowed the free circulation of persons, and thus stimulated the passenger's transport growth within Europe. This development of mobility went hand in hand with an improvement of transport systems: advancements with regards to security, passenger's rights and facilities have been performed. But this strong growth has its limits and impacts negatively on pollution, congestion and accidents. The goal of the EU's common transport policy is therefore to develop transport systems that meet with a triple challenge : a economic, social and environmental challenge. More precisely, the European transport policy aims at providing users transport systems with the following features :

- Efficient and effective
- Affordable
- Offering high quality : more security, safety, facilities, comfort, less congestion
- Consolidating passenger's rights

These transport systems should ensure a high level of mobility within European Union while taking into account environmental matters such as pollution, accidents, congestion, in other words the negative effects of transport. To summarize, a **sustainable mobility** is needed. Adopted by the European Commission in 2001, the White Paper "European transport policy for 2010 : time to decide" develops these objectives and identifies the main problems relatives to transport development. It then proposes policies to confront these difficulties.
"The White Paper offers a dynamic plan of action to achieve a better balance of transport modes which will ease bottlenecks and congestion, and reduce pollution."

How to take up such a challenge ?

➔ Many **infrastructure projects**, called the trans-European transport networks (TENs) have been launched for around ten years. They enable time-saving, reduction of pollution and a balanced approach to land settlement. Even though considerable progresses have been made in the network advancement, it remains plenty to do if we want to finish the realization of all the European corridors by 2020.

➔ **Research and Technological innovations** must be much more developed in order to make transport more environmentally friendly. They should optimize each mode's own potential and limit their negative side-effects. Galileo is an example of innovation programmes led by the European Union, in line with the transport white paper's objectives. Furthermore, research in engine technology must be carried on so as to make the engine more efficient and more economical in energy. The use of alternative energy source has to be strengthened.

➔ The **modal transfer to transport modes less polluting** (particularly for long distance and urban trips) must be enhanced in order to balance better the transport modes.

➔ **Co-modality**, i.e. the efficient and optimal combination of transport mode will also help to perform the objectives set by the white paper.

➔ Lastly, **measures and standards** must be set in order to make movements safer and to fight against pollution as well. France often plays a role in the setting up of these standards;

Evolving context

The objectives of the European transport policy remain unchanged, nevertheless the general context has evolved, notably between 2001 and 2007 :

➔ **The European Union has enlarged** : the UE is gone from 15 to 27 countries in 2007. Such an enlargement has important consequences on the network framework. New axes have appeared. In addition, the new member countries have priorities that totally differ from EU15's : whereas the states of EU 15 focus on problems of pollution, congestion or land use, the main concern of the new member is to improve their accessibility.

➔ The issue of **environment** has become a **priority** : during the last years, environmental pressure applied on the governments have been intensified in order to show that environment has to be taken into account. Indeed, transport is the sector that increased the most its CO_2 emissions between 1990 and 2004 : + 29 %. The share of transport in CO_2 emission accounted for 21 % in 1990 to reach 26 % in 2004 (84 % come from road). Conversely, sectors such as industry, household and services, have seen their share in CO_2 emission decreasing (Source : Eurostat).

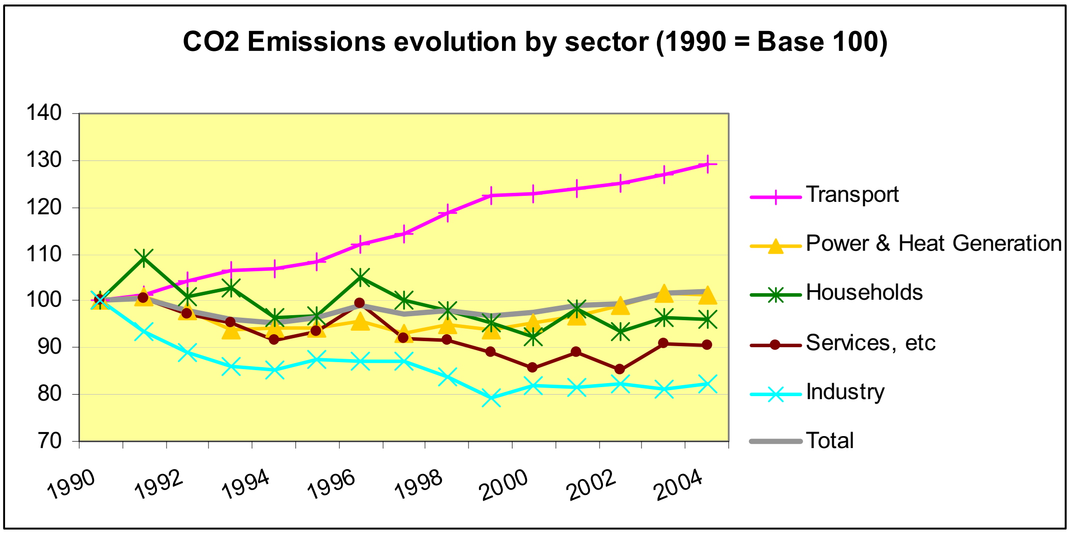


Figure 3-24 : Comparison of CO2 evolutions by sector

(Source :Ref 14)

➔ **The international context** has evolved : the terrorism threat has intensified and is now a priority in the transport : as a result of the 11th of September, many measures

have been taken, especially in airports (for example, the new law in Europe relative to liquid products).

The transport policy impacts directly on the supply, and the supply itself conditions the transport demand.

3.2.3.2. Infrastructure

Infrastructure development played an important role in the past growth of mobility, and should continue in this way.

During the last half century, the development of transport systems was mainly profitable to fast networks :

➔ The length of motorways in EU15 has more than tripled, as shown in Figure 3-25 it went from 16 000 km in 1970 to 55 700 km in 2004. This development combined to the growing motorization of households explains the predominance of car over the other modes.

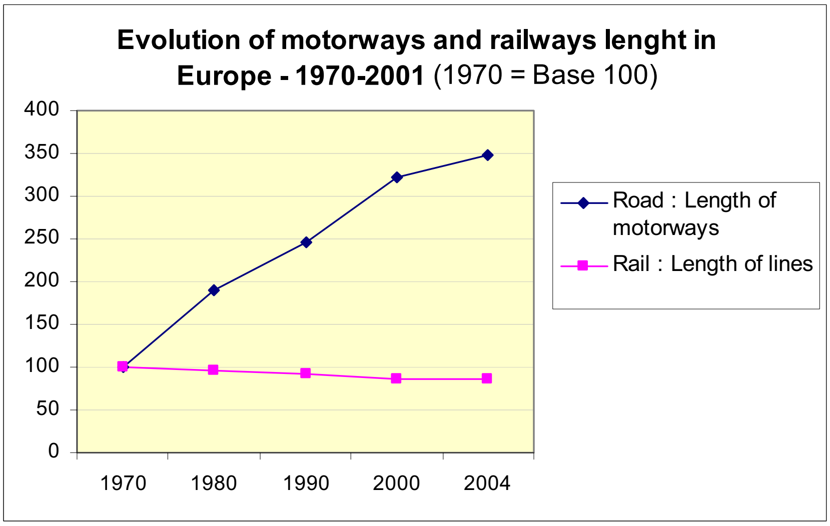


Figure 3-25: Evolution of motorways and railways length between 1970 and 2001 in Europe

Source : Ref 12

➔ Although the length of railways decreased during this period (-15 % in 35 years as shown is figure 11), the high speed rail network appeared in 1981 has strongly developed : high-speed lines reach now 4 800 km. The high speed rail network is expected to increase in size : between 2007 and 2009 12 lines have to be constructed.

	LINE	Length km	Start of oper-ation
BE	Liège - German border	42	2007
BE	Antwerpen - Dutch border	35	2007
NL	Amsterdam/Schiphol - Belgian bd.	120	2008
ES	Tarragona - Barcelona	86	2007
ES	Barcelona - French border	180	2009
ES	Antequera - Malaga	55	2007
ES	Madrid - Valladolid	194	2007
FR	TGV Est (Vaires-sur-Marne - Baudrecourt)	320	2007
IT	Milano - Bologna	196	2008
IT	Bologna - Firenze	77	2009
IT	Novara - Milano	55	2009
UK	London - Southfleet Junction	39	2007

Source : Union Internationale des Chemins de Fer, European Railway Review
Note:
The length indicated above is the length of the line under construction and not necessarily the distance between the places named.

Table 6 : High-speed lines currently under construction

Source : Ref 12

➔ The number of airports has considerably grown since 1960 (source :Ref 13).

ANNEX 3 shows the evolution of the transport network in France, for motorway, HSR lines and airports.

3.2.4. Conclusion on the mobility determinants

Although we observe links between the mobility evolution and features and some economical, demographic and infrastructure factors, the previous analysis is not able to quantitatively measure these links. This is mainly due to the lack of detailed data on the European mobility features and evolution. A deeper analysis of the mobility determinants would then first of all require to get relevant data to estimate how the association of some identified factors can impact the level and the charcateristics of the European traffic.

3.3. Mobility in areas where EPATS is relevant

EPATS aims at opening up some European regions by providing a new way of travelling in areas badly served by air transport and not connected to the high-speed train network. Evaluating the mobility level in areas where EPATS would operate requires:

- Identifying the potential connections on which EPATS would operate
- Evaluating and analyzing the traffic levels on these potential EPATS connections

3.3.1. EPATS potential connections

If a bad level of accessibility can be considered as an essential feature of the potential EPATS connections this element is not sufficient to identify these connections. Indeed, thanks to the implementation of interactive transportation system EPATS would be pertinent on all connection where there is a need of individual transport.

The ESPON project provides accessibility indicators that describe the location of an area with respect to opportunities, activities or assets existing in other areas and in the area itself, where 'area' may be a region, a city or a corridor. See Map 6-1 in the ANNEX 7 and ESPON Project (Ref 11), which say:

"Potential accessibility is a construct of two functions, the activity function representing the activities or opportunities to be reached and the impedance function representing the effort, time, distance or cost needed to reach them (impedance function) (Wegener et al., 2002). For potential accessibility the two functions are combined multiplicatively, i.e. are weights to each other and both are necessary elements of accessibility:

$$A_i = \sum_j W_j^\alpha \exp(-\beta c_{ij})$$

where Ai is the accessibility of area i, Wj is the activity W to be reached in area j, and cij is the generalized cost of reaching area j from area i. Ai is the total of the activities reachable at j weighted by the ease of getting from i to j. The interpretation is that the greater the number of attractive destinations in areas j is and the more accessible areas j are from area i, the greater is the accessibility of area i. Occasionally the attraction term Wj is weighted by an exponent α greater than one to take account of agglomeration effects. The impedance function is nonlinear. Generally a negative exponential function is used in which a large parameter β indicates that nearby destinations are given greater weight than remote ones. The accessibility model used here (based on Spiekermann and Wegener, 1996) uses centroids of NUTS 3 regions as origins and destinations. The accessibility model calculates the minimum paths for the road network, i.e. minimum travel times between the centroids of the NUTS 3 regions. For each NUTS 3 region the value of the potential accessibility indicator is calculated by summing up the population in all other regions including those outside ESPON space weighted by the travel time to go there.

The aggregation over modes is introduced in the impedance function of the accessibility model by combining the information contained in the modal accessibility indicators by replacing the generalised cost c_{ij} *by the 'composite' generalised cost*

$$\overline{c}_{ij} = -\frac{1}{\lambda} \ln \sum_m \exp(-\lambda c_{ijm})$$

where c_{ijm} is the generalised cost of travel by mode m between i and j and λ is a parameter indicating the sensitivity to travel cost. This formulation of composite travel cost is superior to average travel cost because it makes sure that the removal of a mode with higher cost (i.e. closure of a rail line) does not result in a - false - reduction in aggregate travel cost."

Finally the folowing general formul is obtained:

$$A_i = \sum_j \left(f_1(Opportunities) * \sum_m f_2(c_{ijm}) \right)$$

The method developed to identify these EPATS potential connections is the following:

1. We compute the multimodal accessibility level of all European NUTS 2 connections by multiplying the accessibility level of both NUTS2 origin and NUTS2 destination given by ESPON
2. We keep NUTS 2 Origin_Destination (O_D) connections for which the multimodal accessibility level is below the average accessibility level in all European connections
3. We compute economical activity levels of each connections by multiplying the GDP levels of both NUTS2 O-D given by ESPON
4. We keep connections for which economical activity level exceeds the average value on all the considered connections or if the traffic flow exceeds the average traffic flow on the considered connections (assumption which requires future considerations and deeper analysis)
5. We finally keep connections with a distance less than 2500 km which is the maximum range of EPATS aircraft

This methodology is then applied on 28 countries: Austria (AT), Belgium (BE), Bulgaria (BG), Cyprus (CY), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (GR), Hungary (HU), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), Luxembourg (LU), Netherlands (NL), Norway (NO) Poland (PL), Portugal (PT), Romania (RO), Slovakia (SK), Slovenia (SI), Spain (ES), Sweden (SE), Switzerland (CH) , and United Kingdom (UK).

We then obtain that **15 223 connections** among the 62 483 total NUTS 2 connections in all the 28 considered countries are **EPATS potential connections.** All together these potential connections represent **24%** of the total existing NUTS 2 connections in Europe. Annex 3 presents the total number of connections between the 28 countries.

Unfortunately the ESPON traffic groups all trip purposes. This prevents us from being able to analyse the mobility features on EPATS potential connections according to the leisure or business purpose.

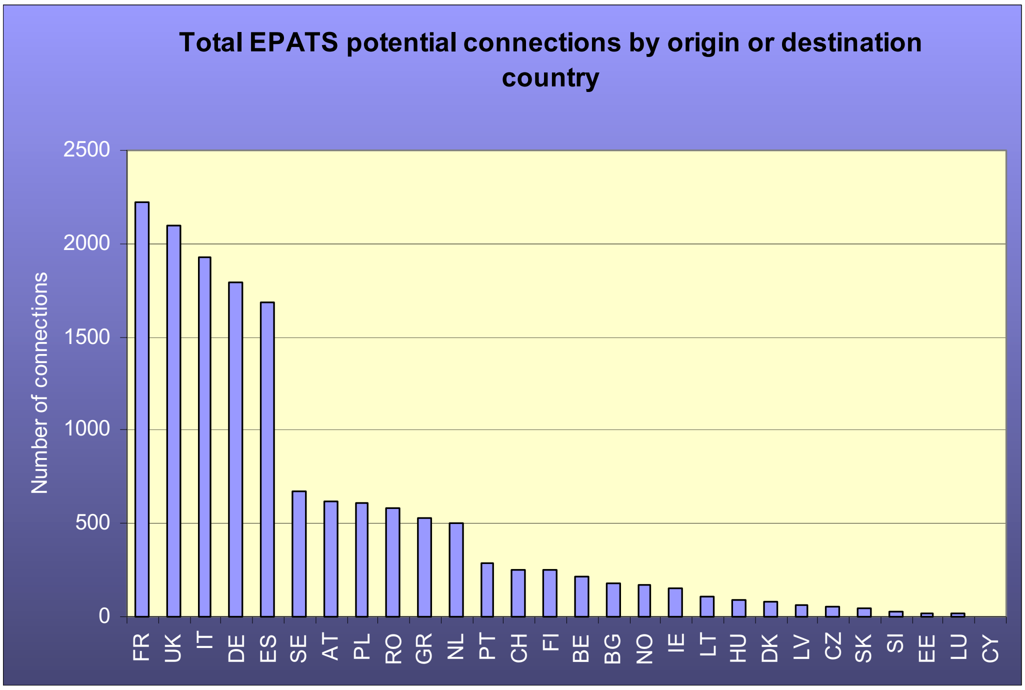


Figure 3-26 : Total EPATS potential connections by origin or destination country

Among all these identified potential connections 63% are made to or from 5 European countries: France, United Kingdom, Italy, Germany and Spain. With 2223 connections to or from French NUTS 2, France is the country concerned by the highest number of EPATS connections while Poland is in eighth position with 607 potential connections to or from Polish NUTS 2.

The Top 10 in terms of number of potential connections between couples of countries also confirms the importance of the 5 European countries previously cited. Indeed no other countries than France, United-Kingdom, Italy, Spain or Germany appear in this Top 10 (Figure 3-27).

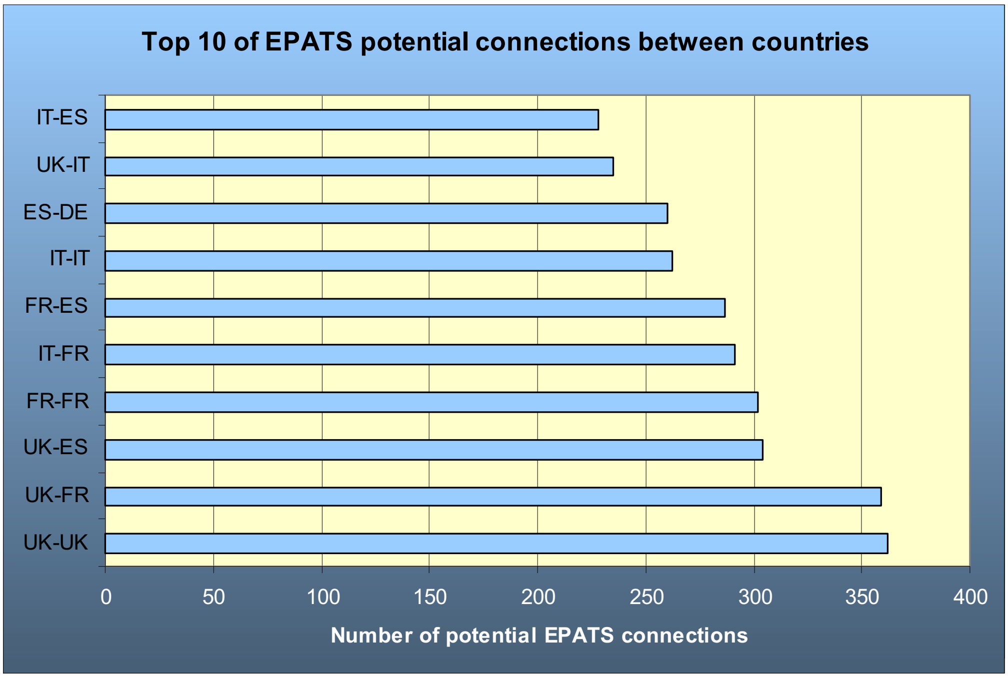


Figure 3-27 : Top 10 of EPATS potential connections between countries

The preponderance of the connections to and from the 5 countries (France, United Kingdom, Italy, Germany and Spain) also exists for France since all together the potential connections between France and these five countries represent 66% of the total EPATS connections with France (Figure 3-28).

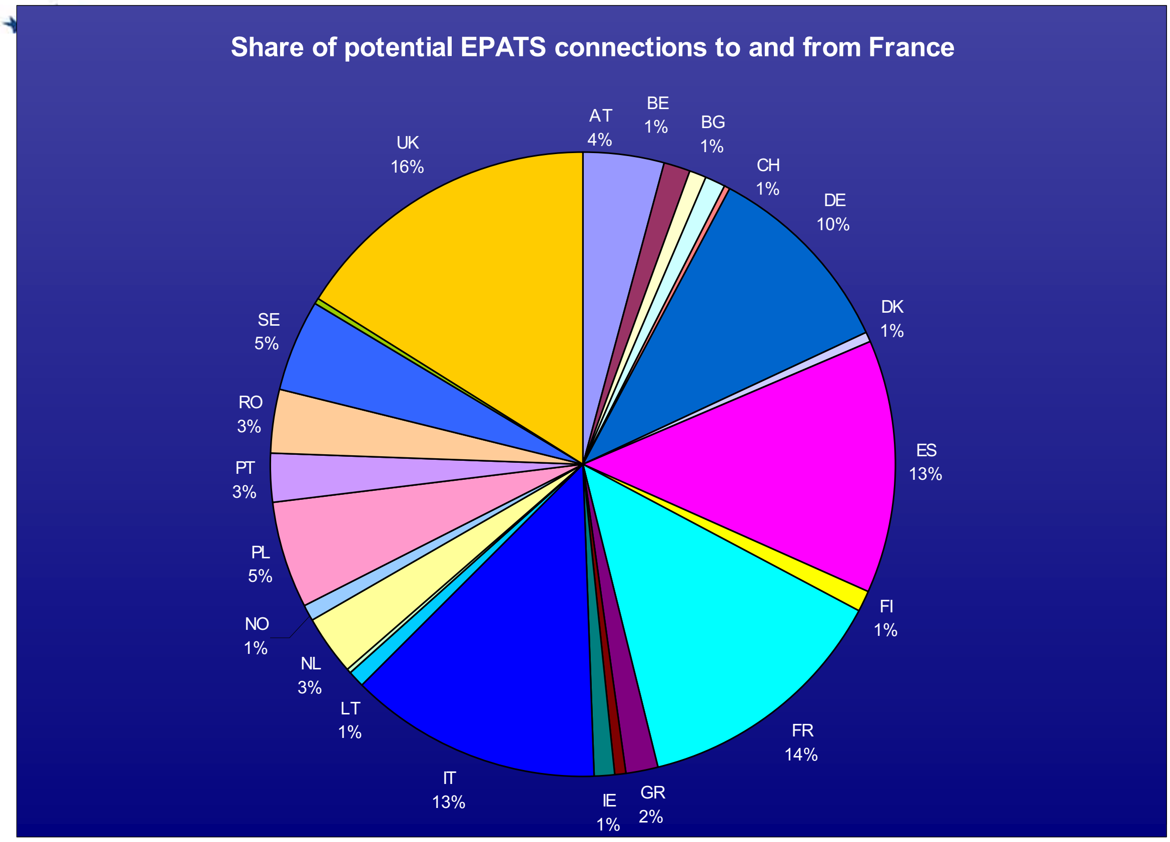


Figure 3-28 : Share of potential EPATS connections to and from France

The case of Poland mainly differs from the case of France with the low importance of connections with Spain. But despite the significant lower share of connections with Spain connections with the five countries considered above represent 72% of the total EPATS potential connections with Poland. Hence when adding the domestic polish connections we obtain that connections with six countries represent 84% of the total EPATS connections with Poland.

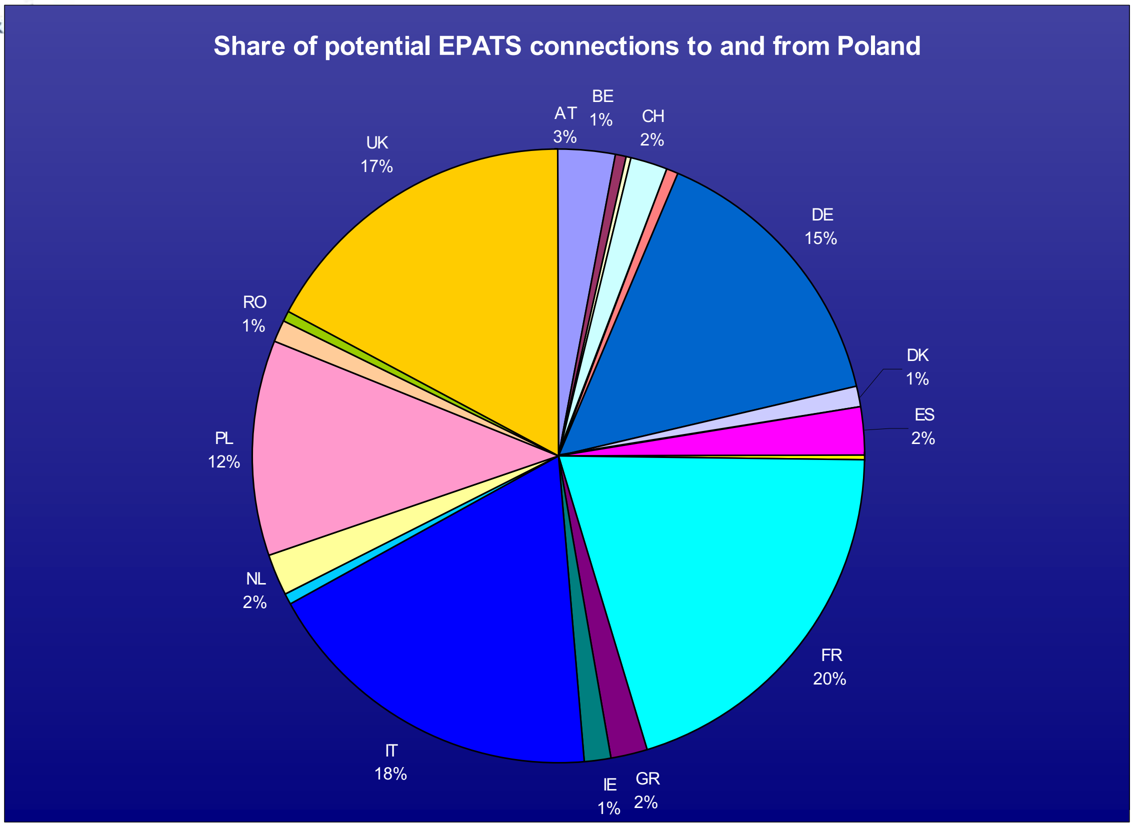


Figure 3-29 : Share of potential EPATS connections to and from Poland

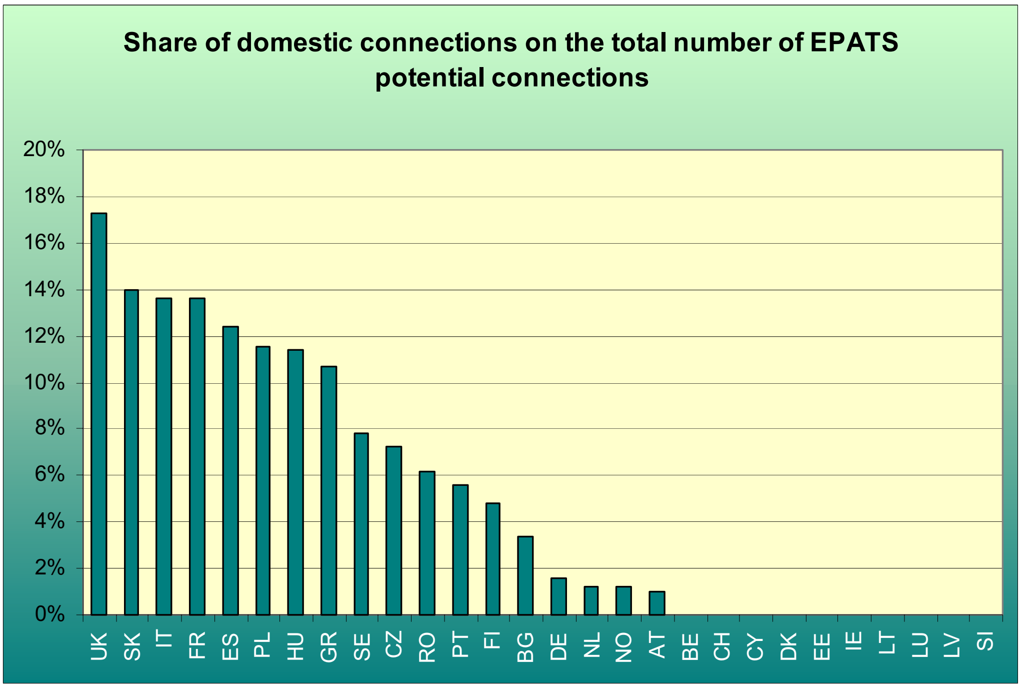


Figure 3-30 : Share of domestic connections on the total number of EPATS potential connections

Generally speaking, domestic connections do not represent more than 17% of the total EPATS potential connections (Figure 3-30). All together, domestic connections only represent 9% of the total EPATS connections. This means that most of the EPATS connections are made between two different countries. Figure 3-31 gives the number of other countries with which each country has potential EPATS connections. This figure shows that 16 among the 29 considered countries have connections with more than 17 other countries.

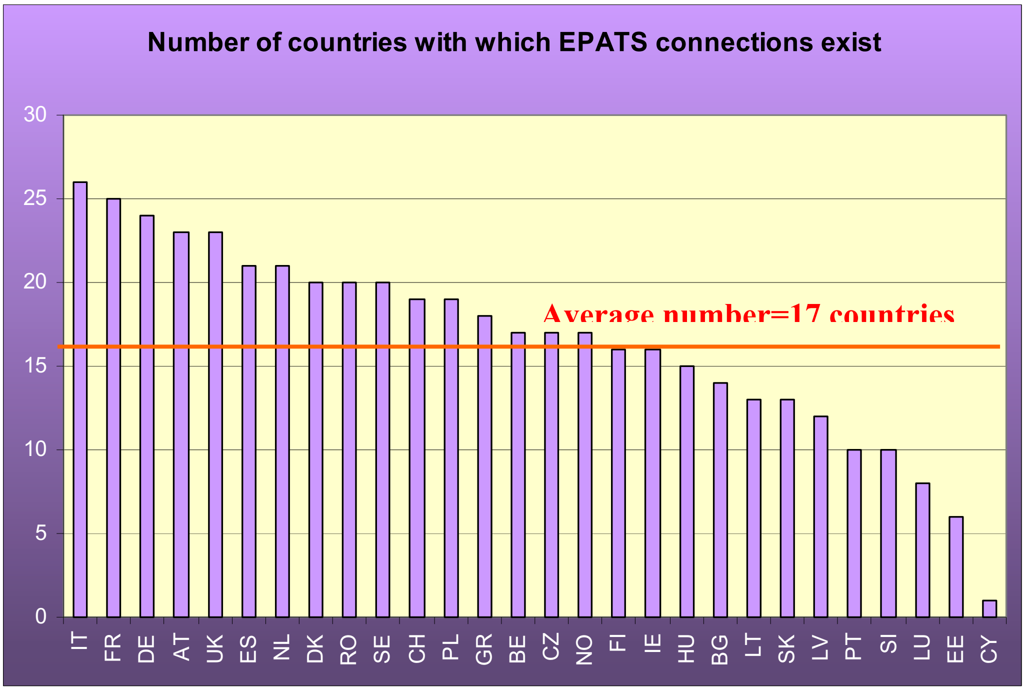


Figure 3-31 : Number of other countries with which EPATS connections exist

3.3.2. Current traffic flows on EPATS connections

Existing traffic levels on the EPATS potential connections can be expressed in two different units: in number of passengers and in number of passenger-kilometers. Both units providing different information on the traffic features and levels it is particularly interesting to differentiate them in the mobility analysis. The current traffic levels on potential EPATS connections are in addition considered for two transport modes: individual road transport and air transport modes. Rail transport mode is indeed not pertinent on such connections with low accessibility levels (meaning bad connections with the rail and in particular high-speed rail network).
In total in 2000, the traffic on all the potential EPATS connections is **4 billion passengers** and **2400 billion passenger kilometers**. Annexes 4 and 5 provide the traffic between countries in both traffic measure units.

The road traffic is predominant when being expressed in terms of number of passengers, since 79% of the total passengers traveling on potential EPATS connections travel by car. However the market share of road transport decreases dramatically in terms of passenger kilometers since it only represents 47% of the total PKM traffic. Air transport mode is indeed mainly used on connections for which the distance between NUTS2 exceeds 1000 Km. Indeed, on one hand

connections with distances exceeding 1000 Km represent 79% of the total potential EPATS connections. On the other hand, the air transport market share is predominant on such connections since the number of air passengers exceeds the road one on 10 009 among the 11 989 connections with a distance exceeding 1000 Km (i.e. on 83% of the connections exceeding 1000 Km).

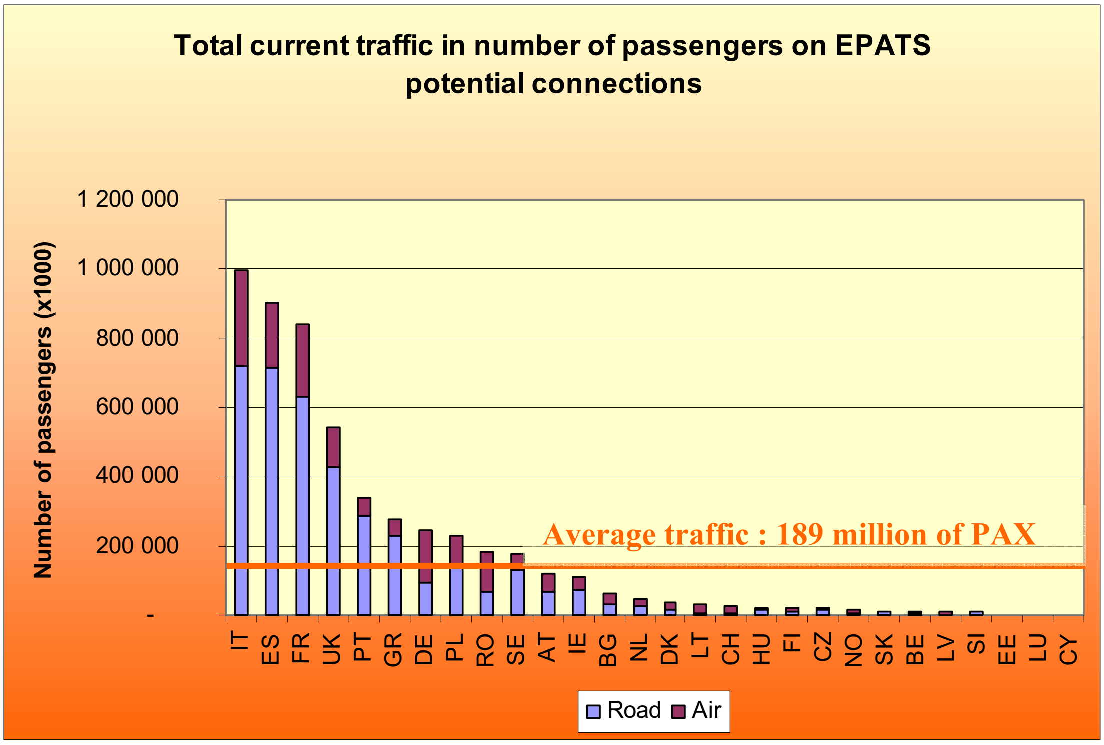


Figure 3-32 : total current traffic in number of passengers on potential EPATS connections

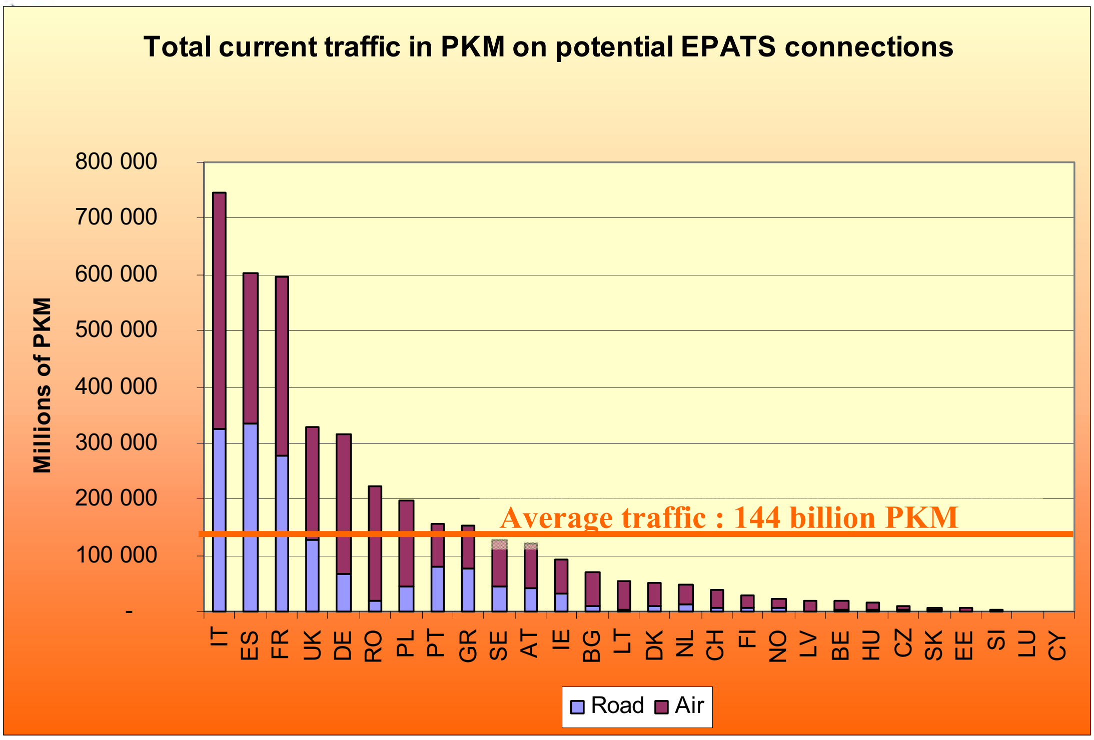


Figure 3-33 : Total current traffic in PKM on potential EPATS connections

As well in terms of number of passengers as in PKM, the highest traffic levels are to and from Italy, Spain and France. These three countries also are the ones with the highest domestic traffic levels as well in terms of passengers (Figure 3-36) as in terms of PKM (Figure 3-37).
Although domestic connections only represent 17% of the total connections, 50% of the total passengers trips on EPATS connections are domestic ones. In particular this share tends to exceed 50% for 7 countries: Spain, France, Greece, Italy, Portugal, Sweden and United-Kingdom (Figure 3-34).

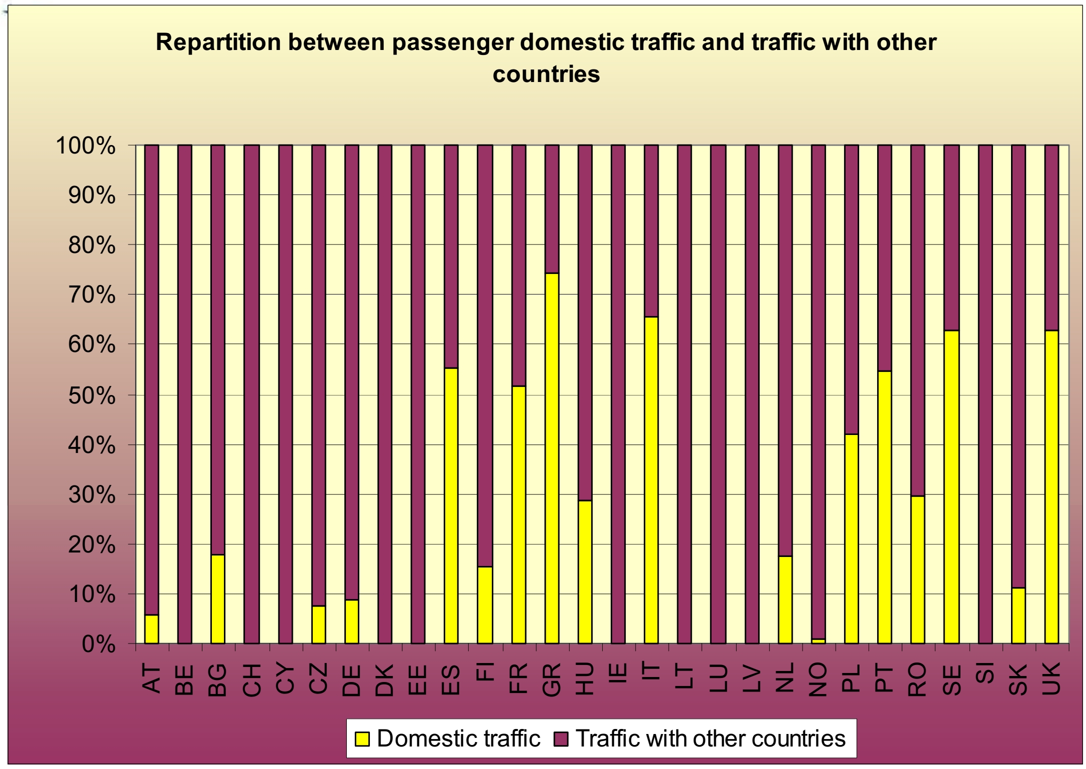


Figure 3-34 : Repartition between passenger domestic traffic and traffic with other countries

The share of the domestic traffic however tends to significantly decrease when measuring the PKM traffic due to the shorter distances of the domestic trips compared to the other trips. Hence only 21% of the total PKM traffic is domestic (Figure 3-35).

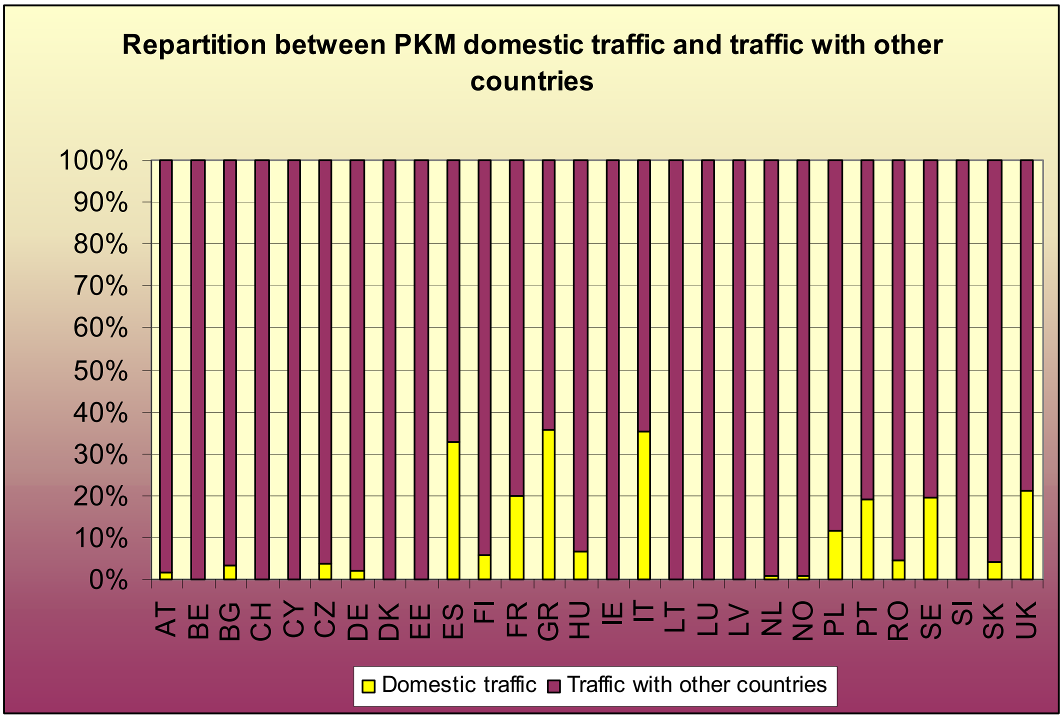


Figure 3-35 : Repartition between PKM domestic traffic and traffic with other countries

Domestic traffic is particularly marked by the very low market share of the air transport (Figure 3-36, Figure 3-37) mode which does not exceed 8% of the passengers and 14% of the PKM. Only Norway which has a very low domestic traffic level (119000 passengers) has a high share of air traffic: 67% of the passengers use the air transport mode on EPATS domestic connections.

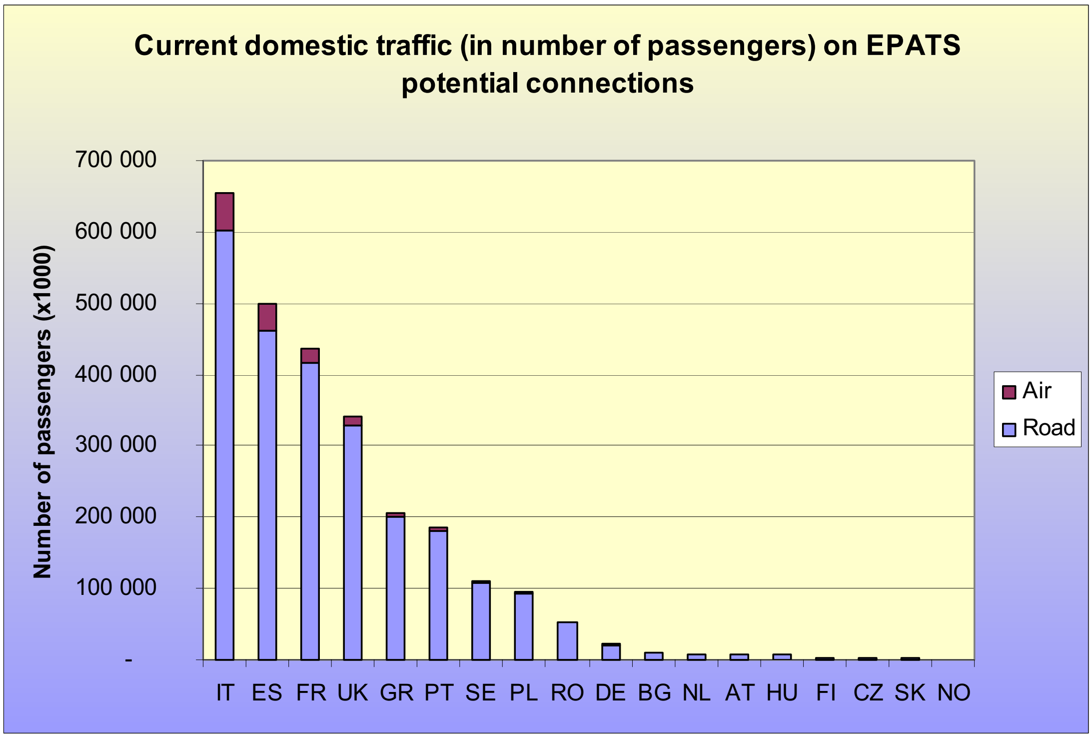


Figure 3-36 : Current domestic traffic (in number of passengers) on EPATS potential connections

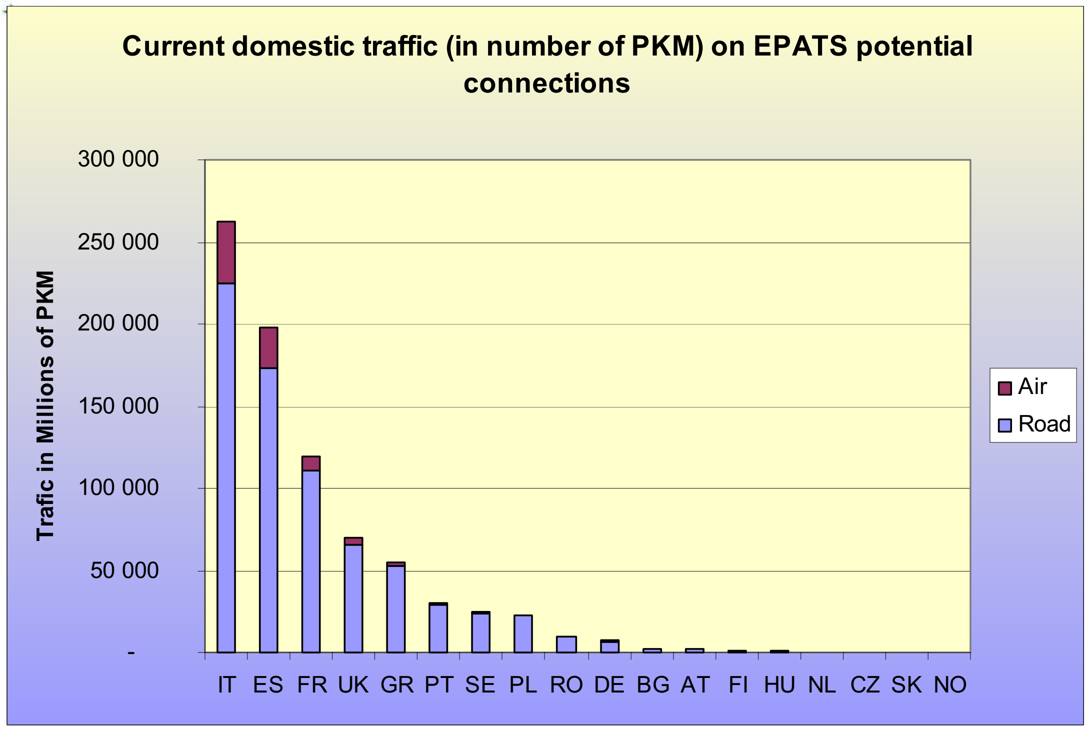


Figure 3-37 : Current domestic traffic (in number of PKM) on EPATS potential connections

When focusing on the connections between two different countries we observe that 12 countries belong to the top 10 of traffic: Spain, France, Portugal, Ireland, United-Kingdom, Italy, Austria, Romania, Germany, Poland and Greece. Figure 3-38 and Figure 3-39 present the couples of countries with the highest levels of traffic. The traffic between France and Spain on the potential EPATS connections appears to be the highest one with 168 millions of passengers and 63 billions of PKM.

If the 10 couples of countries with the highest traffic levels vary according to the traffic measure unit (passengers or passengers-kilometres), some appear in both Figure 3-38 and Figure 3-39: Portugal-Spain, Italy-France, Italy-Spain, Romania-Germany, United-Kingdom-France and Italy-Greece.

Not surprisingly, the market share of the air transport mode is strongly related with the travelled distance (Figure 3-40). On the 10 considered couples of countries the correlation rate between the air transport market share (in number of passengers) and the travelled distance is 96%.

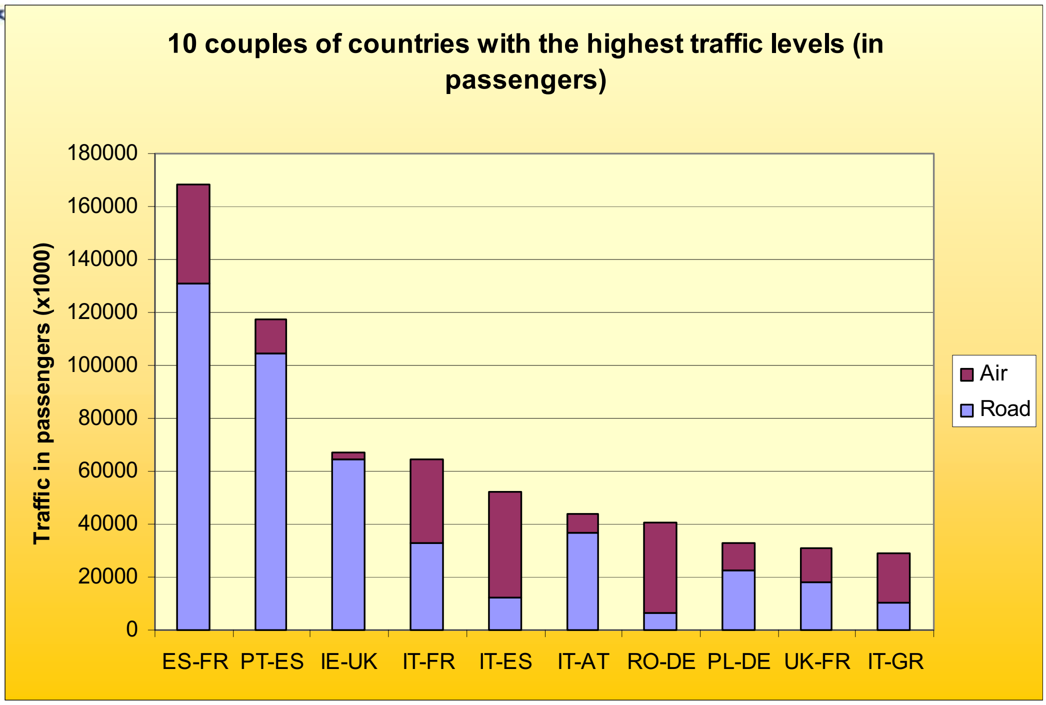


Figure 3-38 : 10 couples of countries with the highest traffic levels (in passengers)

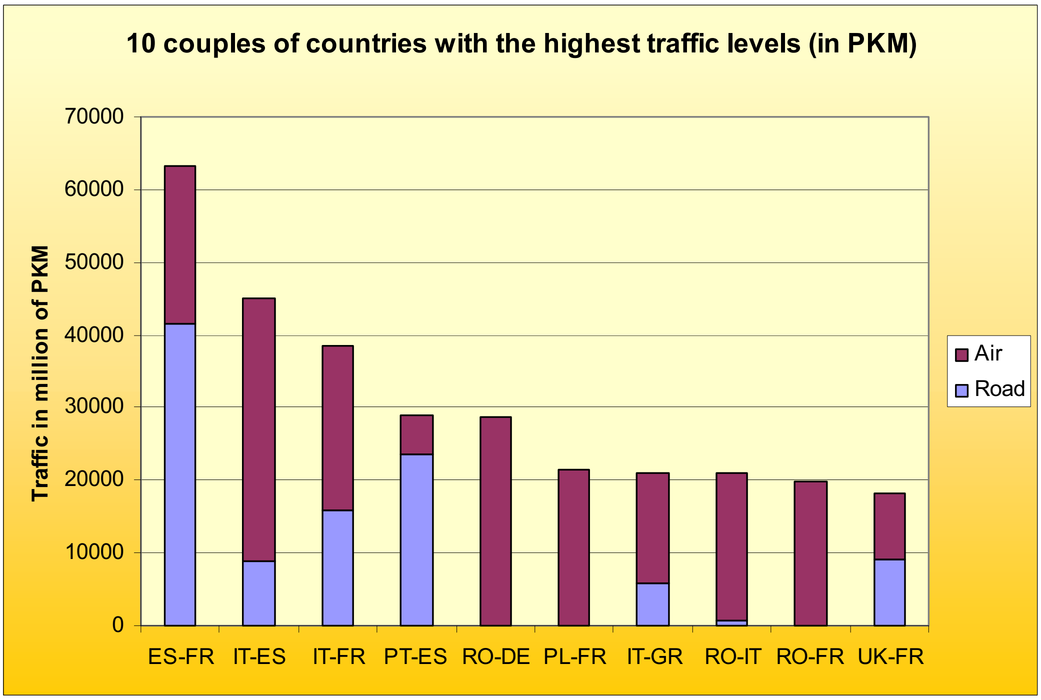


Figure 3-39 : 10 couples of countries with the highest traffic levels (in PKM)

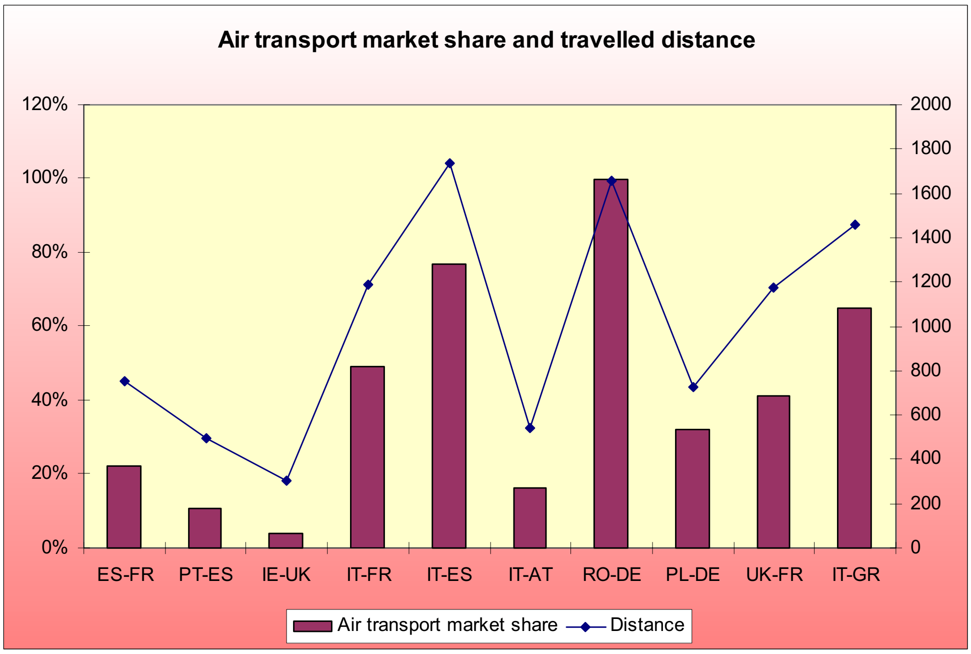


Figure 3-40 : Air transport market share and travelled distance

3.3.2.1. Traffic to and from France

In 2000 the total number of passengers travelling to and from France on potential EPATS connections reaches **436 million passengers**. 52% of these passengers make domestic trips. Other important traffic are between France and Spain (20%) or France and Italy (8%) (Figure 3-41). It follows that 20% of the passengers traffic is between France and the remaining other countries.

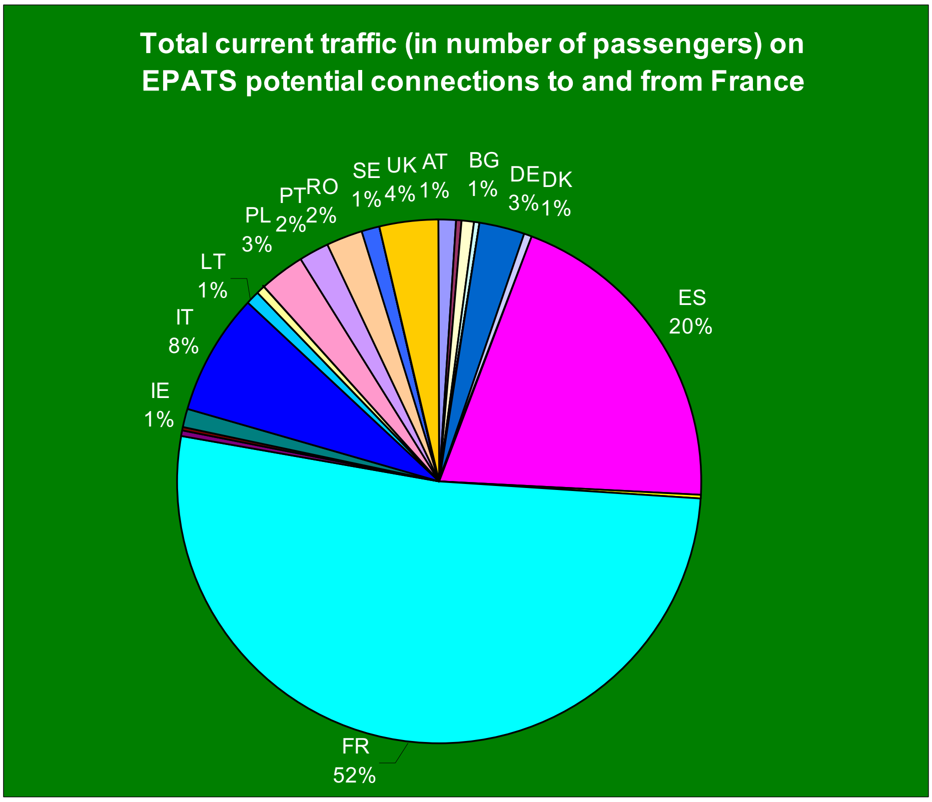


Figure 3-41 : Total current traffic (in number of passengers) on EPATS potential connections to and from France

Although representing a large share of the trips to and from France, the importance of the domestic traffic decreases when measuring the traffic in PKM due to the shorter domestic trip distance. The average distance on domestic connections is indeed 273 Km while the average distance on the total connections to and from France is 1530 Km.

The domestic traffic therefore only represents 20% of the **118 billion of total PKM** on connections to and from France.

The distance factor hence significantly increases the share of abroad traffic compared to Figure 3-41. In particular the traffic between France and Italy represents 13% of the total PKM, and 7% between France and Poland.

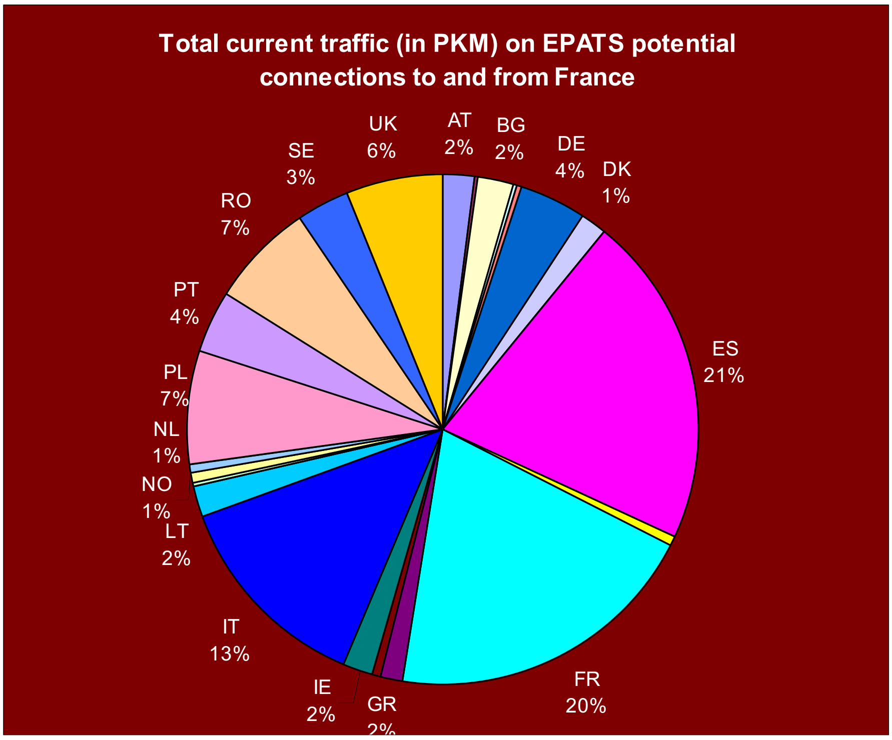


Figure 3-42/ Total current traffic (in PKM) on EPATS potential connections to and from France

The air transport mode tends to be the only mode used on connections between France and Poland, Romania, Bulgaria, Lithuania, Latvia, Slovakia and Estonia. On the other hand the road transport mode tends to be preferred to the air one on connections with an average distance lower than 1200 Km: United-Kingdom, Netherlands, Spain, Belgium, Luxembourg, Switzerland and on domestic connections.

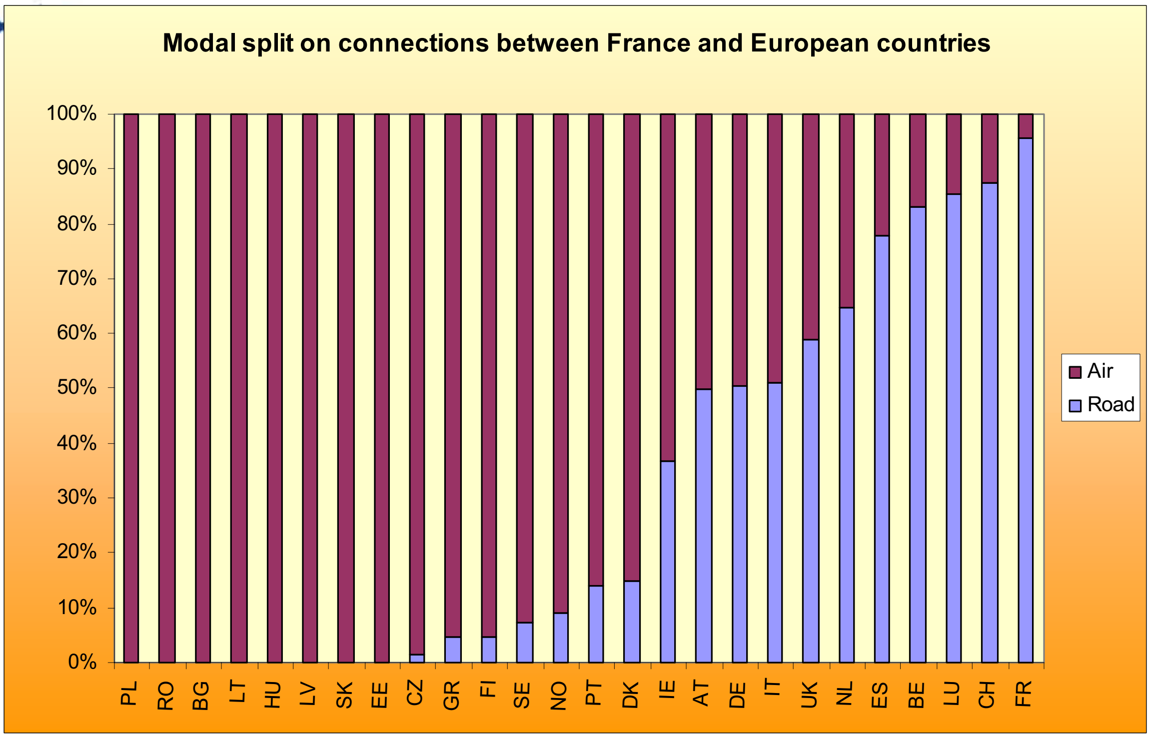


Figure 3-43 : Modal split on connections between France and European countries

3.3.2.2. Traffic to and from Poland

In 2000 the total number of passengers traveling to and from Poland on potential EPATS connections reaches **93 million passengers**. 42% of these passengers make domestic trips. Other important traffic are between Poland and four countries: Germany, France, Italy and United-Kingdom. Traffic with these countries indeed represents 43% of the total traffic to and from Poland (Figure 3-44).

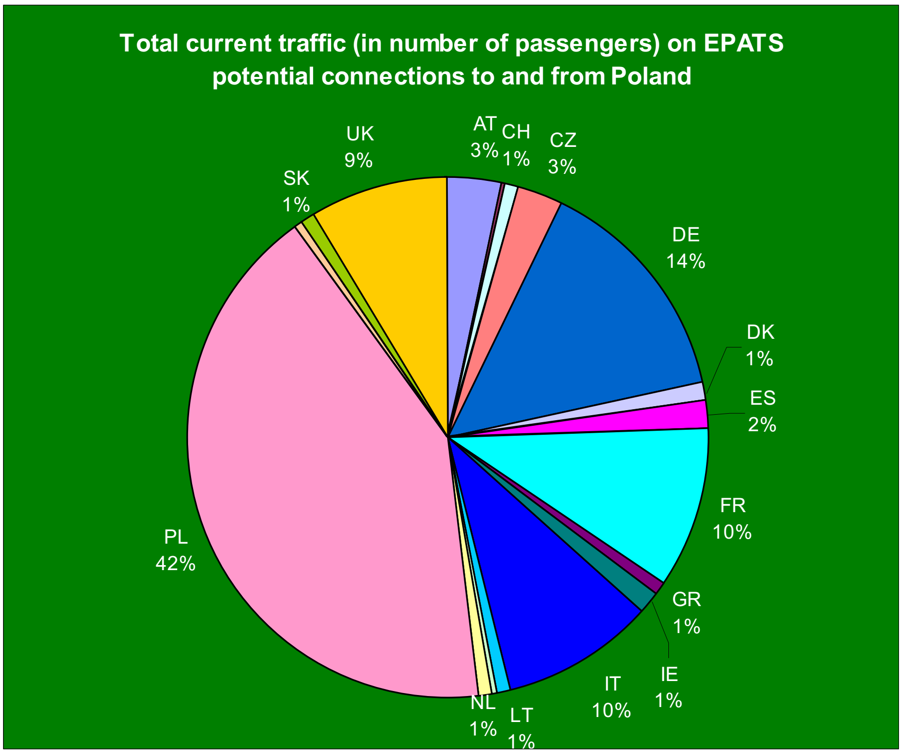


Figure 3-44 : Total current traffic (in number of passengers on EPATS potential connections to and from Poland

When measuring the traffic in terms of number of passenger-kilometres we observe that the domestic market share is only 12% of the total **23 billion of PKM traffic** to and from Poland. Indeed, the average distance on domestic connections is 240 Km while the average distance on the total connections to and from Poland is 1224 km.

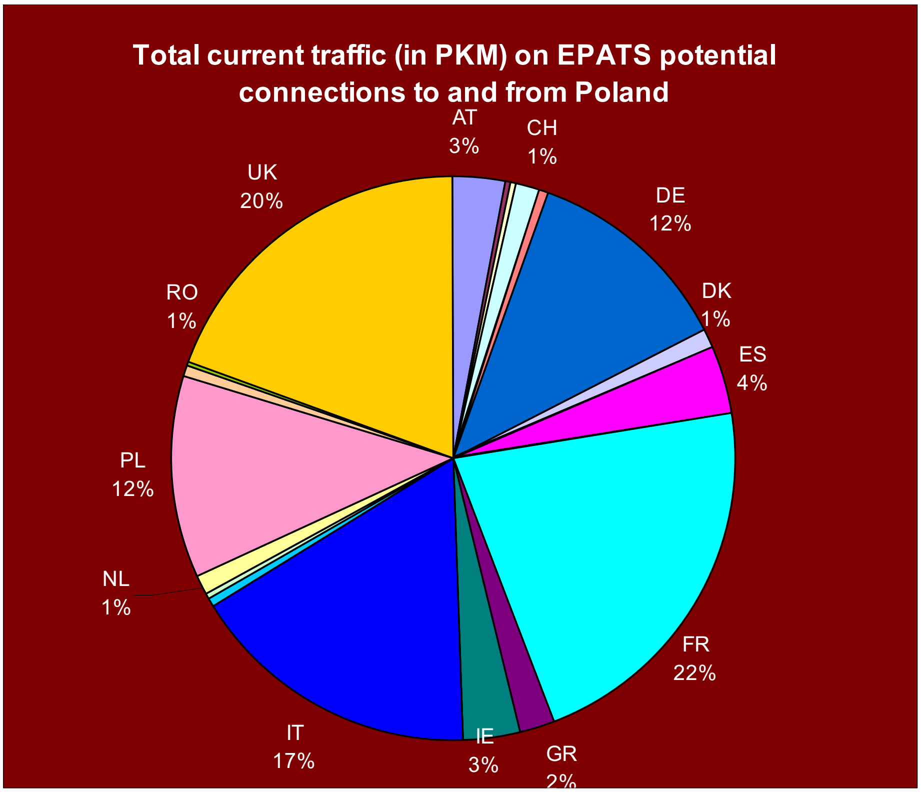


Figure 3-45 : Total current traffic (in PKM) on EPATS potential connections to and from Poland

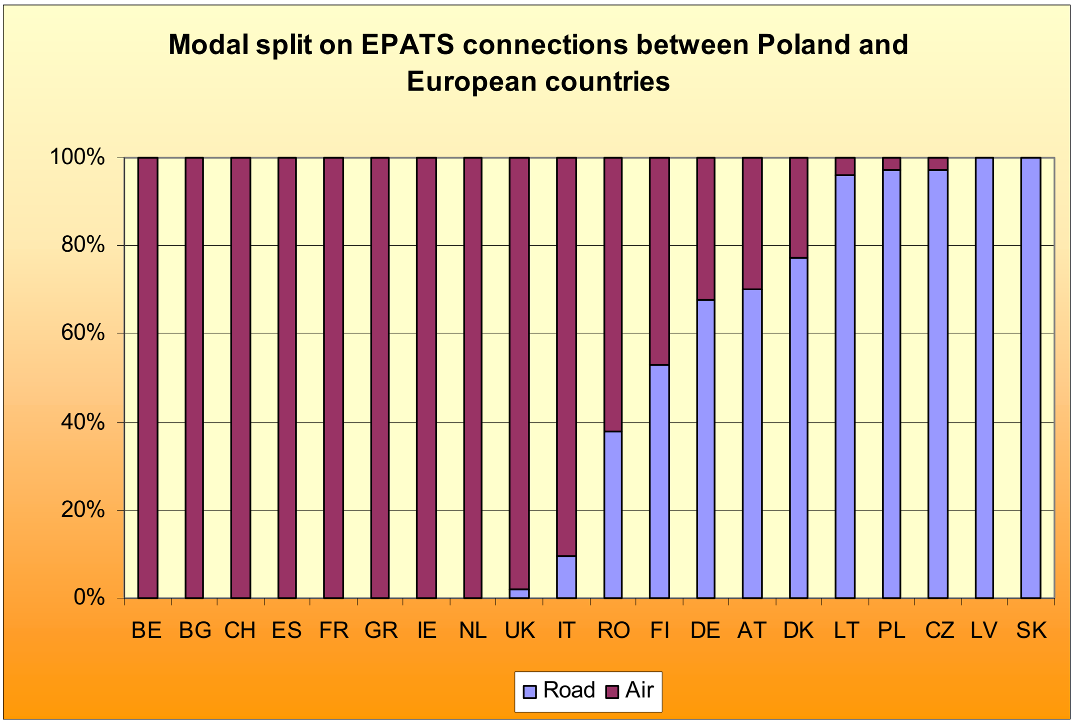


Figure 3-46 : Modal split on EPATS connections between Poland and European countries

The air transport mode is the only mode used on connections between Poland and Belgium, Bulgaria, Switzerland, Spain, France, Greece, Ireland and The Netherlands for which the distance generally exceeds 1400 Km. The road transport mode tends to be however preferred to the air transport mode on connections with an average distance generally lower than 1000 Km:Germany, Austria, Denmark, Lithuania, Czech Republic, latvia, Solvakia and domestic connections.

3.3.3. Concluding remarks on mobility in areas with bad accessibility level

We identify **15 223 connections** between 29 countries that can be considered as **EPATS potential connections.** All together these potential connections represent **24%** of the total existing NUTS 2 connections in Europe.
While the traffic levels on these connections are available for individual road and air transport modes, they are not provided by trip purpose which taking into account this trip purpose in the mobility analysis on the potential EPATS connections.

Among all these identified potential connections 63% are made to or from 5 European countries: France, United Kingdom, Italy, Germany and Spain. With 2223 connections to or from French NUTS 2, France is the country concerned by the highest number of EPATS connection while Poland is in eighth position with 607 potential connections to or from Polish NUTS 2. Domestic connections only represent 9% of the total EPATS connections meaning that most of the EPATS connections are made between two different countries.

Regions considered in the context of EPATs are therefore many regions mainly marked by their low accessibility level, as written in the ESPON project (Ref 11): "[ESPON] *multimodal potential accessibility locates regions with clearly above average accessibility mainly in an arc stretching from Liverpool and London via Paris, Lyon, the Benelux regions, along the Rhine in Germany to Northern Italy. However some agglomerations in more remote areas such as Madrid, Barcelona, Dublin, Glasgow, Copenhagen, Malmö, Göteborg, Oslo, Rome, Naples Thessalonica and Athens are also classified as being central or at least intermediate because their international airports improve their accessibility. At the same time the European periphery begins in regions that are usually considered as being central. Several regions in Germany, Austria and France have below average accessibility values, some of them are even extremely peripheral. Many regions in Portugal, Spain, Ireland, Scotland, Wales, Norway, Sweden, Finland, Southern Italy and Greece have very low accessibility values. These regions do not have good access to international flight services. Nearly all regions of the candidate countries do have below average accessibilities. The only exceptions are the capital cities and partly their surrounding regions because of international airports and important connections. For all other regions the combined effect of low quality surface transport infrastructure and lack of air accessibility leads to the low performance in terms of accessibility. In general, the enlargement of the European Union leads to a decrease in average accessibility. […]*

For example, the mountainous areas like the Massif Central , the Alps in Austria or the Carpates have a low accessibility, by contrast with river basins as in the northern Italy with the Pô. The case of coastal areas is more contrasted, according to local particularities. […]
The coherence of the Nordic network appears clearly with the role of gateway of Kobenhavn. The Baltic States are clearly related to the Nordic triangle, even if the connections could be

improved as for example, from Stockholm to the Baltic states capitals. Indeed, the connections between the Baltic States and continental Europe according to this indicator are inexistent.
In the Iberic Peninsula, a high level of integration is reached between Madrid and the major Spanish and Portuguese cities, but the gap with continental Europe is here[...]

In total in 2000, the traffic on all the potential EPATS connections is **4 billion passengers** and **2400 billion passenger kilometers**. As well in terms of number of passengers as in PKM, the highest traffic levels are to and from Italy, Spain and France. Although domestic connections only represent 17% of the total connections, 50% of the total passengers trips on EPATS connections are domestic ones.

The road traffic is predominant when being expressed in terms of number of passengers, since 79% of the total passengers traveling on potential EPATS connections travel by car. However the market share of road transport decreases dramatically in terms of passengers kilometers since it only represents 47% of the total PKM traffic.

In 2000 the total number of passengers travelling on potential EPATS connections reaches **436 million passengers** to and from France and **93 million passengers** to and from Poland.

The mobility analysis on the potential EPATS connections has however to be restricted to a general traffic analysis without providing more detailed information on the mobility features. Indeed, a deeper knowledge of the mobility features on these connections would need detailed data that currently miss.

3.4. Concluding remarks

When presenting the main characteristics of mobility in EU15, the overview of the European mobility shows the importance of the long-distance traffic (i.e. over 100 Km) in the total traffic since 70 % of European travellers have made long distance journeys in 2001. In addition, the analysis also clearly highlights that the long-distance journeys characteristics change according to the customer profile: business and leisure traveller do not travel the same way (difference in terms of transport mode, duration, traveller features (age, gender, etc.)). Characteristics of long-distance mobility therefore vary a lot according to the trip purpose.

The analysis also highlights that providing a similar mobility analysis at a EU27 level is unfortunately not feasible due to the lack of detailed data on long-distance traffic. As a consequence, data is lacking to perform a detailed deep mobility analysis on the connections where the personal aviation would be pertinent, i.e. on connections associating bad accessibility levels, economic attractiveness and significant traffic flows.

We indeed identify that **15 223 connections** between 28 countries can be considered as **EPATS potential connections.** All together these potential connections represent **24%** of the total existing NUTS 2 connections in Europe.

Despite the lack of detailed data on the traffic occurring on these connections the analysis manage to provide very interesting and important information on the current traffic levels and modal splits. The total traffic on the potential EPATS connections is 2400 billion passengers amongst whom 436 million travel to and from France and 93 million to and from Poland. The analysis also highlights the large market share of the road transport mode on these connections since 79% of the passengers travel by car. The air transport market share often exceeds the road one for distance over 1500 Km and reaches 100% for distances over 2000 Km.

The road transport mode preponderance on the potential EPATS connections hence tend to mean that the traditional air transportation is often less competitive than the road transport mode. But could a different way of travelling by air such as the personal aviation be an alternative to the traditional air transport as well as to road transport?
The answer to this question is the next step of the analysis aiming at assessing the traffic that could be potentially transferred to EPATS by 2020 as well as the EPATS aircraft fleet that would be necessary to satisfy this demand.

4. Potential transfer of passenger demand to personal aviation by 2020 and first estimation of EPATS fleets

4.1. Estimation method

4.1.1. Objectives and scope of study

The goal is to calculate the potential number of passenger-km that could be transferred from current transport modes to EPATS by 2020. These estimations will give a global indication of the future EPATS market. It must be pointed out that "inferred traffic" is not taken into account in this study.

Gross estimations were made at European level, , and at national level on identified regional flows in France and Poland. The calculations were made for the most modern current aircraft: six aircraft fulfilling the EPATS requirements were selected for the calculations. These aircraft represent the best compromise between cost and speed. They can be compared to car and traditional air transport (= "traditional aircraft")[6].

For these estimations, we assumed have to make the assumption that a traveller chooses a transport mode by comparing the modes in terms of money and time. We are were not able to take comfort, security or punctuality into account comfort, security or punctuality in our calculations due to the lack of data available on these aspects and the consequent difficulty to in integrating integrate such qualitative variables.

The method used is the generalized costs minimization method, meaning that we compared the generalized cost for each mode of transport. This generalized cost, depending on the travelled distance and the value of time (cf.Annex 9), is the sum of travel cost and time cost. Then, after calculating generalized costs, we selected the mode of transport having the smallest lowest travel/time cost aggregate. one.

Once the general method has been explained, we present the input data for the base year and describe the scenarios.

4.1.2. Explanation of the methodology

4.1.2.1. Concept of generalized cost

First, to understand the concept of generalized cost, we assumed that a traveller does not choose between 2 modes by comparing only prices; s/he also takes into consideration several qualitative factors such as transport time, frequency of the train or aircraft, comfort, or reason

[6] Due to a lack of data, we were not able to compare EPATS with train in Europe. However, we undertook the comparison with High-Speed-Train in France. Results showed that EPATS could not competitive with HST. For that reason, we decided not to present the case of train.

for travelling. These parameters are subjective: they are not perceived the same way from one passenger to another. Thereby, we defined the concept of generalized cost which assigns a monetary value for all these parameters, given the kind of passenger:

$$\boxed{C_g = C_{travel} + \sum C_i} \quad \text{(in €)}$$

With C_g = Generalized Cost

C_{Travel} = Travel Cost = monetary cost = Direct cost borne by the traveller

C_i = Non-monetary Cost

The only non-monetary cost we used is the "time cost", which depends on the time spent in travelling and on the value of time, i.e. the value that a passenger attributes to his time. More explanations are given in Annex 9. Because of the difficulty in evaluating aspects such as comfort, frequency, etc, we did not factor them into our analysis.

The following formula was used to calculate generalized cost:

$$C_g = C_{travel}(d) + \underbrace{V_t \times T_{travel}(d)}_{\text{Time Cost}}$$

With: C_g = Generalized Cost

C_{Travel} = Travel Cost = Out-of-pocket Cost

d = Travelled Distance

V_t = Value of time

T_{travel} = Travel time = time spent in travelling or waiting

Each generalized cost is specific to the considered transport mode. Besides, it depends on the distance, and also on the value of time, therefore on traveller's features. Indeed, the value of time depends on both the person's income and the reason for travelling (a business man will value an hour wasted in transport more highly than a leisure traveller).

That is why we can affirm that:

Generalized Cost (for transport mode i) **=** f° **(distance, value of time)** With **Value of Time =** f° **(income, trip reason)**

Ideally, factors such as comfort, frequency, punctuality, etc... should be part of the generalized cost. However, a database providing information on such qualitative elements for European

trips unfortunately does not exist, what prevents us including such qualitative factors in our developed methodology of estimation.

Now, let's have a look at the different elements that makes up the generalized cost.

➢ Travel Time

The travel time T_{Travel} can be separated into four distinct parts:

- **Access time** T_{access} to the transport mode = Time to go from origin point to the transport mode
  = access time to the transport terminal + time spent at the terminal for procedures (checking, waiting, boarding)
- **Egress time** T_{Egress} = Time to go from transport mode to destination mode
  = Time spent at terminal after arriving (Transfer Time, Time for picking up luggage) + Time to go from terminal to destination point
- **Transport time** $T_{journey}$ = time spent in transit only
  = Distance ÷ Average Speed
- **Additional time** $T_{additional}$ **:** this should be taken into account only in the case of car travel. It corresponds to the potential breaks the traveller can take while driving. These breaks can be short breaks, as well as stops in hotel for very long distance trips. Time used for sleeping (at hotel) is not included in additional time since it is not considered wasted time. However, time spent eating is included in travel time because for the traveller it could be time spent with his family rather than time spent in a hotel.

The function is therefore:

$$T_{Travel} = T_{access} + \underbrace{\frac{d}{Vm}}_{T_{Transport}} + T_{egress} + T_{additional}$$

With: d = travelled distance
Vm = Average speed

➢ Travel Cost = monetary cost

The direct cost borne by the passenger (= Out-of-pocket cost) is composed of:

- **Access cost** C_{Access} = cost to access the terminal. This cost is fixed.

Note: It is assumed that the passenger goes to the terminal by car.

⇨ Access cost = average distance from origin point to terminal * cost per km by car

- **Egress cost** C_{Egress} = cost to leave the terminal and reach the destination. This cost is fixed.

Note: It is assumed that the passenger goes from the transport mode to his destination point by car.

⇨ Egress cost = average distance from terminal to destination point * cost per km by car

- **Transport cost** $C_{Transport}$: varies with the distance. It corresponds to the multiplication of a "**unit cost**" (a cost per pkm) with the distance. This unit cost is the price per km paid by a passenger to use a transport service (commercial aircraft, EPATS) or to use his personal car.

Note: When unit cost is expressed in vehicle-km, we have to divide this cost by the average number of passengers in the vehicle (obtained using the load factor) in order to obtain the operational cost in passenger-km.

- Potential **additional cost** $C_{Additional}$ such as accommodation cost (for car when stopping in a hotel)

$$C_{Travel} = C_{Access} + \underbrace{Distance \times C_{Unit}}_{C_{Transport}} + C_{Egress} + C_{Additional}$$

4.1.2.2. *Generalised cost minimization method*

➢ **Indifference curves between two modes of transport**

The comparison of the generalized costs enables to compare modes and to choose the one that minimizes generalized cost for a given journey.
Thus, when a traveller with a value of time V_t compares two transport modes, mode i and mode j, he will choose the one having the smallest generalized cost, i.e.:
The traveller chooses the mode i if: $Cg_i < Cg_j$

Or if: $Ctravel_i + V_t \times Ttravel_i < Ctravel_j + V_t \times Ttravel_j$

Or else if: $Ctravel_i - Ctravel_j < V_t \times (Ttravel_j - Ttravel_i)$

This gives 2 options:

The traveller chooses the mode i if:

$$\frac{Ctravel_i - Ctravel_j}{Ttravel_j - Ttravel_i} < V_t \quad when \quad Ttravel_j - Ttravel_i > 0$$

$$\frac{Ctravel_i - Ctravel_j}{Ttravel_j - Ttravel_i} > V_t \quad when \quad Ttravel_j - Ttravel_i < 0$$

We therefore introduce the notion of "**Indifference time value**", Vt_I :

$$\boxed{Vt_I = \frac{Ctravel_i - Ctravel_j}{Ttravel_j - Ttravel_i}} \qquad \text{(in € / h)}$$

If a passenger's time value is equal to the Indifference Time Value, then s/he will have no preference for one mode of transport over another.

In addition, the value of time can be expressed as a function of the distance since cost and time depends on the distance. The idea is therefore to **construct indifference curves**, or in other words to plot "indifference time value" versus "travelled distance". **These indifference curves enable to see clearly the preferred mode for a segment of the market, i.e. for a distance and a value of time given.**

Hence:

The traveller (with a value of time Vt) will choose the mode i if:

$$V_t > Vt_I \quad when \quad Ttravel_j - Ttravel_i > 0 \quad \textit{(Above the curve)}$$

$$V_t < Vt_I \quad when \quad Ttravel_j - Ttravel_i < 0 \quad \textit{(Below the curve)}$$

To summarize, the indifference curve is the limit between the areas of preference for the modes. This is illustrated by the following graph:

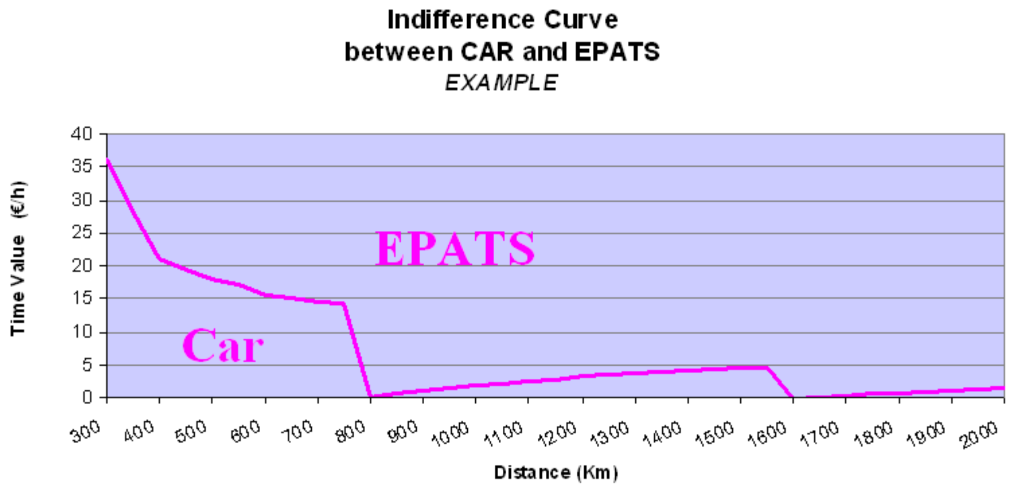


Figure 4-1: Example of indifference curve between car and EPATS

(Data source : ESPON)

In this example, EPATS is compared to car. Let's assume we are in the case where $T_{car} > T_{Epats}$ for any distance. Hence: EPATS is preferred above the curve, and car, below the curve. For instance, a person with a value of time of 15 € / hour will prefer using to use a car for trips of a distance 300 and 600 km. Above 600 km, this person will prefer EPATS.

➢ Passenger-km distribution by distance and value of time

The second part of the method consists in linking the indifference curves to the expected results i.e. to the potential transfer of passenger-km. We have already seen that the Indifference Curve is a representation of "value of time" versus "distance".
We therefore **need to get a table providing passenger-km distribution versus value of time and travelled distance, for each transport mode (Aircraft / Car).**

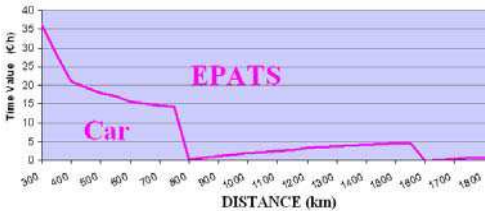
➢ Results

The combination of both previous elements (indifference curves between two modes and passenger-km distribution by value of time and distance) can be used to obtain a modal split. We can use a model split to compare EPATS with another transport mode, and determine a passenger's preferred choice.

The model split is a good way to easily determine the potential transfer of passenger-km to EPATS.

Data and Assumptions

Indifference curves between 2 modes
value of time vs. distance



Passenger-km distribution
vs. distance and value of time

Pkm Distribution		**DISTANCE cat.**		
		D1	D2	D3
TIME VALUE €/h	TV 1	…	..	…
	TV2	…	…	…
	TV3	…	…	…

Modal Split

		DISTANCE cat.		
		D1	D2	D3
VALUE OF TIME €/h	TV 1	…	..	…
	TV2	…	…	…
	TV3	…	…	…

Results: **Potential Transfer of passenger-km to EPATS**
= Sum of the Pkm in the blue cases (in the example)

Car
Epats

The description of the methodology enabled to list the parameters involving in the model. The list is available in Annex 10.

4.1.2.3. Market Segmentation

The above description suggests that we need to divide the market into 2 categories: Business and Leisure, and carry out separate estimations for each category. The stems from the fact that Business and Leisure passengers do not have the same level of value of time. In average, a business passenger has a value of time 3 or 4 times higher than a leisure passenger (Cf.Annex 9). This means that they do not have the same travelling budget . Hence where a business passenger will often tend to use an air transport mode, a leisure passenger will tend to take his car. Therefore, the pkm distribution according to the travelled distance and the value of time are completely different.
The “Business market” can be segmented as well, since there are several types of business travellers: when travelling by plane, some businessmen buy flexible and refundable tickets, while others take economy-class tickets. The difference in price can be quite significant; thus

we have to distinguish between Business Travellers as follows: "**Economical Business Travellers**", and "**Typical Business Travellers**".
Unfortunately we did not have any information regarding the relative rapport between these 2 categories; for the purpose of this analysis, we have assumed that 30 % of business travellers are economical business, and 70 % are typical business.

This creation of 2 categories of business passengers impacts on cost, and thus on indifference curves, but does not have effect on the passenger-km distribution.

4.1.3. Data Collection for the base year and Assumptions

Estimations must be carried out for the year 2020. But first, we have to determine a base year and to collect input data for this base year. Afterwards, we will use a number of scenarios of determine input date for 2020.

The base year is 2005, since it was the most recent year for which we could get data.

Data collection is a very important step in the model building. As shown in section 4.1.2.2, the model is divided in two stages: building of indifference curves, with parameters of cost and time (corresponding to the transport modes characteristics), and on the other hand, journeys distribution with parameters of occupation, income, distance, etc.. In the present section, data collection will be also performed in two steps in the same way.

Each data set is justified (by an official source, or by calculations). The approach consisted first in collecting data for France (because easier to find), second in adapting and updating data for Europe. When assumptions were made for France, they were generally right for Europe. Most European data reflects French data. When they are different, this is noted and explained. Due to a lack of data in the European case, we were sometimes forced to keep French data.

4.1.3.1. Transport modes characteristics required for the building of Indifference Curves

For each transport mode (Car, Traditional Aircraft, EPATS Aircraft), the characteristics required in the model are presented in a table, and then they are commented. Note that these data are relative to the year 2005 and some of them are likely to change by 2020.

- **CAR**

Average Speed *(km/h)*	**Occupancy Rate**			**Number of passenger seats**	**Transportation Unit Cost** *(vehicle-km)*			**Accommodation Cost** *(€ / night / pax)*	
100		**L**	**B**	5		**L**	**B**	**L**	**B**
	Fr.	1.64	1.14		Fr.	0.16	0.58	60	150

	EU	1.96	1.14		EU	0.165	0.58		

Table 4-1: Car characteristics

Legend:
L = Case of a Leisure passenger
B = Case of a Business passenger

For a trip by car it is assumed that:

- Travellers take a break every 2 hours for 10 minutes (in France it is recommended to stop every 2 hours).
- Travellers stop in a hotel after travelling 800 km. This corresponds to a maximum drive time per day of 8 hours (Source: Ref 39)
- The overnight rest lasts 10 hours (source: Ref 39) with 8 hours for sleeping, hence 2 hours corresponding to an additional time to include in the travel time.

There is neither access/egress time or access/egress cost since the traveller has access to his car from his point of departure.

Average Speed:
The average speed used for car travel is French data, coming from the government. (source:Ref 35). The comparison of speed limitations between France and Europe shows that French limitations are similar to those of other European countries. Thus, we used the same average speed for the European case.

Occupancy rate:
The occupancy rate enables to express the transportation cost in passenger-km. The values come from the Tremove model.

Transportation Unit Cost:
Business and Leisure trips are different in terms of transportation costs. For business trips, we have to take the French kilometric cost scale used by companies (0.5 €uro€ / km) plus the toll. This cost takes into account fuel but also insurance, car depreciation, etc. However, when a leisure traveller takes his car, does he really consider all these parameters when comparing with another mode? No, he does not; he only considers cost of fuel and toll. This is the "perceived cost". That is why two different costs are taken.
To calculate the toll cost per vkm in France, we used data from Cofiroute and ASF. We obtained a price of 8 € cent per vkm. Due to a lack of data, it has been assumed that the toll cost at the European level are in line with French costs.
To calculate the fuel cost per vkm, we used three parameters: the fuel price (€uro / L) by fuel type (Diesel / Petrol), the car consumption (L/100km) by fuel type and the share of Diesel / petrol vehicles. The data come from the French government for the French data, and from Eurostat – DG Tren and from ACEA (European Automobile Manufacturers Association) for the European data. The cost per vkm is 8 € cent in France, and 8.5 € cent in Europe.

Accommodation Cost (if stop in a hotel):
There are two different costs for Leisure and Business passengers. The American study (Ref 39) gives a cost of 85$ for accommodation (about 62 €uro). This cost is suitable if we assume that

the average price for a night in a hotel is about 40 €uro (in general one couple pays about 70-80 € for one room) and that the passenger spends 20 €uro more than usual for food and leisure during his rest. However, for a businessman we should use a different price: we took a price of 150 €uro per night per person. We assumed the same prices for Europe and France.

➢ TRADITIONAL AIRCRAFT

Average Speed *(km/h)*	**Access Time** *(hour)*		**Egress Time** *(hour)*		**Transportation Unit Cost** *(pkm)*			**Access & Egress Cost** *(€)*	
640	**L**	**B**	**L**	**B**	**L**	**B1**	**B2**	**Fr.**	2.4
	1.5	1.3	0.75	0.7	0.134	0.2	0.4	**EU**	2.6

Table 4-2: Commercial Aircraft characteristics

Legend:
L = Leisure
B1 = Economy Class Business
B2 = Typical Business

Average Speed:
This is the average of values coming from AEA (Association European Airlines).

Access Time:
The access time for aircraft is composed of access time to the airport plus time spent at the airport for procedures.
From DGAC (cf.Ref 9), airports are on average accessible in 30 minutes.
Time spent at the airport differs from leisure passenger to business passenger: a leisure passenger comes to the airport about one hour before his flight, whereas a businessman is more used to all the procedures, and will take his luggage on board with him in more cases. That is why it has to be considered a shorter time spent at the airport for the businessman: 50 minutes.

Egress Time:
The egress time structure is quite similar to the access time. It is composed of the time spent at the airport after arriving (to pick up luggage) plus the time necessary to leave the airport and reach the destination.
First, we assumed that the time to go from the terminal to the destination point is the same as the access time to the terminal (30 minutes).
Second, we considered that a businessman spends less time at the airport because he tends to take his luggage with him. We therefore assumed that a leisure traveller spends about 15 minutes in the airport after his landing, and a businessman 10 minutes.

Access & Egress cost:
To calculate the access cost to airport we considered that the passenger goes to the airport by car. We multiplied the average distance from city to airport by the cost per km by car. The average distance is about 15 km (cf. Ref 9). Egress Cost is equal to access cost.

Transportation Unit Cost:

It corresponds to the passenger yield, i.e. the price the passenger pays per km to the airline. This is a very complex parameter, difficult to evaluate. Companies use new strategies such as the yield management in order to segment their market and sell a same seat at different prices. However, to simplify we assumed that there are 3 price levels (see §4.1.2.3):

- ➔ a "Leisure price" corresponding to an economy class flight ticket (constraints, no refundable, not flexible ..)
- ➔ a " Economy Business Class", corresponding to a economy class ticket with a certain flexibility
- ➔ a "Normal Business price" (flexible & refundable).

The leisure passenger yield data was sourced from AEA (Association of European Airlines). As for the business passenger yields, we made some calculations using data from Air France and Lufthansa.

➢ EPATS AIRCRAFT

EPATS aircraft fleet type structure and their main characteristics presented below are an outcome of the following analyses:

- Aircraft and European airport Data Base (WP-1)
- Initial approach to WP-4 tasks – concerning mission requirements and cost analysis.
- The preliminary analysis of EU socioeconomic and interregional passenger mobility data – Task 2.1,
- Assumptions under discussion in „EPATS ROADMAP VISION", Warsaw, June 2007 (Ref 20)

The provided data is intended for potential demand of EPATS aircraft estimation using *Indifference generalized costs curve calculation*, which was approved for the realization of Task T.2.2 *Potential transfer of passenger demand to personal aviation by 2020*. A personal car is a reference mode for this method, which on a contrary to train or airlines, similarly as EPATS may realize any direct interregional connection.

Data input may somewhat change in further realization of WP-4, especially in the area of costs and fuel consumption.

The following definitions are consistent with Federal Aviation Administration. See *General Aviation 's Contribution to The U.S.Economy |May 2006*. Future European statistical survey concerning the uses of EPATS aircraft should be in accordance with the following classification and use categories

<u>Classes of EPATS aircraft</u>

The EPATS Aircraft are grouped into the next classes of aircraft, that has been issued a certificate of airworthiness by EASA according to CS-23 Requirements:

1. **Single-engine piston-powered airplanes,** that are the most common Personal-Use aircraft, thanks to their relatively low acquisition cost. The single piston engine drives a single propeller,
2. **Multi-engine piston-powered** airplanes usually have two piston engines driving separate propellers.

3. **Single-or Multi-engine Turboprop airplanes** are powered by one or more turbine engines that drive propellers. Turboprop aircraft typically are larger, faster, and more expensive than piston aircraft. Turboprops are flown for a wide variety of purposes but are most often flown for business, corporate, and other professionally crewed purposes.
4. **Jet** airplanes have two or three turbofan engines and offer the greatest speeds and range capabilities of all EPATS aircraft. Due to the expense and professional requirements of their operation, jets are most commonly operated by corporate and government users.For purposes of this study,jets are further segmented by weight class into two categories (Very Light Jet and Light Jet,)to capture significant cost and use differences.

EPATS aircraft use categories

1. **Personal** – Aircraft flown for the personal purposes of the owner (in own or fractional ownership), that pilot it by themselves. The number of passenger seats include pilot seat. Operating under FAR 91
2. **Business** – These aircraft are flown by owner-pilots for individual or group use for business transportation without a professional crew. The number of passenger seats do not include pilot seat. Such owners are assumed to share a hangar with other users and pay a business insurance rate. They are assumed to purchase the commercial weather report service since travel is important to the conduct of their business and, on average, they fly more frequently than personal users. Operating under FAR 91
3. **Corporate,** – Usually in company or fractional ownership. For purposes of cost evaluation, this category includes all uses, which are assumed to use professional crews. The owners of these aircraft are assumed to rent a private hangar, pay the corporate insurance rate, and hire a professional crew (pay and benefits). Operating under FAR 91.
4. **Air Taxi**. – on-demand passenger operations operating under FAR 135.
5. **Commuter** – scheduled passenger service operating under FAR 135

Vehicle reference and EPATS aircraft types to be considered

ACP-1- Single-Engine Piston - Personal
ACP-2 – Twin-Engine Piston - Business
ACT-1 – Single-Engine Turbo-prop – Air-Taxi
ACT-2 – Twin – Engine Turboprop - Commuter
ACJ-1 – Twin-Engine Very Light Jet (<5000 kg) – Air-Taxi
ACJ-2 – Twin-Engine Light Jet (< 7000 kg) – Corporate

***V-REF – Vehicle reference,** it is assumed to be a car mainly. The data in the table are given only as an example.

The Table 4-3 below indicates their main features:

Parameter	ACP-1	ACP-2	ACT-1	ACT-2	ACJ-1	ACJ-2
Crew	1	1	1	1	1	1
Pas. Seating (PS)	3	5	9	19	5	9
Cruise speed [km/h]	320	350	550	550	700	750
Climb speed/Cruise speed (CC)	0,5	0,5	0,55	0,55	0,6	0,6
Range [km]	1000	1000	1500	1500	2500	2500
SFC [l/km]	0,1	0,2	0,3	0,55	0,3	0,55
SFC [l/pax*km]	0,05	0,06	0,05	0,04	0,09	0,09
Fuel Cost [€/(km*pax)] - Actuel	0,04	0,04	0,04	0,03	0,07	0,07
Fuel Cost [€/(km*pax)] - 2020 - Null	0,05	0,06	0,05	0,04	0,09	0,09
Increase - Fuel Cost [€/(km*pax)]	0,011	0,013	0,011	0,009	0,019	0,020
Operational costs [Euros/h]	200	300	1000	1300	1300	2000
Estimated Price [1000 Euros]	200	400	2000	4000	1500	3500
Climb to cruise level (CT)	0,17	0,33	0,33	0,33	0,33	0,33
Climb Distance (Dclimb) [km]	26,7	58,3	100,8	100,8	140	150
Fixed Flight Op.Time (FFOT) [h]	0,38	0,45	0,62	0,80	0,70	0,77
Waiting & Boarding Time (WBT) [min]	0,17	0,20	0,25	0,33	0,25	0,30
Total fixed operations time (TFOT) [min]	0,55	0,82	0,78	1,05	0,87	0,93
Average Load Factor (LF)	0,7	0,7	0,7	0,7	0,7	0,7
Hours flown by year	300	400	500	1400	400	400
Average GCD	400	400	700	700	1100	1300
Annual Pkm	151 079	364 230	1 185 956	6 358 642	713 424	1 329 979
R	1	1	1,1	1,1	1,15	1,15

Table 4-3: EPATS aircraft characteristics

(Source : Annex 13)

<u>Access / Egress Time & Cost:</u>

The principle is the same as for the case of traditional aircraft. The time to access the airport and to leave the airport is the same as for traditional airport: 30 minutes. The only data that changes is the time spent at the airport:

- ➔ Before the flight: passengers have to arrive between 10 and 20 minutes (depending on the aircraft type, see Table 4-3: WBT) before the flight departure.
- ➔ After the flight: time is assumed to be null (small airport, no need to wait for the luggage)

4.1.3.2. Data Collection for passenger-km distribution table

The passenger-km distribution table (by distance category and time value) was very difficult to determine. This matrix requires a long and meticulous work. Actually we have to proceed by steps to obtain it. The method is illustrated by the following schema:

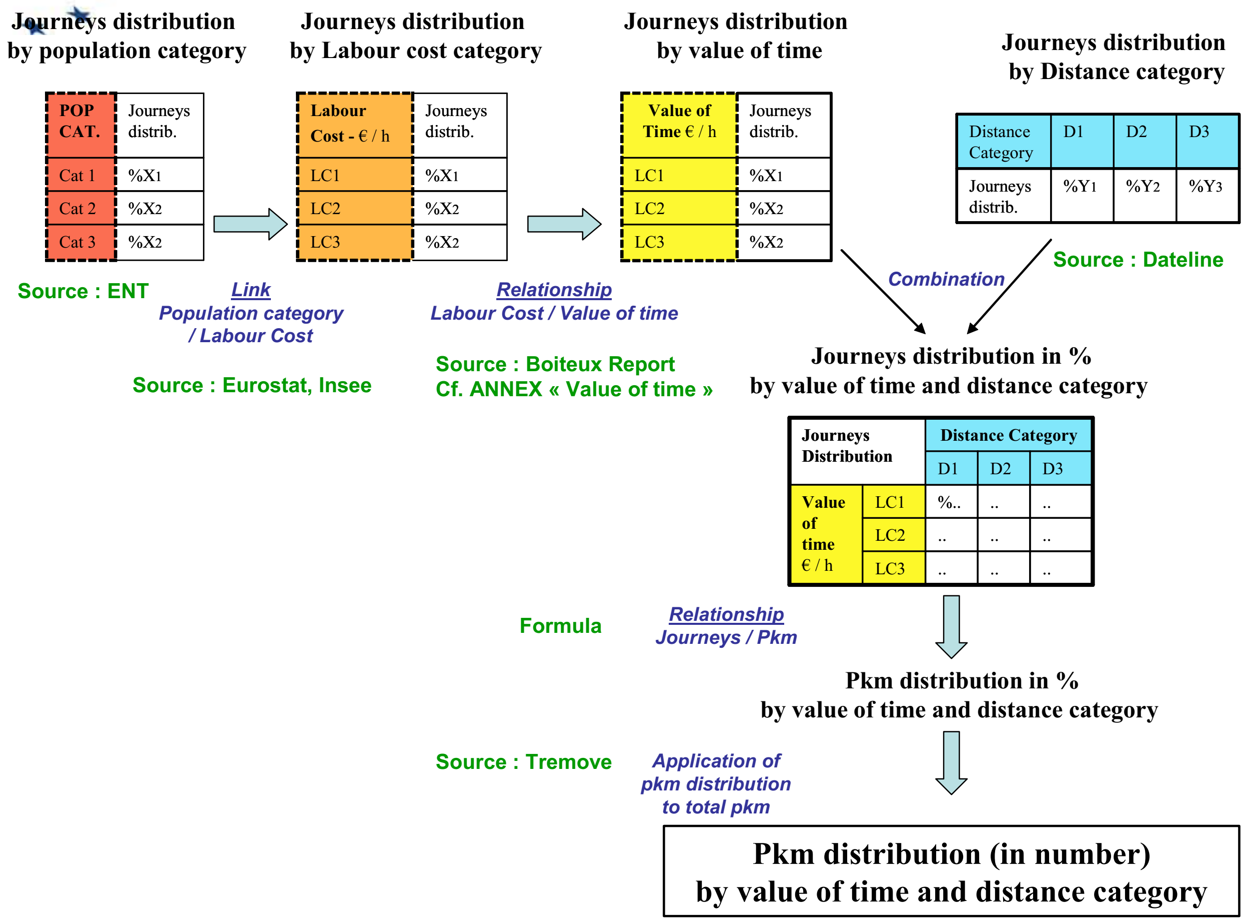


Figure 4-2: Methodology of the construction of passenger-km distribution table

Note: The schema gives in blue the links and in green the sources.

As shown in Figure 4-2, the methodology consists in obtaining first, the journeys distribution in % by population category; and second the journeys distribution in % by distance category.

"Population category" corresponds to a classification of the population by type of occupation for example, as well as by income class. The categories of population are linked to values of time. Afterwards, the multiplication of both distributions yields a double-entry table. The change from journeys to pkm distribution in % is very simple and only requires average distances and a formula. Lastly, the distribution of passenger-km in % is applied to the total number of passenger-km so as to build the table of passenger-km distribution in pkm.
The matrix must be built for the mode "car" and the mode "Aircraft", and for each one, there are two cases: Business and Leisure passenger.

- <u>In case of business trips,</u> the value of time depends on the salary of the traveller, therefore on his occupation. For the case of France, the journeys distribution by occupation is provided by the ENT survey. Then, since the distribution of occupation categories in the population is pretty the same in Europe and France, we can assume that each category will make the share of journeys, wherever in Europe or in France. Thus, we also use the results of ENT survey for the case of Europe.

In case of leisure trips, passengers travel according to household budget. This means that the value of time depends on the disposable income per person, in other words the total household income divided by the number of persons in the household. For the case of France, the journey's distribution by household income category is provided. Despite all our efforts, we were not able to get this table for Europe. In addition, there is no reasons to assume that French data could be duplicated over to other countries. All in all, however, we do not even need this table since the European average income is so low (source: Eurostat) that it is clear EPATS could not interest leisure passengers.

The table below illustrates the results of the methodology. The other tables are presented in Annex 11: Passenger-km Distribution Tables. (The passenger-km distribution is given in %).

EUROPE – Aircraft - Business		Distance Category (km)						
		100-200	200-400	400-600	600-800	800-1000	1000 +	Total
Professional activity	Average time value - € / hour	152 Km	309 Km	481 Km	693 Km	897 Km	1508 Km	
Fishery, manual workers	*9.85*	0.0	0.2	0.5	0.3	0.2	0.9	**2.1**
Farmer	*10.20*	0.0	0.1	0.2	0.1	0.1	0.4	**0.9**
Clerks, sales workers	*10.78*	0.0	0.3	0.7	0.4	0.3	1.4	**3.1**
Technician and associate professionals	*15.98*	0.2	1.8	4.3	2.6	2.0	8.6	**19.4**
Craftsmen, owner of a shop or a company	*18.36*	0.0	0.5	1.2	0.7	0.6	2.4	**5.5**
Professionals, managers	*24.35*	0.5	6.3	15.2	9.2	7.2	30.6	**69.0**
Total		**0.8**	**9.1**	**22.0**	**13.3**	**10.4**	**44.3**	**100 %**

Table 4-4: Table of Passenger-km Distribution in % in Europe- Plane – Business

(Source: DATELINE, Enquête nationale Transport)

4.1.4. Scenarios

By 2020 some parameters of the model will have changed, while others will remain identical. Thus, we need to assess how concerned parameters could evolve over time.
The most difficult and complex element to evaluate is the traffic in terms of passenger x km or of trips. We therefore need to focus on studies providing forecasts for different kinds of traffic (long distance, personal / professional trips, by car / air ...). Even though there are not many studies on this matter for the EU25, we did manage to locate a study that more or less meets our

demand: the ASSESS study. Directed by the European Commission in 2005, this study deals with the "Assessment of the contribution of the TEN and other transport policy measures to the mid-term implementation of the White Paper on the European Transport Policy for 2010". The White Paper of 2001 advocated policy measures in order to achieve a sustainable transport system. These measures are gathered in four objectives: shifting the balance between modes of transport, eliminating bottlenecks, placing users at the heart of transport policy and managing the effect of globalization.
The goal of Assess is then to have an overview of the measures implemented between 2001 and 2005, i.e. to see whether the objectives have been reached or need some adjustments. It also aims at foreseeing the consequences of the implemented measures on traffic and on a certain number of variables such as travel cost or travel time for each mode. Four scenarios have been developed in order to evaluate the effects of the measures. The particularity of this study is that the **scenarios share common assumptions concerning the macroeconomics trends** (Population, GDP, Fuel price, etc). Actually, the scenarios differ in term of degree of implementation of the policy measures: there are the Null, the Partial, the Full and the Extended scenarios.

- **The Null scenario (N-scenario)** assumes that none measure of the White Paper has been implemented, neither at the European level nor in the Member States. In the absence of the White Paper policy measures, the transport situation is assumed to follow the recently observed trend since the late 1990s.
- **Partial implementation scenario (P-scenario)** includes measures already implemented and the ones likely to be implemented before 2010. This scenario probably represents the most likely outcome of the implementation of the main White Paper measures, given the progress so far.
- **Full implementation scenario (F-scenario)** includes all 78 measures introduced in the White Paper and in the White Paper action program.
- **Extended scenario (E-scenario)** is a kind of mix between the partial and the full implementation scenario: for most measures the extended scenario follows the full scenario while for some measures the partial scenario is followed because there is no indication that the full implementation is feasible.
  Also, two policy changes has been introduced. Firstly, the extended scenario includes more pricing measures, in particular higher prices for freight haulage and introduction of road pricing for passengers. Secondly, it includes a faster uptake by market parties of the opportunities that are enabled by the new EU legislation on liberalisation by providing the financial incentives and technological means. This means a faster implementation of the RIS, EMRTS and SESAME technological projects in inland waterways, rail and air transport respectively, as well as a faster introduction of Galileo applications and more effort on competitive tendering and market opening in the rail sector to accelerate reform in the passenger sector.

Table 4-5 shows some differences in the implementation of White Paper measures according to the scenarios. Hence for instance the Single European Sky measure is considered as being implemented in all scenarios except the Null scenario, while the kerosene taxation is only implemented in the Full and Extended scenarios.

Examples of White paper measures	N-scenario	P-Scenario	F-scenario	E-scenario
Single European Sky	No	Yes	Yes	Yes
Harmonisation of airport charges	No	No	Yes	Yes
Kerosene taxation	No	No	Yes	Yes
Airport capacity expansion	No	No	Yes	Partial

Table 4-5: Examples of White Paper measures considered by scenario (Source ASSESS)

These policy scenarios impact differently on travel time (e.g. congestion), **price** (owing to the technological measures, or the choice of new taxation) and quality of service. The Annex 5 of Assess Study: "Modelling scenarios and assumptions" is fundamental since it translates the policy measures of the white paper into indicators. All these factors also condition the travel demand.

The Assess study is based on several models. The one that interests us is the Tremove model. Tremove gives the number of passenger x km forecast each year from 2000 to 2020, according to the transport mode, the trip reason and the trip distance (short or long). The only inconvenient of Tremove is that it does not cover the whole European Union; only the European Union 15 and four new members: Poland, Hungary, the Czech republic, and Slovenia. Nevertheless, this study meets quite our expectations.

From our side, we also had to make assumptions concerning some parameters:

- **Assumption 1:** The population distribution by occupation category will not change.

⇨ This assumption enables to keep the same "journeys distribution by occupation" category.

- **Assumption 2:** The "journeys distribution by travelled distance" will not change

⇨ This assumption, combined with Assumption 1 enables to keep the same journeys distribution by occupation and distance category.

- **Assumption 3:** The gross salaries, whatever the occupation category, will all increase in the same way.

Whilst these assumptions can be criticized, is will be remembered that first, we were unable to locate any data regarding their possible evolution for Europe, and second, without them it is impossible to get the "journeys distribution according to occupation" and the travelled distance.

Annex 11: summarizes the evolution of model parameters and shows the assumptions and forecasting made by the ASSESS study.

4.1.5. Considered EPATS connections

The potential transfer to EPATS of passenger demand is estimated on connections where EPATS is relevant. Such connections are identified in the mobility analysis performed in the task 2.1.

However, only 11682 among all the 15223 identified potential connections between NUTS 2 of 28 countries were used to estimate the potential demand transfer to EPATS. The reason is that ASSESS forecasts only concern 21 countries: Austria (AT), Belgium (BE), Czech Republic (CZ), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Hungary (HU), Ireland (IE), Italy (IT), Luxembourg (LU), Netherlands (NL), Norway (NO) Poland (PL), Portugal (PT), Slovenia (SI), Spain (ES), Sweden (SE), Switzerland (CH) , and United Kingdom (UK).

As a consequence other countries considered in ESPON (i.e. Bulgaria (BG), Cyprus (CY), Estonia (EE), Latvia (LV), Lithuania (LT), Romania (RO), Slovakia (SK)) are not considered for the estimations.

4.1.6. Methodology illustration

Finally, in the estimation process there are five main cases to study:

- Comparison EPATS / Car for a leisure passenger
- Comparison EPATS / Aircraft for a leisure passenger
- Comparison EPATS / Car for a business passenger
- Comparison EPATS / Aircraft for a “Economy Class Business” passenger
- Comparison EPATS / Aircraft for a “Typical Business” passenger

In each case we have to run the model several times so as to take into account the different EPATS aircraft (ACP-1, ACP-2, ACT-1, ACT-2, ACJ-1, ACJ-2), the different scenarios (Null, Partial, Full, Extended), and the different area (Europe /France / Poland).

In order to illustrate our methodology and to explain how results will be extracted, we take here the case of the ACJ-1 aircraft compared with traditional commercial aircraft, for a “Typical business” passenger, in scenario N, in Europe.

Firstly, the table of pkm distribution is updated for the year 2020 thanks to the forecasting of Tremove; values of time are also updated. We finally obtain the following table:

PKM distribution in %		Travelled distance (one way)						
		100 - 200	200 - 400	400 - 600	600-800	800-1000	1000 +	Total
Professional activity	**Average time value**	**152**	**309**	**481**	**693**	**897**	**1 508**	
Fishery, manual workers	*13,27*	0,0	0,2	0,5	0,3	0,2	0,9	**2,1**
Farmer	*13,75*	0,0	0,1	0,2	0,1	0,1	0,4	**0,9**
Clerks, sales workers	*14,54*	0,0	0,3	0,7	0,4	0,3	1,4	**3,1**
Technician and associate professionals	*21,53*	0,2	1,8	4,3	2,6	2,0	8,6	**19,4**
Craftsmen, owner of a shop or a company	*24,74*	0,0	0,5	1,2	0,7	0,6	2,4	**5,5**
Professionals, managers	*32,83*	0,5	6,3	15,2	9,2	7,2	30,6	**69,0**
Total		**0,8**	**9,1**	**22,0**	**13,3**	**10,4**	**44,3**	**100,0**

Table 4-6: pkm distribution – case of: traditional aircraft, "Typical business" passenger, EU, scenario

(Data Source: DATELINE, Enquête nationale Transport)

The lowest limit of values of time is 13.27 € / hour, and the highest limit reaches 32.83 € / hour. Then, the indifference curve is constructed thanks to the characteristics of the modes:

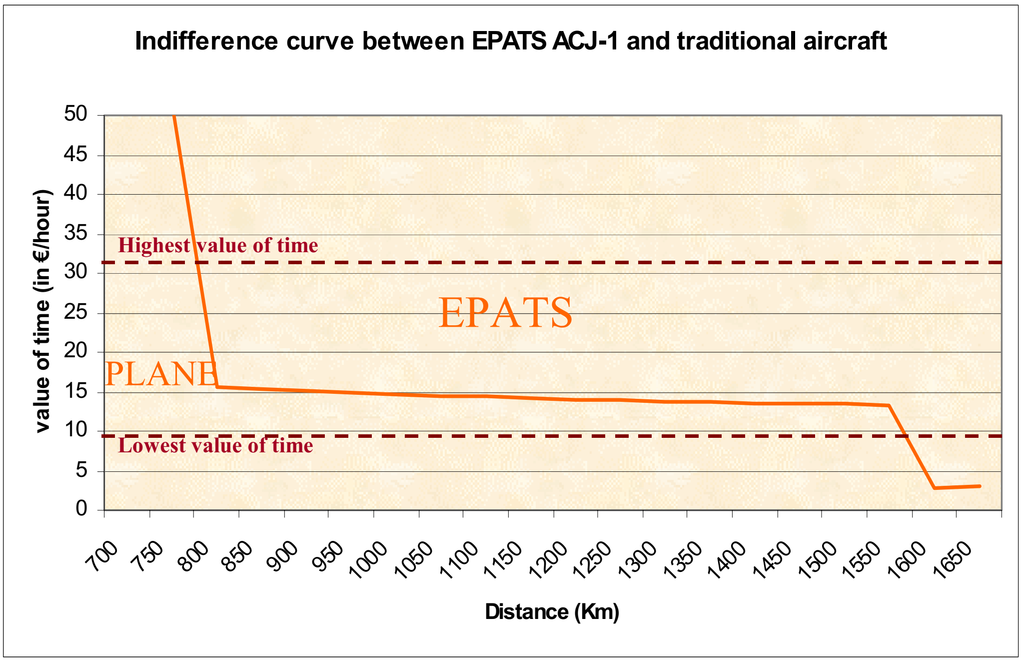


Figure 4-3: Indifference curve: ACJ-1 / traditional aircraft – case of "Typical business" passenger, in scenario N, in Europe.

(Data sources : ESPON, ASSESS)

Above the indifference curve, EPATS will be the preferred choice. Below the indifference curve, traditional air transport will be the preferred choice. On this figure, the lower and upper limits of values of time are represented in order to situate the "Typical business" passenger in respect to the indifference curve.
For instance, between 800 and 1000 km "Typical business" passengers with a value of time exceeding 15€ will prefer EPATS. And from 1600 km all typical business travellers will prefer EPATS ACJ-1 to traditional aircraft.

For each box of the pkm distribution table, we examine which transport mode is preferred. We finally gets the following modal split:

PKM distribution in %		Travelled distance (one way)						
		100 - 200	200 - 400	400 - 600	600-800	800-1000	1000 +	Total
Professional activity	**Average ti**	**152**	**309**	**481**	**693**	**897**	**1 508**	
Fishery, manual workers	*13,27*	0,0	0,2	0,5	0,3	0,2	0,9	**2,1**
Farmer	*13,75*	0,0	0,1	0,2	0,1	0,1	0,4	**0,9**
Clerks, sales workers	*14,54*	0,0	0,3	0,7	0,4	0,3	1,4	**3,1**
Technician and associate professionals	*21,53*	0,2	1,8	4,3	2,6	2,0	8,6	**19,4**
Craftsmen, owner of a shop or a company	*24,74*	0,0	0,5	1,2	0,7	0,6	2,4	**5,5**
Professionals, managers	*32,83*	0,5	6,3	15,2	9,2	7,2	30,6	**69,0**
Total		**0,8**	**9,1**	**22,0**	**13,3**	**10,4**	**44,3**	**100,0**

Table 4-7: Modal split: ACJ-1 / traditional aircraft - case of "Typical business" passenger, in scenario N, in Europe.

(Data Source: DATELINE, Enquête nationale Transport)

Legend:

(orange)	EPATS travel preferred
(cyan)	Traditional air travel preferred

The potential transfer of demand to EPATS is the sum of orange boxes, i.e. 53.2% of the traffic in pkm made by traditional aircraft by typical business travellers would be transferred to EPATS. We can then easily obtain the estimated transfer of traffic expressed in PKM.
Such estimations are done for all the type of travellers and all the categories of aircraft but ultimately, only ACP-2, ACT-2 and ACJ-2 aircraft were retained since they provide the best results.

All transfers are estimated in pkm unit as well as in number of passengers. To estimate the traffic in terms of number of flights we applied a simple rule between flown distance and aircraft type. The EPATS aircraft that we considered were:

- ACP-2 between 200 and 400 km
- ACT-2 between 400 and 100 km
- ACJ-2 between 1000 and 2500 km

When dividing the number of passengers by the number of occupied seats in the EPATS aircraft (i.e. the number of aircraft seats multiplied by the load factor) we obtained an estimation expressed in number of flights.
In addition , since we know, for each aircraft, the total yearly traffic in passenger kilometre that each EPATS aircraft is able to perform, we can deduce the number of aircraft needed to satisfy this estimated traffic.

4.2. Estimation of the potential passenger demand transfer to EPATS

The potential transfer of passenger demand to EPATS was then estimated by applying the methodology presented in section 4.1. Estimations were obtained at European level (considering the 21 countries listed in section 4.1.5) and at national levels for France and Poland. These estimations are given in terms of traffic (expressed in number of passengers, number of passenger kilometres and number of flights) that would be transferred to EPATS and in terms of number of EPATS aircraft that would be necessary to operate to satisfy this demand.

At both European and national level, ACP 2, ACT 2 and ACJ 2 aircraft types proved to be aircraft generating the highest potential transfer of traffic to EPATS. That is why we considered only these three aircraft types in our estimations.

Estimations of the number of flights as well as estimations of the EPATS fleet have been derived from the estimated number of transferred passengers to EPATS and from the category of EPATS aircraft that is considered on each connection. We attributed one category of aircraft per NUTS 2 connection. Estimations performed showed that jet aircraft would never be preferred to other transport modes (road or traditional air transport) on distance below 800 Km. We then consider two different cases of aircraft allocation by connection: Cases A and B. Table 4-8 presents the different allocation rules that we consider in each of the thwo cases. The differences mainly concern the distance limit from which jet aircraft are used. Jet aircraft are used from 800 km in Case A, and 1000 km in Case B.

Aircraft types	CASE A	CASE B
Piston aircraft	200km-250km	200km-250km
Turboprop aircraft	200km-800km	200km-1000km
Jet aircraft	800km-2500km	1000km-2500km

Table 4-8 : Rules of allocation of aircraft type according to the connection distance

4.2.1. European estimations

4.2.1.1. Passenger traffic

Table 4-9 presents the estimations of traffic transfer from road and traditional air transport modes to EPATS, obtained globally for Europe (EU 21).
One of the most important results of the estimations at a European level is the absence of transferred traffic to EPATS (both from road and from air transport mode) for leisure travellers, whatever the considered scenario. Thus, the **transfer of traffic** to EPATS in 2020 would **only concern business passengers.** But not all business passengers: transferred traffic would come from current **road business passengers** and **air "Typical business" passengers**. Hence it is also interesting to note that no traffic originating in Economy Class Business air passengers would be transferred to EPATS.

Not surprisingly, the highest share of traffic transferred to EPATS would come from road transport. Indeed, regardless of the criterion (number of passengers or numbers of PKm), the traffic transferred from road transport would represent 98% of the total transferred traffic.
The main differences between scenarios are the following:
- The Extended scenario generates the highest total of transferred traffic level to EPATS

- The Partial scenario generates the lowest total transferred traffic to EPATS, and the highest transferred traffic level from the air transport mode

Although estimated traffic levels vary according to the scenario, this difference in traffic levels according to scenario does not vary by more than 2%. Hence, even though White Paper measures implemented by the European Commission may well influence the level of road and air traffic potentially transferred to EPATS, there is a significant potential EPATS traffic (in the Null scenario) independently of White Paper implementation.

Unit of traffic	Original transport mode	Trip purpose	Null Scenario	Partial Scenario	Full Scenario	Extended Scenario
Millions of PKM	ROAD	Business	150 380	150 271	151 444	153 826
	AIR	Typical Business	1 731	1 734	1 684	1 626
	TOTAL PKM		152 110	152 005	153 128	155 452
Thousands of PAX	ROAD	Business	315 740	315 512	317 974	322 976
	AIR	Typical Business	3 592	3 599	3 496	3 375
	TOTAL PAX		319 331	319 110	321 469	326 351

Table 4-9: Estimated transferred traffic to EPATS

(Data sources for estimations: ESPON, ASSESS)

For the rest of this traffic analysis, we focus on the Partial scenario, which we consider the most likely scenario (section 4.1.4), as well as the scenario that would transfer the least amount of traffic to EPATS in 2020.

Figure 4-4 presents the estimated EPATS traffic to and from European countries, transferred from air and road transport modes in 2020. Three countries would have the highest level of traffic transferred to personal aviation: Spain, Italy and France. The potential number of passenger kilometres transferred to EPATS to and from each of these three countries would be 4 to 5 times the average level of traffic on the 21 considered European countries. The predominance of Italy and Spain can be mainly explained by the high level of domestic EPATS traffic in these countries that would represent more than 50% of the total traffic to and from these countries. However, the high traffic level to and from France would not only be related to the 32% of domestic traffic but also to the high traffic level with Spain, Italy and United-Kingdom (that would represent 27% of the total EPATS traffic to and from France).

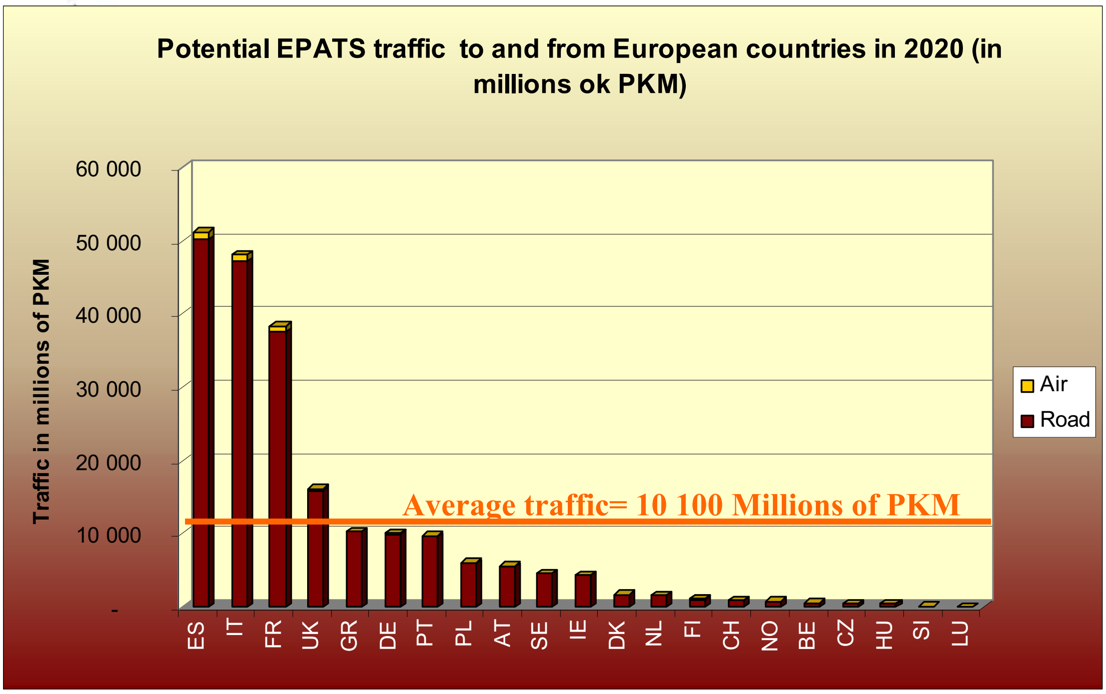


Figure 4-4: Potential EPATS traffic to and from European countries in 2020 (in millions of PKM) (Data sources for estimations: ESPON, ASSESS)

4.2.1.2. Flights

Table 4-10 presents the estimated number of flights by scenario according to the three different cases of aircraft allocation on connections. Differences in the estimated number of EPATS flights can reach 6 millions of flights between the different cases. The use of jet aircraft from 1000 km (Case B) would lead to the lowest estimated number of EPATS flights while the use of jet aircraft from 800 Km would lead the highest number (Case A). Hence the higher is the connection distance from which jet aircraft are used, the lowest is the number of EPATS flights.

Number of flights	Null scenario	Partial scenario	Full scenario	Extended scenario
CASE A	44 424 793	44 394 255	44 719 220	45 394 011
CASE B	42 954 064	42 924 291	43 241 912	43 898 992

Table 4-10 : Estimated number of EPATS flights by scenario in the three considered cases of aircraft allocation

Let's consider in more details CASE B, with the Partial scenario which is the most likely scenario. We then observe (Figure 4-5) that Italy, Spain and France would be the three European countries with the highest level of EPATS flights.
However, it is important to note that while Spain would be the European country with the highest level of PKM traffic, Italy would be the country with the highest number of EPATS flights. The reason of the predominance of Italy in terms of number of EPATS flights is the high level of traffic to and from Italy on connections with distances between 200 and 250 Km. This traffic demand would be satisfied by using Piston aircraft that have a small number of passengers (in maximum 5 passengers), leading to numerous flights.

The high traffic level on connections with distances between 200 and 300 Km also explains the high number of EPATS flights to and from Greece, while the corresponding PKM traffic only reaches the average traffic level between countries (Figure 4-4).
Estimated EPATS traffic between countries, expressed in PKM, number of passengers and number of flights are shown in Annex 14.

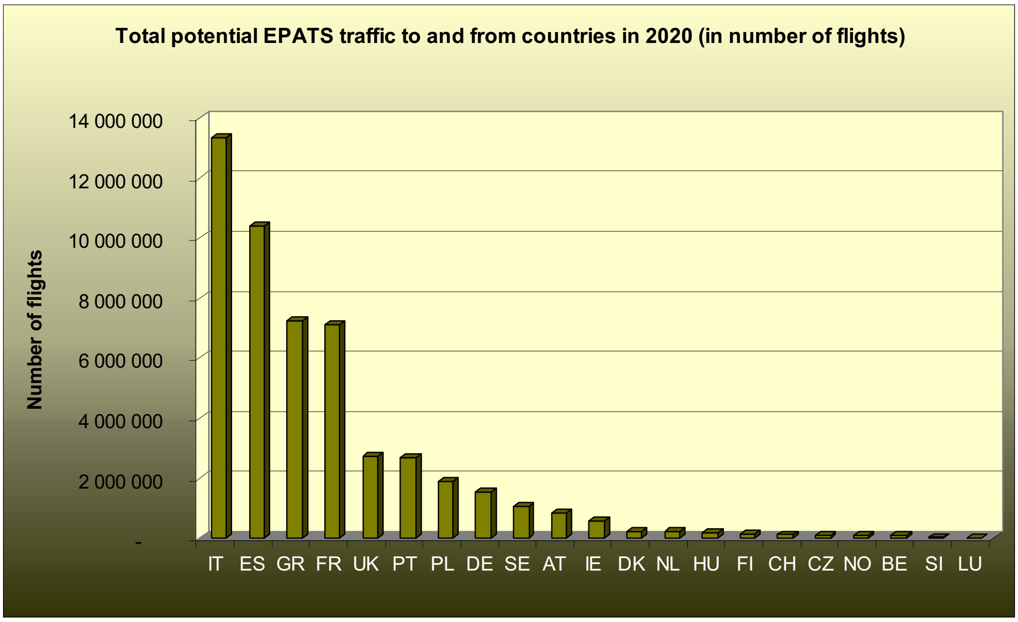


Figure 4-5: Total potential EPATS traffic to and from European countries in 2020 (in number of flights)

(Data sources for estimations: ESPON, ASSESS)

Besides the importance of the domestic EPATS traffic in Europe that would represent 82% of the flights, it is also interesting to note the existence of some connections between countries that would potentially have a high level of EPATS traffic. Table 4-11 presents the 10 connections between European countries with the highest estimated traffic level. It is in particular interesting to stress the importance of the traffic level between France and Spain, that would represent 31% of the total number of flights on these TOP10 destinations.

Connections between countries	Number of EPATS flights
FR-ES	865 700
PT-ES	593 370
IT-FR	281 940
UK-IE	185 872
PL-DE	167 441
UK-FR	164 663
IT-ES	144 170
IT-AT	143 493
FR-DE	106 086
IT-GR	95 728

Table 4-11 : Connections between European countries with the 10 highest estimated EPATS traffic

(Data sources for estimations: ESPON, ASSESS)

4.2.1.3. Fleet

Table 4-12 presents the number of EPATS aircraft that would be necessary to operate to satisfy the total potential PKM traffic demand. In total we estimate that **around 99 000 EPATS aircraft** would be operated in 2020 in **Case A** and **90 000 in Case B**.

Total fleet	Null Scenario	Partial Scenario	Full Scenario	Extended scenario
CASE A	98 669	98 602	99 317	100 808
CASE B	89 317	89 255	89 924	91 302

Table 4-12: Estimated EPATS fleet

(Data sources for estimations: ESPON, ASSESS)

The highest total number of EPATS aircraft that would be operated on EPATS connections would be generated by the Extended scenario and the lowest by the Partial scenario.

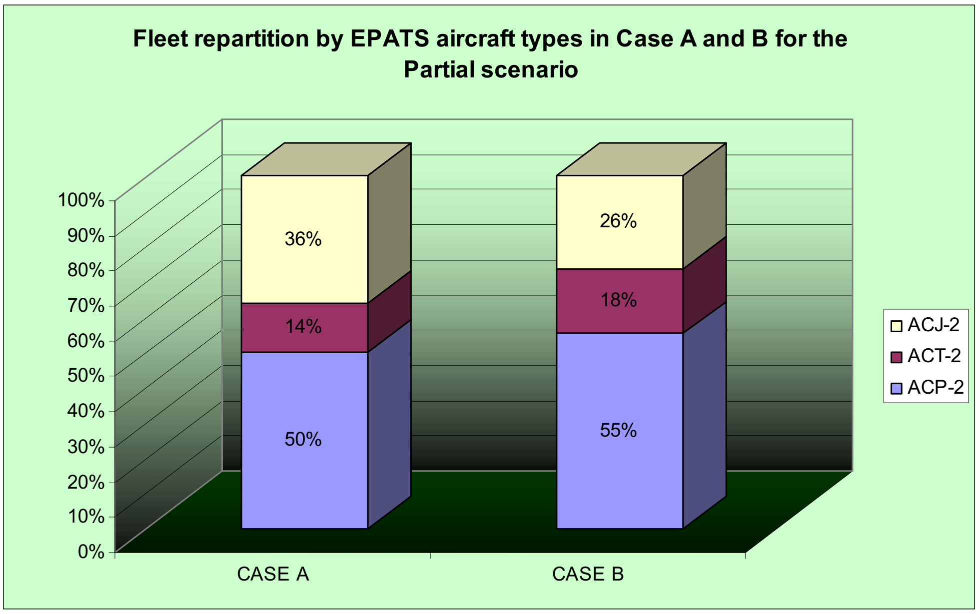


Figure 4-6 : Fleet repartition by EPATS aircraft type in Cases A and B for the Partial scenario

Let's consider the Partial scenario to compare the estimated aircraft number between aircraft type (Figure 4-6). We observe that Piston aircraft (ACP-2) would be the most commonly used EPATS aircraft, representing at least 50% of the total European EPATS fleet. On the same time, due to their high passenger capacity (maximum 19 passengers), there would be 3 times fewer Turboprop aircraft than piston aircraft. Jet aircraft would represent from 26 to 36% of the total European EPATS fleet in cases B and A respectively.

In total, we estimate that around (see Table 4-13)

- 23 million flights will be performed with Piston aircraft at Flight level 250
- 15 to 16 million flights will be performed with Turboprop aircraft at Flight level 250
- 3.7 to 6.3 million flights will be performed with Jet aircraft at Flight level 350

Nb of flights per aircraft type (Partial scenario)	CASE A	CASE B
ACP-2	22 910 747	22 910 747
ACT-2	14 990 357	16 313 325
ACJ-2	6 277 927	3 700 219
Total	**44 179 030**	**42 924 291**

Table 4-13 : Number of estimated flights by EPATS aircraft type

(Data sources for estimations: ESPON, ASSESS)

4.2.2. Estimations for France

Estimations of the potential traffic that would be transferred to EPATS in 2020 and the corresponding need aircraft fleet can also obtained be determined by running the model specifically on French domestic EPATS connections. Using French data on input (see Annex 11) enabled us to refine the NUTS 2 estimations obtained in the European estimation (section 4.2.1) thanks to their higher accuracy compared to average data used for Europe.
Estimations are performed on **302 French domestic connections**.

4.2.2.1. Passenger traffic

French estimations mainly differ from the global European estimation by the existence of a potential **transfer of road traffic** to EPATS for **leisure purpose**.
Despite this potential transfer of leisure traffic to EPATS, **Business** would remain the **main trip purpose** for which transfer of traffic to EPATS would occur. In fact, the number of leisure passengers transferred to EPATS would be 98 times lower than the number of business passengers transferred.

Unit of traffic	Original transport mode	Trip purpose	Null Scenario	Partial Scenario	Full Scenario	Extended Scenario
Millions of PKM	ROAD	Leisure	360	313	275	333
		Business	14 462	14 462	14 785	14 638
	AIR	Typical Business	100	100	92	83
	TOTAL PKM		**14 922**	**14 875**	**15 152**	**15 054**
Thousand of PAX	ROAD	Leisure	390	339	298	360
		Business	35 491	35 491	36 283	35 922
	AIR	Typical Business	206	206	189	171
	TOTAL PAX		**36 087**	**36 036**	**36 771**	**36 454**

Table 4-14: Estimated transferred traffic to EPATS on French domestic EPATS connections

(Data sources for estimations: ESPON, ASSESS)

In total the EPATS traffic in France would reach 15 billion PKM (or 36 million Passengers). As in the European case, differences in estimation levels between scenarios do not exceed 2%.

4.2.2.2. Flights

Table 4-12 presents the total number of EPATS flights that would occur in 2020 in France. In total we estimate that there would be **around 4.7 millions flights** in 2020. The difference between estimations in cases A and B does not exceed 2%.

Nb of flights	Null Scenario	Partial Scenario	Full Scenario	Extended Scenario
Case A	4 757 598	4 749 550	4 845 696	4 806 178
Case B	4 673 593	4 694 660	4 790 996	4 744 479

Table 4-15: Estimated EPATS fleet

(Data sources for estimations: ESPON, ASSESS)

As in section 4.2.1, we will focus the rest of our analysis on estimations obtained in the Partial scenario.
Table 4-16 shows the 10 connections between NUTS 2 on which are estimated the highest number of flights. We observe that the highest traffic level would always occur between Midi-Pyrenees and Aquitaine regions. More generally speaking, high levels of EPATS traffic would occur to and from these two regions since they appear three to four times in the list of Top 10 French EPATS connections (Table 4-16).
Estimated traffic between all French NUTS 2 regions is available in Annex 15 for the Partial Scenario.

Highest number of FLIGHTS	
CASE A	
Connections	Traffic
Midi-Pyrénées/Aquitaine	646 522
Languedoc-Roussillon/Midi-Pyrénées	324 193
Bretagne/Centre	121 289
Provence Alpes Cote d'Azur/Midi-Pyrénées	116 681
Poitou Charentes/pays de la Loire	82 352
Rhones-Alpes/Aquitaine	64 773
Bourgogne/Champagne Ardennes	63 760
Limousin/aquitaine	62 789
Rhones-Alpes/Midi-Pyrénées	61 205
Aquitaine/Poitou Charentes	51 683

Table 4-16: Highest estimated EPATS traffic level on French NUTS 2 connections

(Data sources for estimations: ESPON, ASSESS)

4.2.2.3. Fleet

Due to the small differences in traffic according to the different scenarios, the estimated number of EPATS aircraft that would be necessary to operate to satisfy the potential demand for EPATS domestic flights in France, does not vary much between scenarios. We therefore choose to show only the estimated fleet in the case of the Partial scenario. Table 4-17 provide theses estimated number of EPATS aircraft. In total we estimate that from **8 400 to 8600 aircraft** would be operated on French domestic connections in 2020.

Nb of aircraft in Partial scenario	Case A	Case B
ACP-2	5 894	5 926
ACT-2	1 815	1 965
ACJ-2	894	507
Total	**8 603**	**8 398**

Table 4-17: Estimated EPATS fleet in France for partial scenario

(Data sources for estimations: ESPON, ASSESS)

One specificity of the estimated fleet for French domestic connections compared to the European fleet comes from the very low market share of jet aircraft that would only represent 2% of the total needed EPATS aircraft. This low market share comes from the small number of domestic connections exceeding 1000 Km (only connections including Corsica or French Rivera regions) and the low traffic level on these connections (only 1% of the total estimated EPATS domestic PKM). Hence, even though the estimated fleet for European traffic to and from France is composed of numerous jet aircraft due to the large EPATS traffic over distances exceeding 1 000 Km, it is not the case when only considering the estimated fleet on French domestic connections.

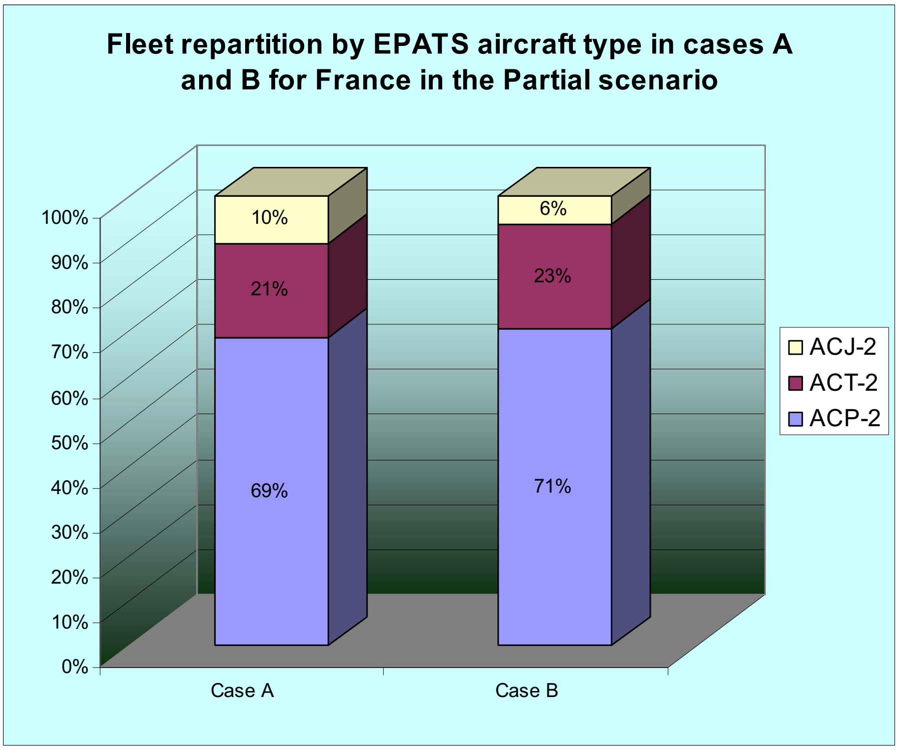


Figure 4-7 : Fleet repartition according to EPATS aircraft in cases A and B for France in the Partial scenario

Besides, a very large number of piston aircraft would be necessary to satisfy the traffic demand. Piston aircraft would represent 70% of the total number of EPATS aircraft required.

In total, we estimate that (in the Partial scenario) in France around (see Table 4-18):

- 2.6 million flights will be performed with Piston aircraft at Flight level 250
- 1.9 to 2 million flights will be performed with Turboprop aircraft at Flight level 250
- 44 000 to 196 000 flights will be performed with Jet aircraft at Flight level 350

Number of French flights by aircraft type (Partial scenario)	CASE A	CASE B	Flight level
ACP-2	2 628 425	2 651 165	250
ACT-2	1 924 773	1 999 249	250
ACJ-2	196 352	44 245	350

Table 4-18 : Number of estimated flights in France by EPATS aircraft type

(Data sources for estimations: ESPON, ASSESS)

The choice of using jet aircraft on connection with distances from 800 or from 1000 km will then significantly impact the number of needed jet aircraft to satisfy the potential demand. Indeed, case A will need 4.5 times more jet aircraft than case B.

4.2.3. Estimations for Poland

Estimations of the potential transfer of traffic to EPATS in 2020 on domestic Polish connections were obtained by using collected Polish data available in Annex 11. As for the French case, using data specific to Poland returned results which were more detailed than for Poland.
Estimations are performed on **70 Polish domestic connections**.

4.2.3.1. Passenger traffic

As in the European estimations (§ 4.2.1), the estimated traffic that would be transferred to EPATS on domestic Polish connections would never originate in leisure travellers. Only business traffic made by road transport would be transferred to EPATS.

Unit of traffic	Original transport mode	Trip purpose	Null Scenario	Partial Scenario	Full Scenario	Extended Scenario
Millions of PKM	ROAD	Business	8 364	8 332	8 414	9 017
Thousand of PAX	ROAD	Business	28 302	28 194	28 473	30 513

Table 4-19: Estimated transferred traffic to EPATS on Polish domestic EPATS connections

(Data sources for estimations: ESPON, ASSESS)

Once again, the highest EPATS traffic level was obtained in the Extended scenario and the lowest for the Partial scenario (Table 4-19).
However, differences between estimated traffic levels between scenarios are higher than in the European (or the French) case, at 8% (vs. 2% for Europe or France). This suggests that the

level of EPATS traffic in Poland would be more sensitive to the implementation level of the White Paper measures than in France or more generally in Europe.

4.2.3.2. Flights

Number of EPATS flights	Null Scenario	Partial Scenario	Full Scenario	Extended Scenario
	4 315 442	4 299 012	4 341 584	4 652 586

Table 4-20 : Estimated number of EPATS flights in Poland

Differentiating Cases A and B for Poland does not make sense since the maximum distance on Polish domestic connections does not exceed 600 Km.

As shown on Table 4-20 the number of EPATS flights will reach around **4.3 millions flights**. Hence although the PKM traffic in Poland would be 44% lower than in France, the estimated number of Polish flights would only be 8.5% lower than the estimated number of French flights. This small difference between French and Polish estimations in terms of number of flights, come from the high traffic level on polish connections with distances not exceeding 250 Km and requiring the use of Poston aircraft with in maximum 5 seats.

Table 4-21 shows the highest EPATS traffic levels on Polish connections, when focusing on the Partial scenario that would lead to the lesser level of transferred traffic to EPATS. This table clearly shows that the connection between Warminsko-Mazurskie and Mazowieckie regions would have the highest level of EPATS traffic. With the Lodzkie region, the Mazowieckie region would be involved in 4 connections belonging to the TOP 10 of EPATS traffic in Poland.

Estimated traffic between all Polish NUTS 2 regions is available in Annex 16 for the Partial Scenario.

Highest number of FLIGHTS	
Connections	Traffic
Warminsko-Mazurskie / Mazowieckie	564 451
Slaskie / Podkarpackie	356 755
Slaskie / Lodzkie	228 998
Mazowieckie / Malopolskie	187 054
Wielkopolskie / Lodzkie	145 779
Lodzkie / Dolnoslakie	112 418
Slaskie / Mazowieckie	98 169
Malopolskie / Lodzkie	70 324
Pomorskie / Mazowieckie	66 333
Wielkopolskie / Mazowieckie	48 547

Table 4-21: Highest estimated EPATS traffic level on Polish NUTS 2 connections

(Data sources for estimations: ESPON, ASSESS)

4.2.3.3. Fleet

Due to the absence of distances above 1000 km on EPATS connections, no Jet aircraft would be operated in Poland. In addition, the low capacity of Piston aircraft led to a high estimation for the number of ACP-2 aircraft.
Table 4-17 shows the estimated number of EPATS aircraft that would be necessary to satisfy the potential demand for EPATS domestic flights in Poland. In total, we estimate that at least **7 000 aircraft** would be operated on Polish domestic connections in 2020, where 87% would be piston aircraft.

Aircraft type	Null Scenario	Partial Scenario	Full Scenario	Extended Scenario
ACP-2	6 328	6 304	6 367	6 823
ACT-2	953	949	959	1 027
Total	**7 281**	**7 254**	**7 325**	**7 850**

Table 4-22: Estimated EPATS fleet in Poland

(Data sources for estimations: ESPON, ASSESS)

In total, we estimate that in Poland (in Partial scenario) around (see **Erreur ! Source du renvoi introuvable.**):

- 3 million flights will be performed with Piston aircraft at Flight level 250
- 1 million flights will be performed with Turboprop aircraft at Flight level 250

Number of Polish flights by aircraft type	Partial Scenario	Flight level
ACP-2	2 957 449	250
ACT-2	1 341 563	250

Table 4-23 : Number of estimated flights in Poland by EPATS aircraft type

(Data sources for estimations: ESPON, ASSESS)

4.3. Sensitivity analysis

Estimation of traffic and fleet obtained in section 4.2 are based on estimated operating costs for EPATS aircraft provided in WP1. However these costs could increase when for instance adding new materials in aircraft so as to be compliant with SESAR requirements or when adding new environmental taxes, etc. It is therefore particularly interesting to test the sensitivity of the estimated potential EPATS demand to an increase in the unit operating cost of EPATS aircraft. We choose to consider two cases: an increase in the EPATS cost of 20% and an increase of 30%. This sensitivity analysis is performed when considering the Partial scenario which is the most likely scenario.

4.3.1. Europe

Table 4-24 shows the impacts of cost increase on the estimated EPATS traffic level. An increase of 20% in the EPATS cost would lead to a decrease of 15% in the estimated EPATS PKM traffic level while an increase of 30% would lead to a reduction of 29% in this traffic (Figure 4-8). This difference is accentuated when considering the number of passengers since a cost increase of 30% would lead to a reduction in the number of EPATS passengers reaching 40%.

Unit of traffic	Original transport mode	Trip purpose	Basic situation	Cost +20%	Cost +30%
Millions of PKM	ROAD	Business	150 271	127 484	105 894
	AIR	Typical Business	2 961	2 676	2 148
	TOTALPKM		**153 232**	**130 160**	**108 041**
Thousands of PAX	ROAD	Business	315 512	266 450	188 247
	AIR	Typical Business	4 955	4 083	2 706
	TOTAL PAX		**320 466**	**270 533**	**190 953**

Table 4-24 : Impacts of EPATS cost increase on the estimated traffic levels

(Data sources for estimations: ESPON, ASSESS)

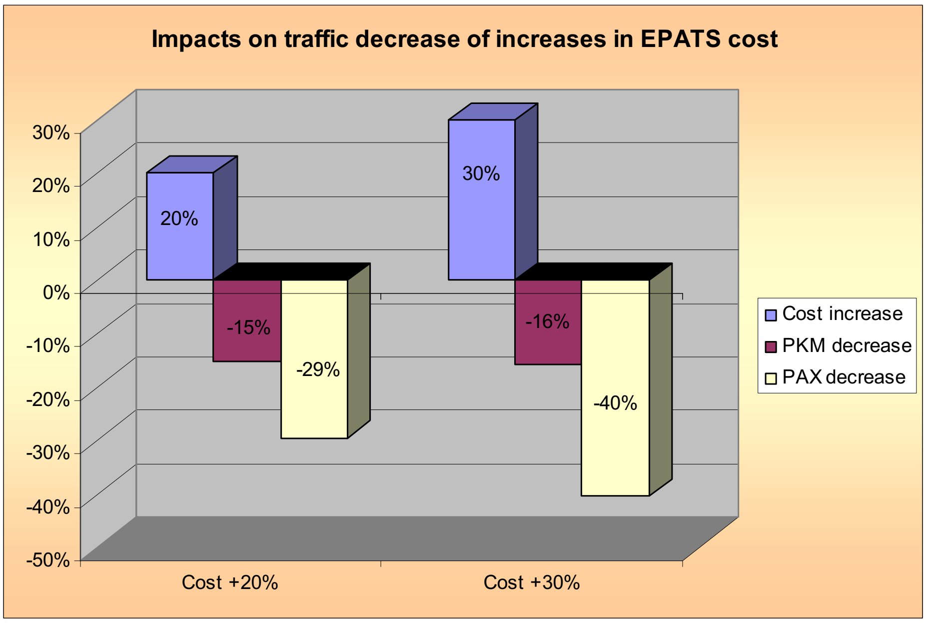


Figure 4-8 : Impacts on traffic decrease of increases in EPATS cost

(Data sources for estimations: ESPON, ASSESS)

More than that, the estimated number of flights would significantly decrease in case of a cost increase of 30% since we would observe 62% to 65% less EPATS flights in Europe than in the basic situation.

Considered situations		Nb of flights	Traffic decrease compared to the basic situation
Basic situation	Case A	44 394 255	
	Case B	42 924 291	
Cost +20%	Case A	39 827 684	-10%
	Case B	38 357 719	-11%
Cost +30%	Case A	16 649 478	-62%
	Case B	15 179 514	-65%

Table 4-25 : Impacts of EPATS cost increases on the estimated number of flights

(Data sources for estimations: ESPON, ASSESS)

Impacts on the fleet levels and composition would also significantly differ in case of +20% or +30% cost increase (Figure 4-9). Indeed the 14% decrease in the total number of EPATS aircraft due to the 20% cost increase, would mainly come from the lower number of jet aircraft compared to the basic situation, while the 72% decrease in the number of aircraft in case of +30% cost increase would mainly come from the non use of piston aircraft (while such aircraft type represents 55% of the basic situations).

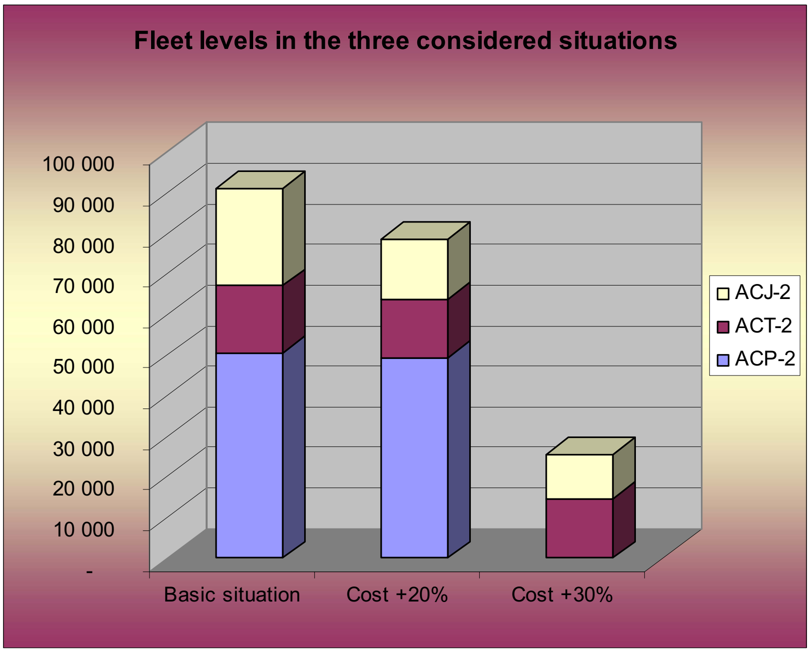


Figure 4-9 : Fleet levels in the three considered situations

4.3.2. France

The French EPATS traffic would tend to be slightly more sensitive to EPATS costs increases than the European one. Indeed the reduction in the number of passengers in France reaches 32% in case of Cost +20% and 44% in case of Cost +30% while these percentage are 29% and 40% respectively in Europe (Table 4-26, Figure 4-10).

Unit of traffic	Original transport mode	Trip purpose	Basic situation	Cost +20%	Cost +30%
Millions of PKM	ROAD	Leisure	313	0	0
		Business	14 462	12 926	10 033
	AIR	Typical Business	118	85	66
	TOTAL PKM		14 893	13 011	10 099
Thousand of PAX	ROAD	Leisure	339	0	0
		Business	35 491	31 316	20 093
	AIR	Typical Business	225	162	113
	TOTAL PAX		36 055	31 478	20 206

Table 4-26 : Impacts of an EPATS cost increase on the estimated traffic

(Data sources for estimations: ESPON, ASSESS)

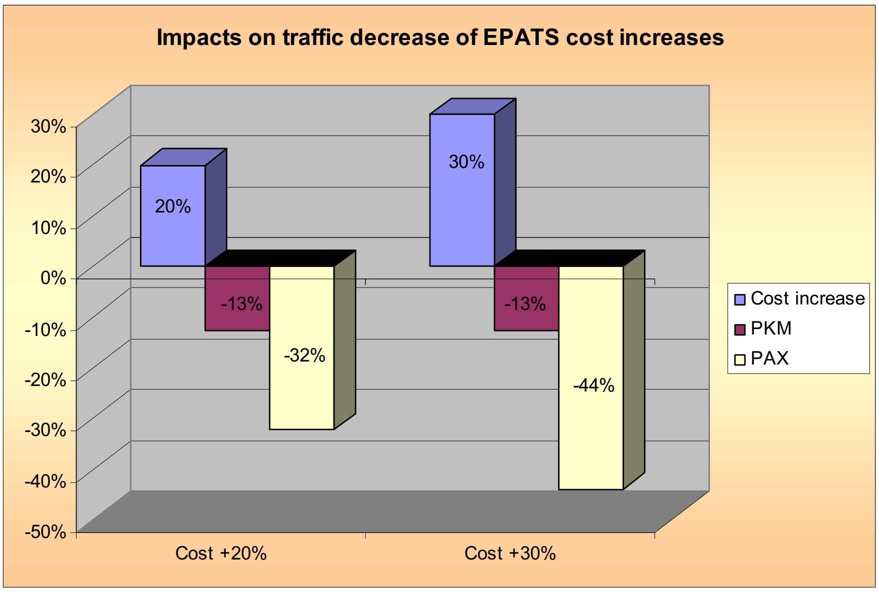


Figure 4-10 : Impacts on French traffic decrease of EPATS cost increases

As we also observed ion the European case, the impact on the number of flights decrease would tend to be particularly marked in case of a cost increase reaching 30%. The corresponding number of French flights would indeed decrease by around 67% what is slightly more than in Europe (for which the decrease is 62%/65%).

Considered situations		Nb of flights	Traffic decrease compared to the basic situation
Basic situation	CASE A	4 752 532	
	CASE B	4 669 780	
Cost +20%	CASE A	4 324 338	-9%
	CASE B	4 324 338	-7%
Cost +30%	CASE A	1 535 737	-68%
	CASE B	1 529 588	-67%

Table 4-27 : Impacts of EPATS cost increases on the estimated number of French flights

(Data sources for estimations: ESPON, ASSESS)

However the main remarkable impact of increases in the EPATS cost would concern the estimated fleet. Indeed while a 20% cost increase would only lead to a reduction by 8% in the total number of EPATS aircraft, a 30% cost increase would lead to a reduction of 80% of the EPATS fleet in France compared to the basic situation (Figure 4-11, Table 4-28).

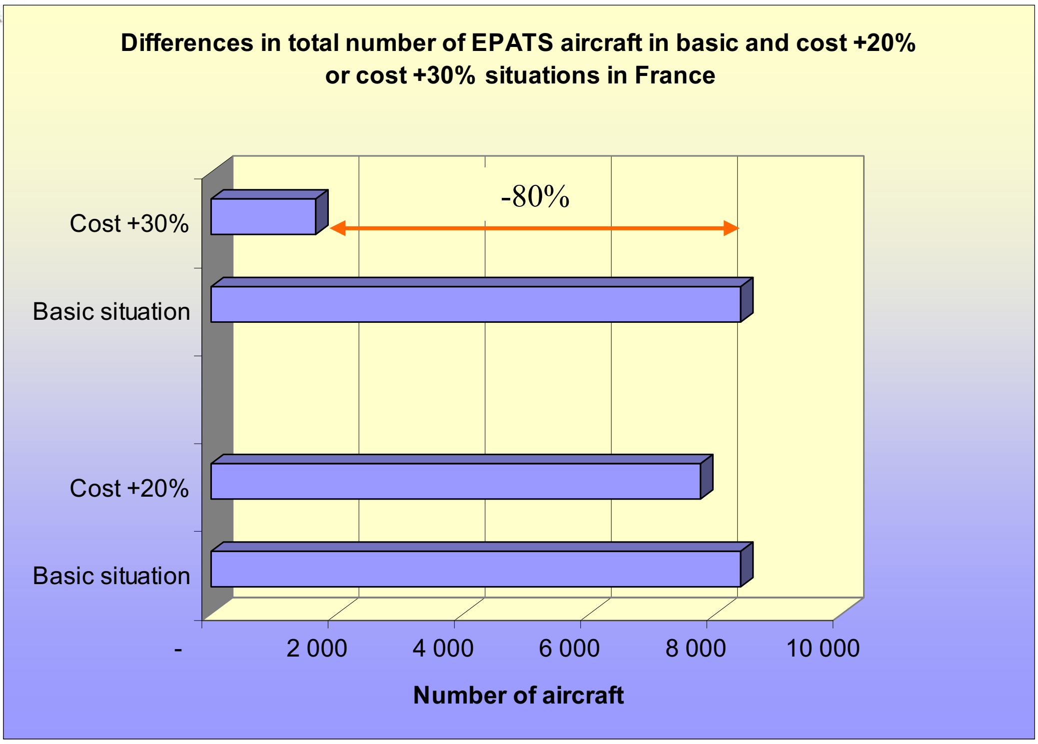


Figure 4-11 : Differences in the estimated EPATS fleet in basic, Cost +20% and Cost +30% situations

Aircraft type	Basic situation	Cost +20%	Cost +30%
ACP-2	5 926	5 894	9
ACT-2	1 965	1 665	1 572
ACJ-2	507	206	73
Total	8 398	7 766	1 655

Table 4-28 : Estimated fleet of EPATS aircraft in France in Basic, Cost +20% and Cost +30% situations

4.3.3. Poland

The Polish EPATS traffic would tend to be much more sensitive to EPATS costs increases than the European or French ones. Indeed the reduction in the number of passengers in Poland would reach 50% in case of Cost +20% and 90% in case of Cost +30% while these percentage are 29% and 40% respectively in Europe (Table 4-29,Figure 4-12).

Unit of traffic	Original transport mode	Trip purpose	Basic situation	Cost +20%	Cost +30%
Millions of PKM	ROAD	Business	8 332	4 041	1 385
	TOTAL PKM		**8 332**	**4 041**	**1 385**
Thousand of PAX	ROAD	Business	28 194	14 171	2 819
	TOTAL PAX		**28 194**	**14 171**	**2 819**

Table 4-29 : Impacts of an EPATS cost increase on the estimated traffic

(Data sources for estimations: ESPON, ASSESS)

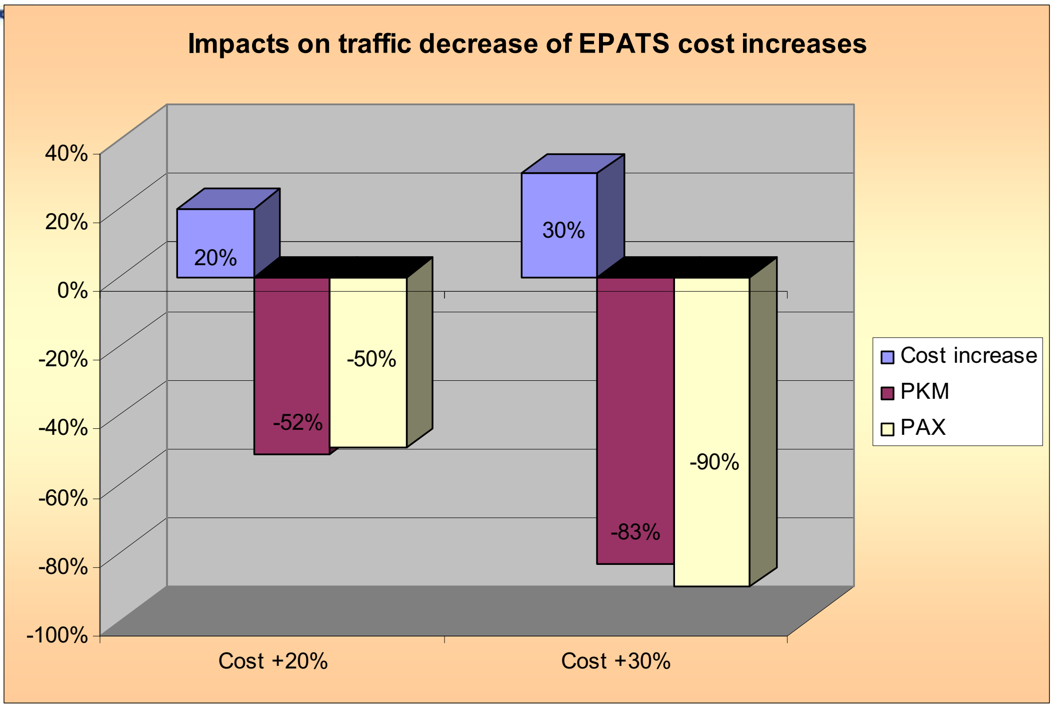


Figure 4-12 : Impacts on Polish traffic decrease of EPATS cost increases

This very high sensitivity of Polish estimated passenger traffic to increases in EPATS costs also results in a very large decrease in the estimated number of flights. The number of flights will indeed decrease by 25% if the EPATS cost increases by 20% and by 95% if the EPATS cost increases by 30% (Table 4-30) (while these percentage only reach 10% and 65% in Europe respectively).

Considered situations	Nb of flights	Traffic decrease compared to the basic situation
Basic situation	4 299 012	0%
Cost +20%	3 244 698	-25%
Cost+30%	211 948	-95%

Table 4-30 : Impacts of EPATS cost increases on the estimated number of Polish flights

(Data sources for estimations: ESPON, ASSESS)

Not surprisingly estimated EPATS fleet would also be significantly reduced in case of an increase in EPATS costs reaching 30%. In this case the number of aircraft in Poland would decrease by 97% compared to the basic situation (Figure 4-13, Table 4-31). In this case only 218 turboprop aircraft would be necessary to satisfy the potential EPATS demand.

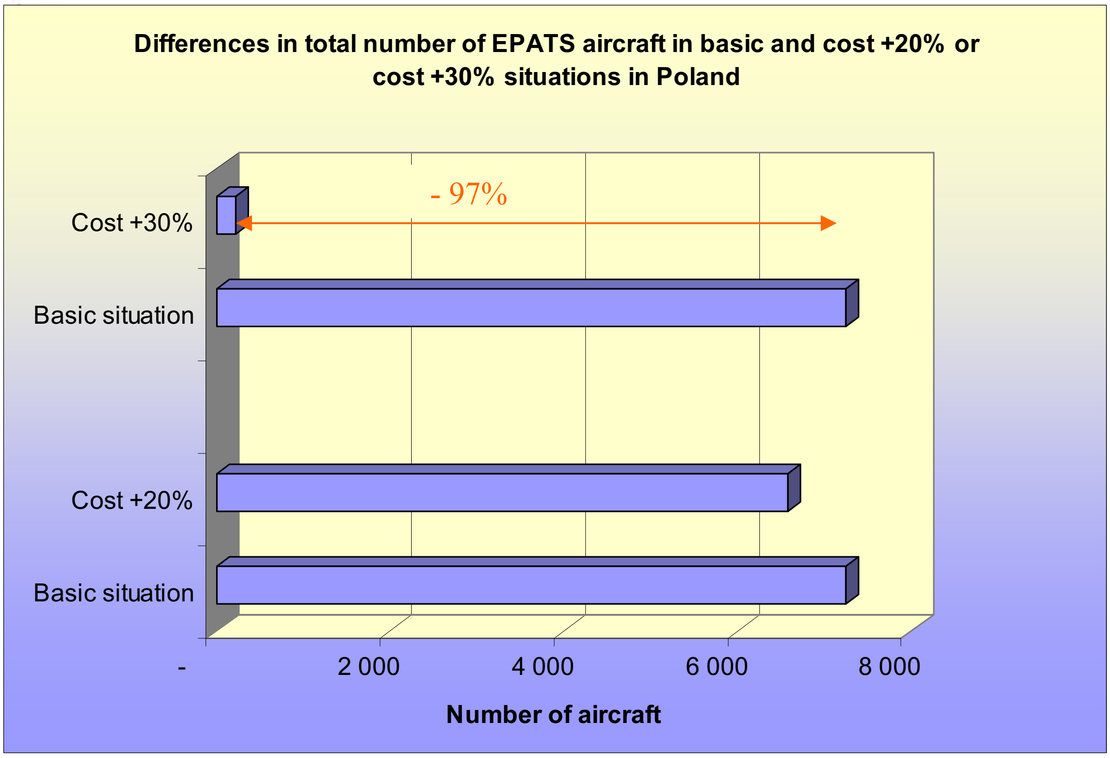


Figure 4-13 : Differences in the estimated EPATS fleet in basic, Cost +20% and Cost +30% situations

Aircraft type	Basic situation	Cost +20%	Cost +30%
ACP-2	6 304	6 304	-
ACT-2	949	274	218
ACJ-2	-	-	-
Total	7 254	6 579	218

Table 4-31 : Estimated fleet of EPATS aircraft in France in Basic, Cost +20% and Cost +30% situations

5. Identified needs for further works and research

The objective of this section is to identify the needs of further works and research in EPATS. These needs concern two domains: European data on mobility and the methodology used to estimate EPATS traffic.

6. Additional work needed on a mobility database

6.1. Difficulties encountered with mobility data

Forecasting of interregional & intra-European personal transportation, especially including EPATS small aircraft transportation, requires exhaustive knowledge of interregional passenger traffic as well as on socio-economic situation including complex and authoritative information concerning wealth and income distribution of population.
During passenger flow and their structure analysis (modal split, directions and distances, volume, purpose and wealth (income) structure of travellers), the following, available sources were used: domestic and European Statistical and transport Institutions databases (Eurostat, Eurocontrol, AIS), Research Institutes and Research and Development Facilities compilations, European Programmes framework research analysis, especially including: ESPON, DATELINE, TREMOVE, SCENES, EUNET, ASSESS and numerous internet publications and data.
Despite the huge amount of gathered data and analyzed, it was not possible to create a complete image of interregional passenger traffic structure in the European Union. The main reasons for this are:

- lack of source and complex information concerning long-distance personal car travel (volume and O-D travel directions), which account for more than 70% of passenger traffic,
- incoherence and gaps in data concerning air traffic, especially air-taxi and on-demand traffic. Lack of authoritative information on all existing airport infrastructures. The available complete information is limited to 420 communication airports, which represents but 20% of total airports in Europe,
- no data gathering, storing and formatting procedure compatibility in Member States publications,
- no qualitative data relative to the level of comfort, punctuality, etc. in the current database,
- no authoritative knowledge on wealth and personal income structure in respective regions especially in terms of the top last quintile and percentile of distribution (i.e. people who use the fastest, individual modes of transport),
- the existing data concerning transport infrastructure and flows do not at all reflect reality in many cases, especially in new Member States of the Union. This data is also correlated with income distribution in respective regions (lack of knowledge on number of journeys, distances and mode of transport according to income distribution)
- no complex and reliable models describing accurately interregional and inter-sub regional passenger flows.

Given the above, we had to make several assumptions (data published in the above mentioned European programmes reflect the reality and income distributions take shape of Lorenz-Pareto law) and use passenger flow models suited to the current knowledge and allocated resources. Main EPATS system passenger traffic flow directions, their volume and characteristics should be taken with reserve and used for orientation in the main areas of system implementation.

These areas, including EPATS characteristics are one of the initial assumptions for a new conception of air traffic management and control system planned in the SESAR programme.

The main reason of lack of complex and authoritative information on European interregional passenger traffic is the lack of particular transport and economic objectives and no Central European Institution coordinating achieving transport system development strategy. The importance of this is arising especially outside main communication channels, despite a fair number of undertaken researches and participating research centres. This knowledge cannot be acquired basing on fragmented and not always compatible data gathered and processed according to methods specific to Member States. The transport system is interconnected among all countries and requires complex and homogenized operation procedures as well as statistical and research, similarly to the Single European Sky. Attempts to build accurate databases on transport and passenger flows within Member States is at the mercy of the goodwill of political players and is prone to failure, to say nothing of the difficulties in obtaining good quality data in terms of definitions, criteria and format. One of the results of this is divergences of the outcomes of abovementioned programmes.

6.2. Proposition on additional work needed on a mobility database

A coherent and sustainable European Union transport system development and implementation in European regions, which is one of the main aim of EPATS project, requires undertaking common initiatives at the levels of the European Union, Member States and regional powers in order to create a common platform to plan, coordinate and monitor research concerning a European transport system, mobility, accessibility to public goods and future needs of personal transport forecasting.

In the light of the preceding, we recommend the following:

1. Creating a European Centre for Personal Interregional Transport as a common research platform of the EU Members and taking responsibility for preparation of fundamentals for political decisions taking regarding interregional personal transport development.

2. Planning and initiating research on EPATS interactive transport system aligned to research on 4-dimensional flight planning system.
   EPATS Interactive Transportation Management Centre (ITMC) initiative should be correlated to System Wide Information Management – Inter-Operability Centre (SWIM-IOP)

3. Planning and initiating a European interregional passenger transport modelling and forecasting using authoritative mobility database especially taking under consideration EPATS transport subsystem.

4. Including adequate research to the prepared ESPON 2013 programme in order to verify potential EPATS connections and forecasted volume of transport transferred from personal car transport.

5. Initiating close cooperation among European programmes responsible for personal air and surface transport in interconnected topics and including common goals. This is especially true for ESPON 2013, SESAR and EPATS programmes. It is coherent with

SESAR and ESPON 2013 performers intentions, which the application for further research writes the following sentences: "*A user-oriented approach shall be adopted for the ESPON 2013 Programme. The ESPON 2013 Programme shall, through commited involvement and awareness raising, offer targeted analytical deliveries upon demand, responding to needs.*"

7. Need for further work on EPATS traffic estimations

7.1. Identified needs of method improvements

Estimations of the transferred traffic to EPATS in 2020 for all NUTS 2 in Europe were obtained by using common passenger-kilometre distribution tables for all the considered European countries. In other words, we used average data to represent the behaviour of the European travellers.
The use of specific data for national estimations (i.e. for the French and Polish estimations) representing the specific behaviour of national travellers helped to refine the estimations obtained at a European level, when for instance helping to identify that a potential share of the transferred traffic to EPATS would occur for leisure purposes while European estimations are not able to provide estimated leisure transferred traffic. For instance, in France where, even though the EPATS business traffic would be predominant, 2% of the transferred PKM would originate in leisure travel.

Hence, the rough estimations obtained using a European model could be significantly refined if we were to apply the methodology at national level (on domestic and inter-countries traffic) to all European countries.

Other aspects to improve concern the estimation methodology based on the generalised cost method. Such improvement would indeed mainly concern the need of refining the generalised cost formula by including qualitative factors. Indeed, if available, qualitative data such as comfort, frequency, punctuality, etc... will be included in the generalized cost formula so as to better characterize travellers behaviours.

An additional methodology improvement would also concern the way to identify the type of EPATS aircraft needed for each flight. In this study, we only managed to associate one category of EPATS aircraft by trip distance without being able to take other criteria into account. An essential next step should therefore be to perform a thorough analysis on the optimal aircraft type according to the traffic volume and characteristics to refine the fleet estimation per aircraft type.

The calculation outcomes revealed that larger (P-5, T-19 and J-9) aircraft types (out of the 6 models) are more cost-efficient. The analyzed 6 aircraft included 2 sizes of piston (3 and 5 passenger seats), 2 of turboprop (9 and 19 seats) and 2 of jets (5 and 9 seats).
These results were caused by the assumption that load factor is constant. Reality, however, is different and we cannot maintain constant and identical average load factor independantly of the flow density level and its fluctuation on different Origin-Destination routes. Load factor is determined by periodical (monthly) and random (daily) fluctuations of traffic volume on interregional connections. Most of the EPATS potential interregional flow does not exceed 1000-2000 passengers yearly. Assuming 3-6 passengers daily to determine optimal fleet structure, ignoring periodical and random character of flows may generate unreliable outcomes.

As of yet, European researches on long distance travel were limited to yearly aggregated numbers. Only air traffic provides data on periodical changes of passenger flow, but it consider only main communication channels.
Increasing accuracy of EPATS aircraft demand requires more in-depth European interregional passenger traffic surveys and investigations. Apart from other factors of transport mode choice, which also have to be considered (comfort, preferences, accessibility, etc.), these investigations has to answer the following mulitlevel questions:

- How many passengers (N_{ij}) travels from region (i) to region (j)?
- What mode do they use (m)?
- What purpose (p)?
- What value of time (income) (v) category do they belong to?
- What are the monthly (periodical) and daily (random) fluctuations of $N_{ij,m,p,v}$?

The answers to these questions allow for better prediction of EPATS system demand, not only at the global level, but also regional. These answers are also important for development of other modes of transport, exceeding the scope of EPATS project. The adequate surveys and investigations should be initiated.

The applied method of optimal mode choice and potential demand of transportation mode – based on minimization of generalized costs, seems to be the most rational. Some methods and data for component cost calculations require improving, especially:

- operational costs
- value of time
- accommodation costs
- other variables (comfort, stress, …) expressed in monetary form

At global level, externalities (environmental, noise, accidents, congestion, traffic control, etc.) which play a significant role in transport policy and which are not analyzed nor have balanced impact, should be included in the considerations and taxation policy.

Amount of data and numerical operations on models used for choice of optimal mode of transport and fleet optimization exceeds capacity of calculation tools used up to now, i.e. Excel and Mathcad. There exists a need for specialized calculation software allowing for virtual application of the assumed transport model and determining by it the best EPATS aircraft fleet structure for respective regions of Europe.

7.2. Proposition of further works in EPATS traffic estimations

According to the abovementioned in section 7.1, it is proposed:

1. To refine the generalised cost formula when including qualitative factors so as to better characterize travellers behaviours.

2. To perform a deep analysis on the most accurate aircraft type according to the traffic volume and characteristics to refine the fleet estimation per aircraft type.

3. To make estimations of the potential EPATS traffic from each European country to obtain the total traffic at the whole European level.

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Values assumed for the aeroplanes are based on the comparative analyses, taking mainly into account the difference in: fatalities rate and crash externalities, traffic congestion, street parking, local air pollution, roadway costs and traffic services.

European projects

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ANNEX 1 : French long-distance journeys comprising at least one night

- Short and long distance travel of French citizens in France and abroad

	DESTINATION	COURTS SÉJOURS		LONGS SÉJOURS		TOTAL	
		Séjours	2005/04	Séjours	2005/04	Séjours	2005/04
Personnel	France métropolitaine	95,5	*-1,1%*	69,6	*-3,2%*	165,1	*-2,0%*
	Étranger	5,3	*-5,4%*	14,6	*-1,4%*	19,9	*-2,5%*
Professionnel	France métropolitaine	6,3	*-13,7%*	1,4	*-17,6%*	7,7	*-14,4%*
	Étranger	1,6	*23,1%*	0,8	*0,0%*	2,4	*14,3%*
TOTAL		**108,7**	*-1,9%*	**86,4**	*-3,1%*	**195,1**	*-2,5%*

En millions de séjours — Source : SDT (Direction du Tourisme, TNS Sofres)

Source : Ref 10

- Average duration of leisure journeys in nights

« Ministère des Transports, de l'Equipement, du Tourisme et de la Mer »

	Durée moyenne de séjour (en nuitées)									
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004***	**2005***
Mer	8,7	8,5	8,6	8,2	8,2	8,1	8,0	7,9	8,0	7,8
Montagne	7,3	7,2	7,2	7,5	7,4	7,4	7,4	7,1	7,0	7,0
Campagne	8,0	8,2	5,4	5,3	5,2	5,0	5,0	5,0	4,9	4,8
Lac	5,3	5,3	8,4	7,3	7,8	7,5	7,9	7,3	7,3	7,0
Ville	4,7	4,7	4,6	4,7	4,6	4,6	4,6	4,4	4,5	4,4
Autre	5,9	5,4	5,7	5,8	5,9	5,4	5,7	5,4	6,0	5,8

*Jusqu'en 2003, le champ de l'enquête était « les Français de 15 ans et plus », à partir de 2004, il devient « les résidents en France de 15 ans et plus ».

Source : Ref 10

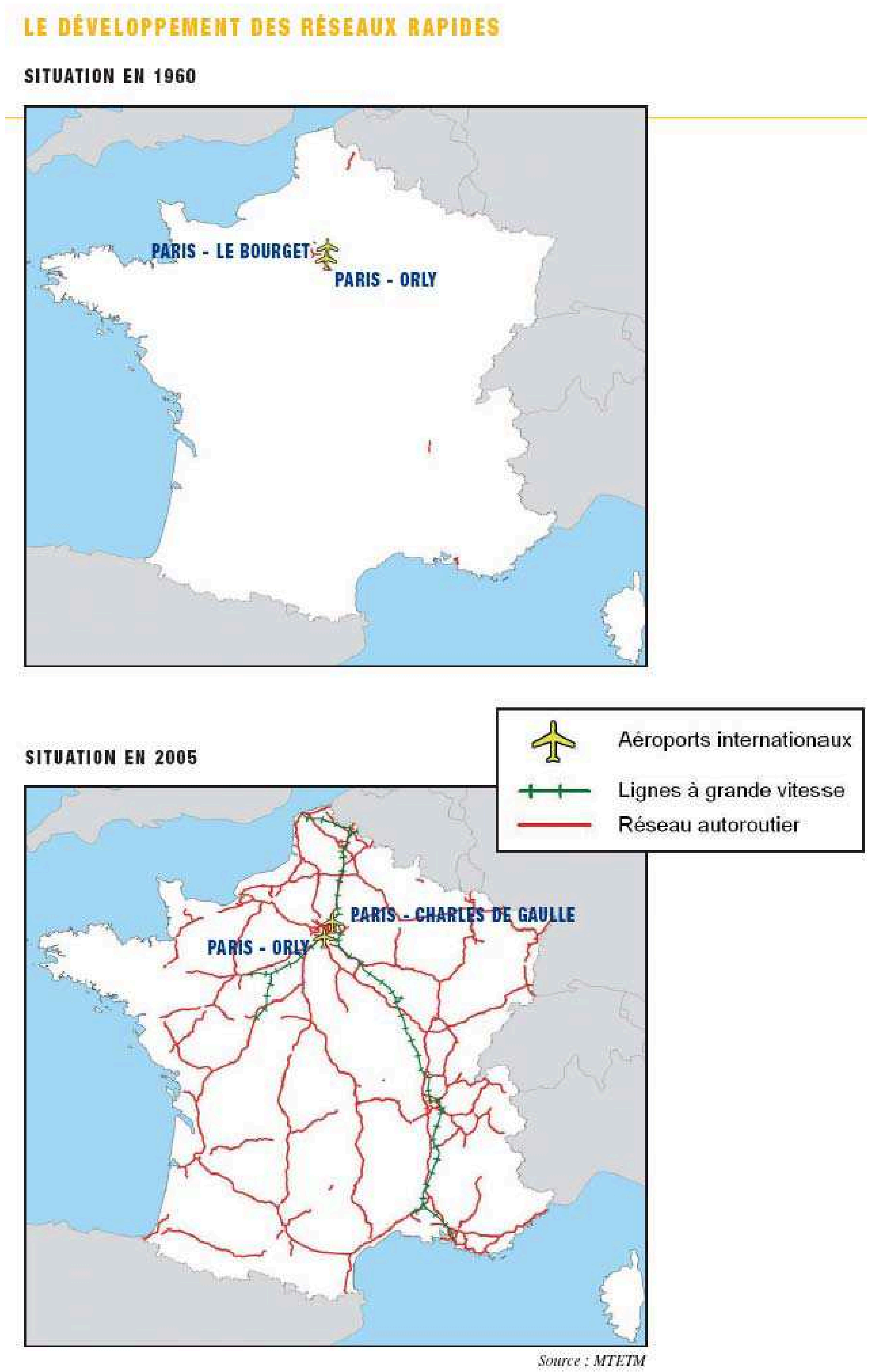
ANNEX 2 : Departure Rate in France

	Repartition échantillon	Taux de non-départ	Nb séjour /pers/an	Nb nuitées /pers/an	Nuitées/séjour
total	**100,0%**	**25,6**	**3,2**	**20,0**	**6,1**
Sexe					
Homme	46,1%	26,5	3,1	18,9	6,0
Femme	53,9%	24,8	3,4	21,0	6,2
Age de l'enquêté					
<20 ans	2,7%	28,4	2,3	13,4	**5,9**
20-30ans	13,9%	28,3	3,0	12,6	**4,3**
30-45ans	26,8%	**21,3**	3,4	17,8	5,3
45-60ans	21,1%	26,3	3,3	19,3	5,9
60-70ans	18,5%	**20,0**	3,7	**27,4**	7,5
>=70ans	16,9%	**34,9**	**2,8**	23,4	**8,4**
Statut familial					
en couple	64,4%	22,2	3,4	21,1	6,1
Seul, divorcé, veuf	35,6%	**31,7**	3,0	**18,1**	5,9
Niveau d'instruction					
<3ième	24,4%	**36,1**	**2,3**	16,6	**7,3**
Technique court	23,3%	**29,0**	**2,5**	15,8	**6,3**
Bac	22,9%	**22,5**	**3,4**	21,8	**6,2**
Supérieur	29,4%	**16,6**	**4,5**	24,8	**5,5**
Occupation actuelle					
Excerce une profession	41,8%	**19,9**	3,7	18,7	5,2
A déjà travaillé	43,9%	28,1	2,9	21,2	**7,4**
N'a jamais travaillé	14,0%	**34,0**	3,2	20,3	6,2
Profession					
Agri., exploitant	0,9%	**47,5**	**1,3**	6,7	5,1
Art, comm, chef d'entr.	1,8%	27,7	2,1	11,0	5,8
Cadre sup	6,4%	**7,7**	**5,7**	28,7	5,2
Cadre moyen	13,1%	12,8	4,4	22,2	5,1
Employé	17,3%	23,8	2,8	14,9	5,3
Ouvrier	10,6%	**35,6**	**2,0**	10,5	5,2
Ancien agr, art, com.	3,6%	**38,2**	2,1	16,2	**7,5**
Anciens cadr, inter.	16,9%	19,5	4,1	31,4	**7,6**
Anciens empl, Ouvr.	11,9%	**32,0**	2,7	21,1	**8,0**
Inactif	11,0%	**34,9**	2,8	18,9	6,7
Elève, étud. >14ans	6,6%	**34,6**	2,5	13,0	5,4

Secteur d'activité					
Salarié grde entrep.	46,0%	25,7	3,2	18,9	6,0
Salar entr. publique	9,2%	19,4	**4,0**	24,3	5,8
Salarié de l"état	20,4%	**17,0**	**4,1**	26,1	6,3
Travail. indépendant	7,6%	**34,6**	**2,4**	15,1	6,3
NConcerné	16,7%	**35,0**	**2,4**	15,4	6,1
Taille de l'agglomération de résidence					
Commune rurale	23,4%	**33,5**	**2,8**	**13,1**	4,7
agglo < 20 000 h.	17,4%	**32,4**	**3,1**	**16,0**	5,2
20-100 000 h.	15,1%	**27,1**	**3,5**	**18,5**	5,3
> 100 000 h.	28,9%	**23,1**	**3,9**	**21,6**	5,5
Agglomération Paris.	15,3%	**12,6**	**5,1**	**32,5**	6,4
Revenu mensuel du ménage					
< à 6KF	10,4%	**50,8**	**1,7**	9,8	5,7
de 6 à 8KF	10,5%	**38,0**	**2,1**	12,3	5,9
de 8 à 10KF	13,4%	**33,0**	**2,6**	15,7	6,1
de 10 à 15KF	31,1%	**24,0**	**2,9**	18,6	6,2
de 15 à 17,5KF	10,2%	**15,2**	**3,8**	23,2	6,0
de 17,5 à 20KF	8,3%	**13,6**	**4,3**	26,7	6,0
> 20KF	15,9%	**10,1**	**5,3**	32,8	6,1
Taille du ménage					
1 personne	22,6%	**28,4**	**3,6**	21,8	6,0
2 personnes	38,4%	22,0	**3,6**	**24,0**	6,6
3 personnes	15,8%	**29,4**	2,6	14,9	5,7
4 personnes	14,9%	24,4	2,8	15,3	5,4
5 personnes et +	8,3%	**29,6**	2,5	**14,6**	5,9
Nombre d'adultes					
1 adulte	23,9%	28,5	3,5	21,3	6,0
2 adultes	55,0%	21,9	3,4	21,7	6,2
3 adultes et +	21,2%	**31,9**	**2,4**	14,2	5,9
Nombre d'enfants dans le ménage					
Pas d'enfant	75,1%	25,9	**3,4**	**21,6**	**6,3**
1 enfant	11,4%	**27,8**	2,7	**14,0**	5,3
2 enfants	9,7%	20,9	3,0	16,5	5,5
3 enfants et +	3,7%	24,0	2,7	16,1	6,0

(Source INRETS Ref 19)

ANNEX 3 : Infrastructure Evolution in France



ANNEX 4 : EPATS potential connections

	AT	BE	BG	CH	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HU	IE	IT	LT	LU	LV	NL	NO	PL	PT	RO	SE	SI	SK
AT	6	0	15	0	0	5	11	1	2	92	19	94	61	4	8	75	8	0	7	11	9	18	12	34	40	4	2
BE	0	0	2	0	0	0	1	0	0	47	8	29	7	0	6	14	4	0	1	1	11	4	7	14	23	0	0
BG	15	2	6	6	0	1	62	3	0	1	0	21	6	0	0	37	0	0	0	7	0	2	0	7	3	0	0
CH	0	0	6	0	0	0	1	0	2	50	7	23	40	2	4	25	3	0	2	0	5	11	18	19	12	0	1
CY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
CZ	5	0	1	0	0	4	4	0	0	7	2	7	1	0	2	2	1	0	1	0	1	3	0	6	2	0	1
DE	11	1	62	1	0	4	28	1	8	260	74	228	126	6	30	182	32	0	25	20	38	92	41	188	132	0	1
DK	1	0	3	0	0	0	1	0	0	9	4	12	5	2	1	8	1	0	1	1	2	7	0	7	5	1	1
EE	2	0	0	2	0	0	8	0	0	0	0	1	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0
ES	92	47	1	50	0	7	260	9	0	208	0	287	1	9	9	228	0	6	0	90	0	15	41	5	9	1	3
FI	19	8	0	7	0	2	74	4	0	0	12	24	0	1	0	9	0	0	0	17	8	1	0	2	32	2	0
FR	94	29	21	23	0	7	228	12	1	287	24	302	37	11	21	291	17	1	6	72	17	121	59	73	105	0	5
GR	61	7	6	40	0	1	126	5	0	1	0	37	56	4	0	126	1	4	0	15	0	12	0	15	7	0	2
HU	4	0	0	2	0	0	6	2	0	9	1	11	4	10	1	19	0	0	0	0	1	0	0	3	1	0	4
IE	8	6	0	4	0	2	30	1	0	9	0	21	0	1	0	13	0	0	0	8	1	9	0	0	4	0	1
IT	75	14	37	25	2	2	182	8	3	228	9	291	126	19	13	262	14	0	10	59	8	111	37	95	48	4	9
LT	8	4	0	3	0	1	32	1	0	0	0	17	1	0	0	14	0	0	1	7	0	3	0	0	0	0	0
LU	0	0	0	0	0	0	0	0	0	6	0	1	4	0	0	0	0	0	0	0	1	0	2	1	1	0	0
LV	7	1	0	2	0	1	25	1	0	0	0	6	0	0	0	10	1	0	0	5	0	1	0	0	0	0	0
NL	11	1	7	0	0	0	20	1	2	90	17	72	15	0	8	59	7	0	5	6	12	13	15	28	39	1	0
NO	9	11	0	5	0	1	38	2	0	0	8	17	0	1	1	8	0	1	0	12	2	0	0	1	16	1	0
PL	18	4	2	11	0	3	92	7	0	15	1	121	12	0	9	111	3	0	1	13	0	70	0	6	0	0	3
PT	12	7	0	18	0	0	41	0	0	41	0	59	0	0	0	37	0	2	0	15	0	0	16	0	0	0	0
RO	34	14	7	19	0	6	188	7	0	5	2	73	15	3	0	95	0	1	0	28	1	6	0	36	16	1	0
SE	40	23	3	12	0	2	132	5	0	9	32	105	7	1	4	48	0	1	0	39	16	0	0	16	52	7	0
SI	4	0	0	0	0	0	0	1	0	1	2	0	0	0	0	4	0	0	0	1	1	0	0	1	7	0	0
SK	2	0	0	1	0	1	1	1	0	3	0	5	2	4	1	9	0	0	0	0	0	3	0	0	0	0	6
UK	76	32	0	20	0	5	200	10	0	304	27	359	0	10	32	235	18	2	5	70	35	105	39	29	114	5	4
Total	**614**	**211**	**179**	**251**	**2**	**55**	**1791**	**82**	**18**	**1682**	**249**	**2223**	**526**	**88**	**150**	**1926**	**110**	**18**	**65**	**499**	**169**	**607**	**287**	**586**	**668**	**27**	**43**

Table 7-1 : Number of EPATS potential connections between countries

ANNEX 5 : Current Road+Air passenger traffic on the potential EPATS connections (x1000 passengers)

	AT	BE	BG	CH	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HU	IE	IT	LT	LU	LV
AT	6919	0	1141	0	0	1328	1359	234	162	5126	494	5042	2832	444	1296	21961	769	0	560
BE	0	0	278	0	0	0	47	0	0	415	79	1129	42	0	408	253	205	0	44
BG	1141	278	11168	699	0	89	4731	352	0	155	0	2789	6874	0	0	4714	0	0	0
CH	0	0	699	0	0	0	110	0	128	1373	139	1834	657	136	427	1744	418	0	236
CY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0
CZ	1328	0	89	0	0	1435	1683	0	0	306	24	265	6	0	129	451	67	0	50
DE	1359	47	4731	110	0	1683	21707	1143	553	8038	2708	11084	3510	320	4589	12084	3721	0	1714
DK	234	0	352	0	0	0	1143	0	0	1745	551	2553	387	114	702	2315	94	0	43
EE	162	0	0	128	0	0	553	0	0	0	0	40	0	0	0	252	0	0	0
ES	5126	415	155	1373	0	306	8038	1745	0	499140	0	84237	71	544	1358	26012	0	44	0
FI	494	79	0	139	0	24	2708	551	0	0	3182	506	0	10	0	415	0	0	0
FR	5042	1129	2789	1834	0	265	11084	2553	40	84237	506	435820	1992	818	4181	32403	2758	26	415
GR	2832	42	6874	657	0	6	3510	387	0	71	0	1992	206045	176	0	14389	43	22	0
HU	444	0	0	136	0	0	320	114	0	544	10	818	176	6502	81	1924	0	0	0
IE	1296	408	0	427	0	129	4589	702	0	1358	0	4181	0	81	0	3785	0	0	0
IT	21961	253	4714	1744	50	451	12084	2315	252	26012	415	32403	14389	1924	3785	654448	2156	0	1262
LT	769	205	0	418	0	67	3721	94	0	0	0	2758	43	0	0	2156	0	0	705
LU	0	0	0	0	0	0	0	0	0	44	0	26	22	0	0	0	0	0	0
LV	560	44	0	236	0	50	1714	43	0	0	0	415	0	0	0	1262	705	0	0
NL	275	96	469	0	0	0	4425	370	109	1536	219	1762	130	0	787	1102	699	0	368
NO	336	164	0	55	0	18	1551	508	0	0	127	774	0	8	82	478	0	10	0
PL	3925	185	97	986	0	3091	16404	1304	0	1795	1	11569	890	0	1457	10863	1085	0	206
PT	597	238	0	758	0	0	2005	0	0	58682	0	7644	0	0	0	4375	0	19	0
RO	4246	1506	2975	2301	0	429	17229	1235	0	738	88	9215	3338	766	0	12884	0	42	0
SE	2381	202	135	161	0	20	7801	2581	0	605	2999	4647	135	3	642	3673	0	16	0
SI	632	0	0	0	0	0	0	36	0	44	5	0	0	0	0	3662	0	0	0
SK	329	0	0	48	0	652	277	46	0	194	0	282	96	2025	48	539	0	0	0
UK	1603	846	0	456	0	181	5409	1294	0	8660	448	15382	0	736	33567	7129	3179	27	273
Total	**63993,4**	**6137,33**	**36666**	**12665,1**	**49,7935**	**10223,1**	**134203**	**17605,1**	**1243,75**	**700820**	**11997,7**	**639169**	**241636**	**14608,8**	**53539**	**825322**	**15897,7**	**205,313**	**5877,87**

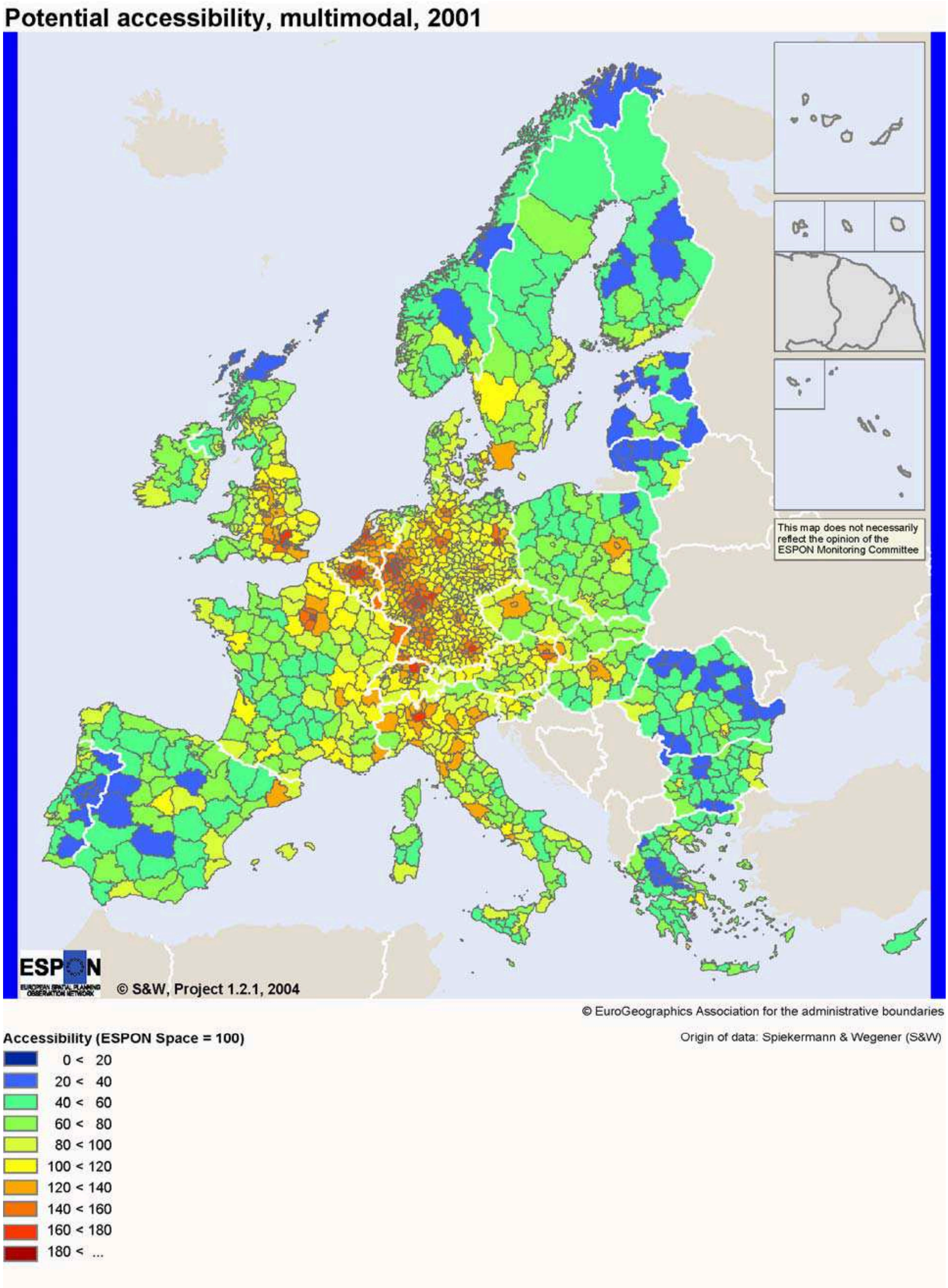
Table 7-2 : Current road+air passenger traffic on the potential EPATS connections

ANNEX 6 : Current Road+Air PKM traffic on the potential EPATS connections (in millions of PKM)

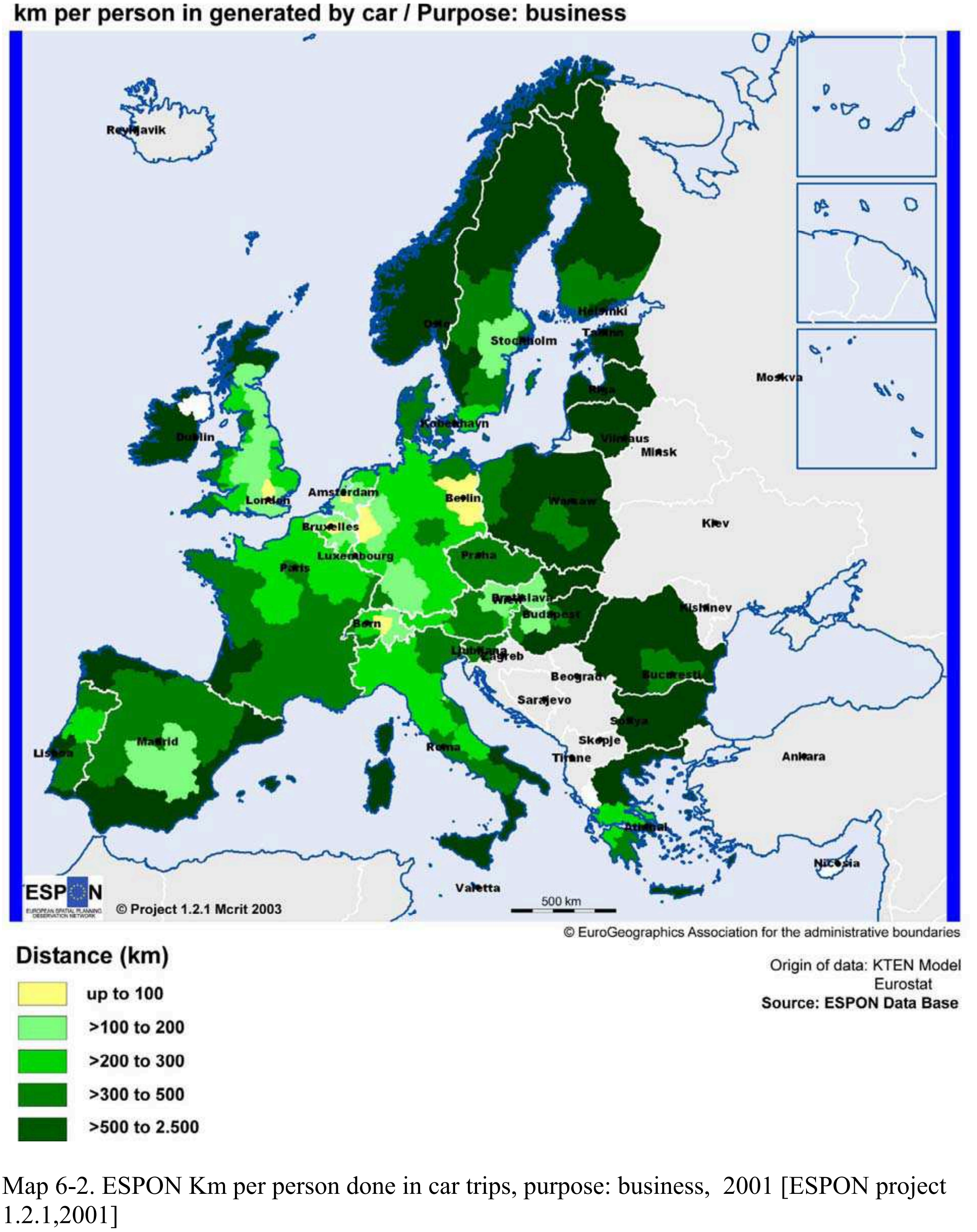
	AT	BE	BG	CH	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HU	IE	IT	LT	LU	LV
AT	2211	0	1592	0	0	597	971	342	315	9054	1086	6161	4716	252	2528	11868	1028	0	902
BE	0	0	636	0	0	0	38	0	0	725	150	770	99	0	411	489	374	0	87
BG	1592	636	2236	1360	0	130	8899	772	0	375	0	6303	2938	0	0	7901	0	0	0
CH	0	0	1360	0	0	0	102	0	303	2214	301	1136	1302	178	695	2120	767	0	471
CY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	101	0	0	0
CZ	597	0	130	0	0	333	381	0	0	588	48	374	11	0	263	301	70	0	65
DE	971	38	8899	102	0	381	7041	384	1088	15834	5005	12903	7167	360	7355	18058	5145	0	2729
DK	342	0	772	0	0	0	384	0	0	3961	666	4195	924	165	1350	4034	102	0	54
EE	315	0	0	303	0	0	1088	0	0	0	0	98	0	0	0	602	0	0	0
ES	9054	725	375	2214	0	588	15834	3961	0	198298	0	63337	157	1195	3039	45109	0	71	0
FI	1086	150	0	301	0	48	5005	666	0	0	1611	1131	0	21	0	980	0	0	0
FR	6161	770	6303	1136	0	374	12903	4195	98	63337	1131	118965	4512	1317	6178	38502	5865	21	900
GR	4716	99	2938	1302	0	11	7167	924	0	157	0	4512	54427	253	0	20988	94	50	0
HU	252	0	0	178	0	0	360	165	0	1195	21	1317	253	1127	196	1866	0	0	0
IE	2528	411	0	695	0	263	7355	1350	0	3039	0	6178	0	196	0	7915	0	0	0
IT	11868	489	7901	2120	101	301	18058	4034	602	45109	980	38502	20988	1866	7915	261909	4157	0	2730
LT	1028	374	0	767	0	70	5145	102	0	0	0	5865	94	0	0	4157	0	0	241
LU	0	0	0	0	0	0	0	0	0	71	0	21	50	0	0	0	0	0	0
LV	902	87	0	471	0	65	2729	54	0	0	0	900	0	0	0	2730	241	0	0
NL	286	38	1079	0	0	0	1447	229	245	2968	385	1727	313	0	970	1980	1163	0	682
NO	641	265	0	105	0	28	2187	533	0	0	138	1553	0	16	130	1057	0	17	0
PL	3117	281	146	1460	0	459	11936	1001	0	4140	2	21466	1818	0	3329	16769	480	0	150
PT	1378	469	0	1391	0	0	4490	0	0	28983	0	11700	0	0	0	9401	0	37	0
RO	4954	3185	969	4202	0	545	28601	2277	0	1721	208	19893	3276	186	0	20838	0	86	0
SE	4278	343	285	314	0	33	10404	1324	0	1414	1854	9597	314	7	1426	7512	0	27	0
SI	182	0	0	0	0	0	0	53	0	64	11	0	0	0	0	460	0	0	0
SK	159	0	0	66	0	87	197	58	0	429	0	474	157	294	118	627	0	0	0
UK	2996	676	0	654	0	309	7927	2293	0	17398	1054	18092	0	1553	10154	15003	7114	29	654
Total	**61612,2**	**9036,45**	**35619,2**	**19140,2**	**100,912**	**4623,7**	**160649**	**24718,7**	**2651,92**	**401076**	**14650,5**	**357169**	**103517**	**8985,23**	**46056,7**	**503278**	**26599,4**	**338,23**	**9665,62**

Table 7-3 : Current road+air PKM traffic on the potential EPATS connections

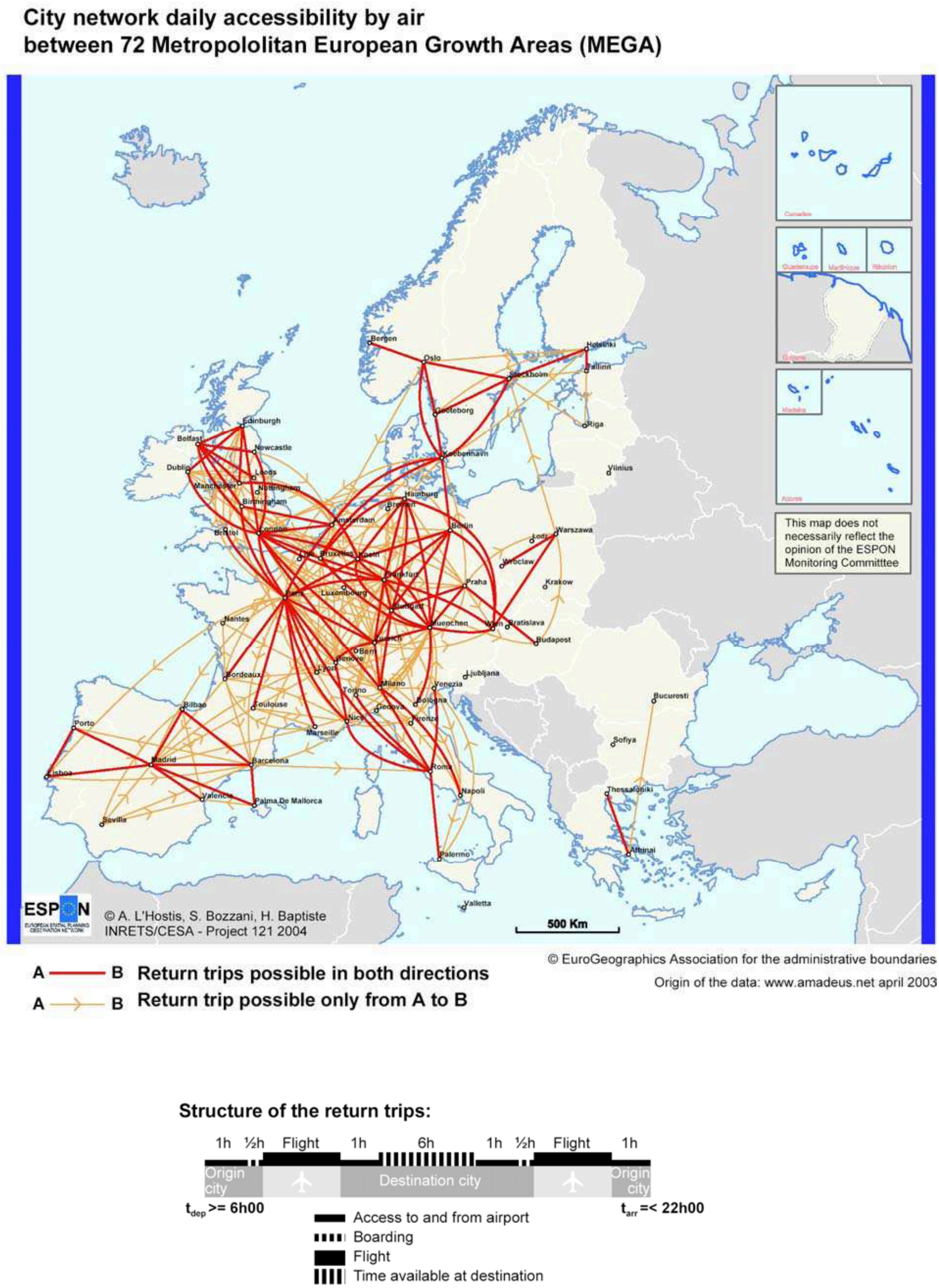
ANNEX 7 :



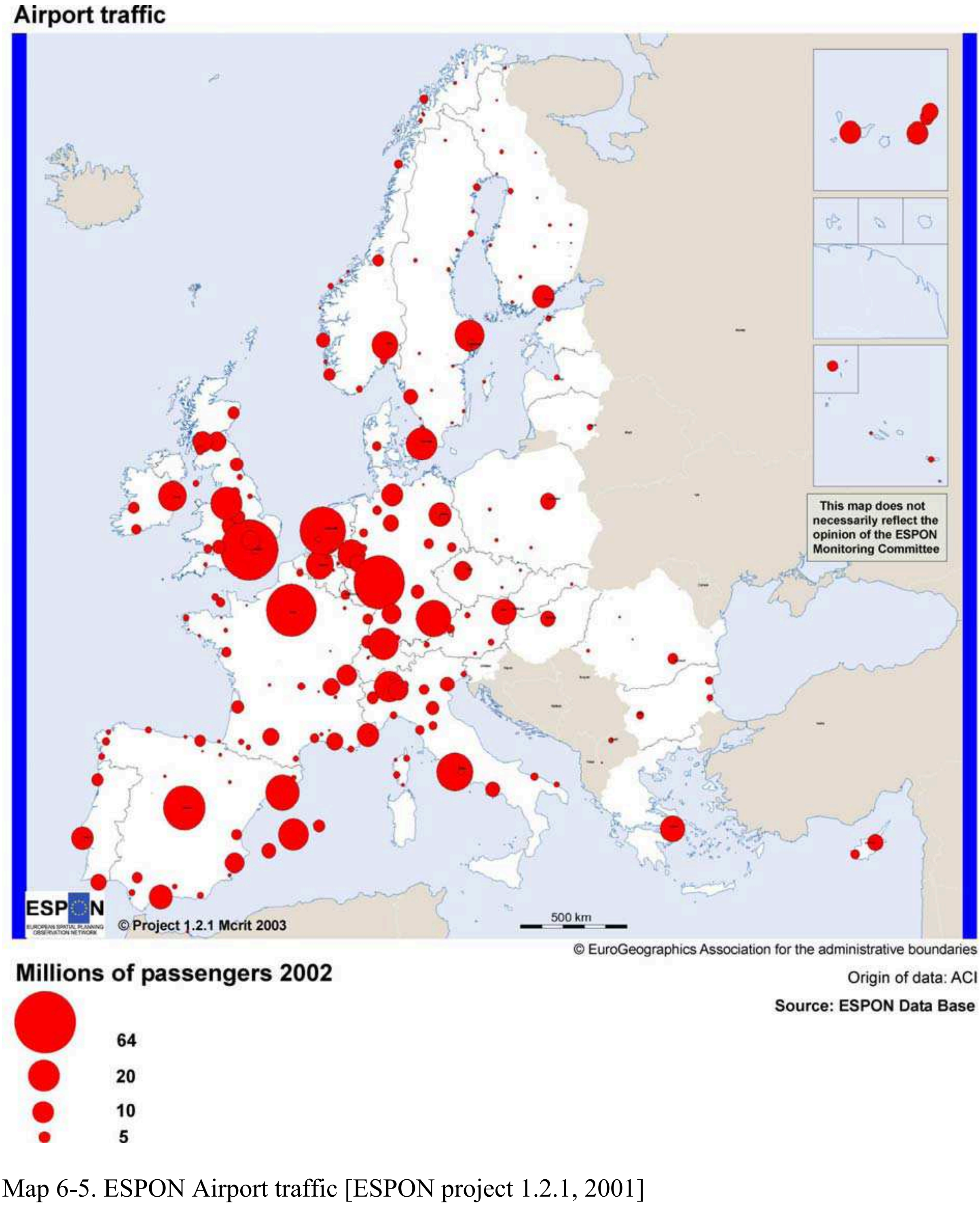
Map 6-1. ESPON Multimodal potential accessibility 2001, [ESPON project 1.2.1,2001]



Map 6-2. ESPON Km per person done in car trips, purpose: business, 2001 [ESPON project 1.2.1,2001]



Map. 6-3. EPSON Accessibility to cities in one day by air [ESPON project 1.2.1,2001]



Map 6-5. ESPON Airport traffic [ESPON project 1.2.1, 2001]

ANNEX 8 :Outcome distribution approximation

Theory
Italian researcher, Vilfredo Pareto proposed an universal power law, valid for all time and countries, which determines income distribution. This discovery formulated at dawn of 20th century was corrected with time. The studies have shown, that the Pareto power law, usually presented in Cumulative Density Function (CDF) form on logarithmic scales graphs, applies to the top income, 1-3% of the population only: $P(x) = x^{-(1+\alpha)}$

The rest of the population (97-99%) follows a distribution, which could be better or worse approximated, burdened with certain trade-offs, using three, alternative, probability density functions (PDF):

$$P(x) = \begin{cases} \frac{1}{T}\exp(-x/T) & \text{exponential,} \\ \frac{1}{xs\sqrt{2\pi}}\exp\left[\frac{-\log^2(x/m)}{2s^2}\right] & \text{log-normal,} \\ \frac{(\beta)^{-(1+\alpha)}}{\Gamma(1+\alpha,0)}x^{\alpha}\exp(-x/\beta) & \text{gamma.} \end{cases}$$

T is the only one parameter of the exponential distribution and its P(x) is maximal at x=0. The log-normal and gamma distributions have two parameters each: m, s and β, α. Their maxima equal $x = me^{-s^2}$ and $x = \alpha\beta$, and P(x) is zero at x = 0. The last condition is difficult to keep, because there live people who do not have any income.

The adequate estimations are done to obtain the above mentioned parameters. However it is impossible to perform the functions estimations without detailed individual income.

Model choice and estimation
After considering the available data, the next step is choosing and fitting the distribution functions. Log-normal and gamma functions are complex in finding parameters, especially when dealing with such, available data aggregations. Therefore exponential function is chosen for further analysis.

Gross wages expressed in US Dollars (at current exchange rate) distributions are found in three steps:

1st step - determination of the exponential function presented in PDF form
2nd step - determination of 99% of CDF
3rd step - Pareto extension application to the top, last 1% of population
4th step - aggregated distributions calculation

The exponential PDF function was slightly modified[7]:

$P(x) = \exp(-x/T)$
where:
x – interval average value assuming uniform distribution in the interval

[7] The outcome seems to be better when omitting the 1/T.

T – unknown parameter for each country

The interval range is 5 thousand dollars starting from 2.5 thousand dollars.

While detailed data are not available, parameter T cannot be estimated using non-linear regression methods, therefore some guesswork has to be done. The method bases on choosing out of thin air the most probable, highest interval of gross wages and calculating the appropriate T-value knowing the number of active population. The disadvantage of this step is a possible unjust generalization when applying the same income limit to every country.

195 – 200 thousand dollars yearly was chosen as the most probable upper limit interval.

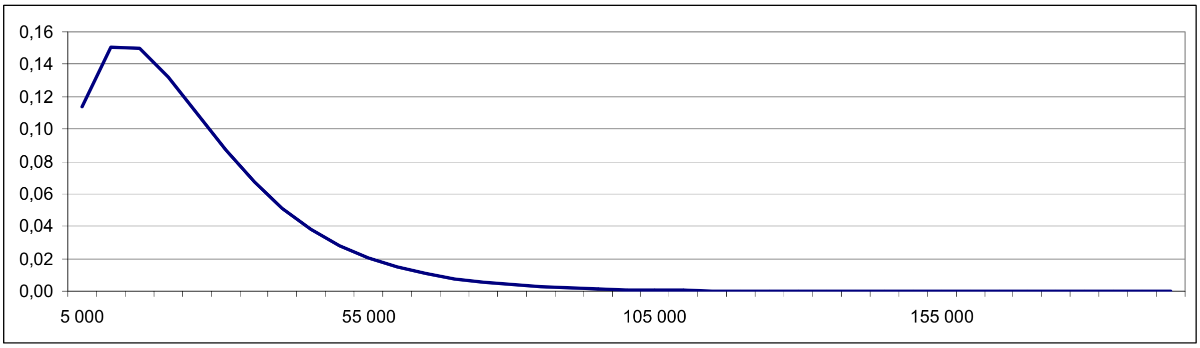


Figure 7-1 : Example of exponential distribution (PDF) of gross wages which holds true for 99% of population

Using the obtained distribution in CDF form the last, top 1% of it is cut and exchanged for Pareto power law: $P(x) = x^{-(1+\alpha)}$

where:

x – interval average value assuming uniform distribution in the interval

α – unknown parameter for each country (called Pareto index)

Now, the last 1% of population income distribution is found assuming the limiting interval.

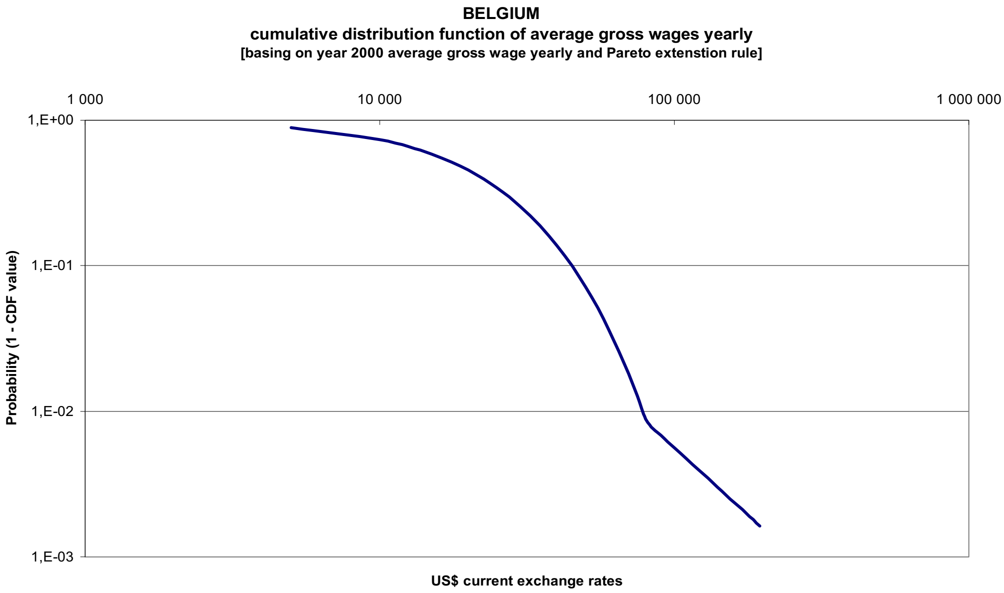


Figure 7-2 : Example of exponential gross wages distribution with Pareto power law extension. Axes are in logarithmic scale.

Annex 9:Value of Time

It is important to be able to evaluate the "value of time" criterion since this value can be used to justify an investment in transport infrastructures, in a transport policy or the implementation of a new concept such as EPATS. Time value is used in methods of traffic forecasting as well.

The value of time is defined as the additional cost a traveller is willing to pay in order to decrease the time spent in transport (usually to decrease the duration by one hour). This time is indeed considered as wasted time which could have been used for other activities. Value of time is expressed in €/hour.

The valuation of time is not an easy task, since there is no overriding parameter; rather, "time value" is a very complex parameter that takes a lot of factors into account, such as mode of transport, purpose of trip, choice of comfort, length of trip, disposable income, personal factors, and so on. For instance, the time spent in a crowded metro and the time spent in a first-class HST with dining and working facilities are not valuated in the same way.

That is why the value of time is valuated differently for different clientele. It is thus necessary to separate values of time for leisure and business trips: a businessman travelling by plane (round trip in the same day) in order to go to a meeting is much more sensitive to a decrease of transport time than a tourist leaving for one month, who prefers paying less expensive even though it takes more time.

Value of time is quite difficult to assess. Up to now there is no model able to take into account all the parameters (problems with subjective factors especially). The value of time is estimated by different methods, and results are very different between the European Countries. However it is possible to outline the main trends:

- The value of time for business trips represents between 70 to 80 % of the labour cost whereas for leisure trips, the value of time is between 30 and 50 % of the value of time of business trips.
- The value of time grows with income.
- The value of time depends on the trip conditions: it increases when comfort decreases.

These results come from the Boiteux report (**Erreur ! Source du renvoi introuvable.**)

We will retain the following table in order to link time value to labour cost:

	Share of time value for **Business** trips in Labour Cost	Share of time value for **Leisure** trips in Labour Cost
Interval	70 to 80 %	21 to 40 %
Selected Value	75 %	30 %

Table: Relationship between Labour Cost and Time value

Source: Boiteux Report

Annex 10: List of model parameters

The following table summarizes the parameters involved in the model.

Categories		**Parameters**	***Comments***
Indifference Curves	**Time**	Average Speed	
		Access Time (to transport mode)	*= Access time to terminal + Time spent at the terminal for procedures*
		Egress time	*= time spent at the terminal after arriving + Time to go from terminal to destination point*
		Additional Time (for break, etc.)	*Only for Car*
	Cost	Number of passenger seats	
		Load Factor / Occupation Rate	
		Operating cost	*For car, this cost is calculated thanks to: Fuel Cost by fuel type, Car consumption by fuel type, share of Diesel / petrol, toll* *For the other modes this cost is directly given*
		Access Cost (to terminal)	*= Distance to the terminal * Car Cost per pkm*
		Egress cost	*= Distance from terminal to destination * Car Cost per pkm*
		Additional Cost = Accommodation Cost	*Only for Car*
Passenger-km distribution for each mode (distance / Time Value)			

Annex 11: Passenger-km Distribution Tables

The tables below give the distributions of passenger-km (in %) by value of time and distance category for various modes and various types of passenger, for the base year (2005).

Note: The pkm distribution is the same for Economy Class Business passengers and Typical Business passengers.

PKM DISTRIBUTION IN %

FRANCE – Car- Leisure			Distance Category (km)						
			100-200	200-400	400-600	600-800	800-1000	1000 +	Total
Share in the population	Interval of value of time - € / hour		142 Km	279 Km	476 Km	683 Km	876 Km	1350 Km	
2.10	<	***0.76***	0.4	0.6	0.5	0.3	0.1	0.1	**2.0**
5.78	***0.76***	***1.30***	0.6	0.9	0.8	0.4	0.1	0.1	**2.8**
10.00	***1.30***	***1.91***	0.9	1.4	1.2	0.6	0.1	0.2	**4.6**
13.47	***1.91***	***2.60***	2.0	3.0	2.6	1.3	0.3	0.4	**9.5**
12.72	***2.60***	***3.21***	2.3	3.6	3.1	1.5	0.4	0,5	**11.3**
31.94	***3.21***	***5.20***	6.9	10.6	9.1	4.5	1.0	1,4	**33.6**
15.76	***5.20***	***7.64***	4.9	7.6	6.5	3.2	0.8	1,0	**24.1**
6.33	***7.64***	***12.23***	1.9	2.9	2.5	1.2	0.3	0,4	**9.1**
1.90	***12.23***	***and +***	0.6	0.9	0.8	0.4	0.1	0,1	**3.0**
	Total		20.5	31.4	27.2	13.5	3.1	4.3	100

FRANCE – Aircraft - Business		**Distance Category (km)**						
		100-200 142 Km	200-400 279 Km	400-600 476 Km	600-800 683 Km	800-1000 876 Km	1000 + 1350 Km	Total
Professional activity	**value of time - € / hour**							
Clerks, sales workers	***12.9***	*0.0*	*0.2*	*0.8*	*0.6*	*0.5*	*1.0*	**3.1**
Farmer	***13.4***	*0.0*	*0.1*	*0.2*	*0.2*	*0.1*	*0.3*	**0.9**
Fishery, manual workers …	***13.5***	*0.0*	*0.2*	*0.5*	*0.4*	*0.4*	*0.7*	**2.1**
Technician and associate professional	***17.9***	*0.0*	*1.5*	*4.8*	*3.7*	*3.2*	*6.2*	**19.4**
Craftsmen, owner of a shop or a company	***22.4***	*0.0*	*0.4*	*1.4*	*1.0*	*0.9*	*1.8*	**5.5**
Professionals, managers in Public sector	***23.9***	*0.0*	*1.1*	*3.7*	*2.8*	*2.5*	*4.8*	**15.0**
Professionals, managers in Private sector	***34.7***	*0.0*	*4.1*	*13.5*	*10.3*	*8.9*	*17.4*	**54.0**
Total		*0.0*	*7.5*	*24.9*	*19.0*	*16.4*	*32.2*	100.0

EUROPE – Aircraft - Business		**Distance Category (km)**						
		100-200 152 Km	200-400 309 Km	400-600 481 Km	600-800 693 Km	800-1000 897 Km	1000 + 1508 Km	Total
Professional activity	**Average time value - € / hour**							
Fishery, manual workers	***9.85***	0.0	0.2	0.5	0.3	0.2	0.9	**2.1**
Farmer	***10.20***	0.0	0.1	0.2	0.1	0.1	0.4	**0.9**
Clerks, sales workers	***10.78***	0.0	0.3	0.7	0.4	0.3	1.4	**3.1**
Technician and associate professionals	***15.98***	0.2	1.8	4.3	2.6	2.0	8.6	**19.4**
Craftsmen, owner of a shop or a company	***18.36***	0.0	0.5	1.2	0.7	0.6	2.4	**5.5**
Professionals, managers	***24.35***	0.5	6.3	15.2	9.2	7.2	30.6	**69.0**
Total		**0.8**	**9.1**	**22.0**	**13.3**	**10.4**	**44.3**	**100 %**

FRANCE – CAR - Business		**Distance Category (km)**						
		100-200	200-400	400-600	600-800	800-1000	1000 +	Total
Professional activity	**value of time - € / hour**	142 Km	279 Km	476 Km	683 Km	876 Km	1350 Km	
Clerks, sales workers	***12.9***	2.1	2.0	1.0	0.3	0.0	0.1	**5.5**
Farmer	***13.4***	0.9	0.9	0.4	0.1	0.0	0.1	**2.3**
Fishery, manual workers …	***13.5***	6.4	6.4	3.2	0.8	0.0	0.4	**17.2**
Technician and associate professional	***17.9***	11.8	11.7	5.9	1.5	0.0	0.8	**31.7**
Craftsmen, owner of a shop or a company	***22.4***	4.0	3.9	2.0	0.5	0.0	0.3	**10.6**
Professionals, managers in Public sector	***23.9***	2.6	2.6	1.3	0.3	0.0	0.2	**7.1**
Professionals, managers in Private sector	***34.7***	9.5	9.5	4.7	1.2	0.0	0.6	**25.6**
Total		**37.3**	**37.0**	**18.5**	**4.8**	**0.0**	**2.4**	**100.0**

EUROPE – CAR - Business		**Distance Category (km)**						
		100-200	200-400	400-600	600-800	800-1000	1000 +	Total
Professional activity	**Average value of time - € / hour**	142 Km	279 Km	476 Km	683 Km	876 Km	1350 Km	
Fishery, manual workers	***9.85***	5.6	6.6	2.7	0.8	0.5	1.0	**17.2**
Farmer	***10.20***	0.8	0.9	0.4	0.1	0.1	0.1	**2.3**
Clerks, sales workers	***10.78***	1.8	2.1	0.9	0.3	0.2	0.3	**5.5**
Technician and associate professionals	***15.98***	10.4	12.1	5.0	1.5	0.9	1.8	**31.7**
Craftsmen, owner of a shop or a company	***18.36***	3.5	4.1	1.7	0.5	0.3	0.6	**10.6**
Professionals, managers	***24.35***	10.7	12.5	5.2	1.6	0.9	1.8	**32.6**
Total		**32.8**	**38.2**	**15.8**	**4.8**	**2.8**	**5.5**	**100 %**

POLAND – CAR - Business		Distance Category (km)				
		101-200km	**201-300km**	**301-500km**	**501-700km**	
value of time - € / hour		**150**	**250**	**400**	**600**	**Total**
0,0 €	0,9 €	0%	0%	0%	0%	0%
0,9 €	1,3 €	0%	0%	0%	0%	1%
1,3 €	1,8 €	1%	2%	4%	4%	11%
1,8 €	2,4 €	1%	1%	2%	2%	7%
2,4 €	3,1 €	1%	1%	1%	0%	4%
3,1 €	3,7 €	1%	2%	3%	3%	9%
3,7 €	4,8 €	1%	0%	1%	0%	3%
4,8 €	5,7 €	3%	4%	3%	2%	12%
5,7 €	9,5 €	2%	2%	4%	2%	9%
more than	9,5 €	7%	15%	13%	9%	45%
						100%

Annex 12: Evolution of model parameters

We can distinct three kinds of parameters in the model: constant unchanging parameters; parameters which remain constant whatever the scenarios; and parameters which change according to the scenario.

1. Unchanging parameters

The following parameters are assumed not to change:

- EPATS / Aircraft Average Speed
- Access time
- Egress time
- Additional Time
- Occupancy rate (source: Tremove)
- Toll
- Accommodation Cost
- Relationship between income / labour cost and value of time
- Business journeys distribution by occupation and travelled distance (from assumptions 1 and 2 in IV.4)
- Average travelled distance

2. Parameters remaining constant between scenarios

GDP per capita and fuel cost evolution will impact on:

- Average incomes and hence on time value
- Car / Aircraft / Epats unit cost
- Access cost (because depends on the car unit cost)
- Egress cost (because depends on the car unit cost)

% 2005 – 2020	Total Growth of GDP per capita	Total growth of fuel cost
EU	34.78	28.70
France	32.62	28.70

Table: Forecast for GDP per capita and Fuel price evolution between 2005 and 2020

Source: Assess and DG Tren Assumptions

<u>How will GDP per capita growth impact on the value of time ?</u>
We assume that income growth follows GDP per capita growth. Hence, the value of time will grow in line with GDP per capita.
<u>How will fuel cost growth impact on transportation unit cost ?</u>

The fuel cost growth impacts directly on the part of the unit cost that corresponds to the fuel.

- **For EPATS aircraft and traditional aircraft**:

What is the share of fuel cost in the total operating cost ?
For traditional airlines, the fuel cost accounted for 20 % of the TOC in 2005. (source: **Erreur ! Source du renvoi introuvable.**)
For Personal Aviation, we used data from WP 1 to calculate the share of fuel cost in TOC for each aircraft. Our calculations show that it is generally between 20 and 25 % of TOC.

3. Parameters linked to the scenarios

Transport policy can have a more or less important impact on cost and time of transport. The following table indicates the impact of each scenario on the parameters, by differentiating between transport modes. The null scenario does not appear since this scenario assumes that no policy measure will be implemented by 2020. The impact is quantified in % with respect to Null scenario. In last column, the reason of the evolution is given.

Transport mode	Parameters	Partial Scenario	Full Scenario	Extended Scenario	Reason
CAR	Transportation Unit Cost	0	0	*2.55 €cent/vkm*	**Infrastructure charging**: External costs should be added to private costs in terms of toll per pass-km. However, pricing for passenger modes is not a White Paper measure, so pricing for passenger transport is included in the Extended scenario only.
	Travel Time	0	-2 %	-3 %	**Galileo Programme**
AIR & EPATS	Transportation Unit Cost	0	0	*0.95 €cent/vkm*	**Infrastructure charging** (External Cost)
AIR	Transportation Unit Cost	0	-1,5 %	-2 %	▪ **Single European Sky** should enable to shorter route length => Reduced cost ▪ **Insurance requirements** and **compensation** for air passengers should increase fares ▪ **New allocation of slots** => greater share of low cost => Reduced travel costs; ▪ **taxation of kerosene** product
	Travel Time	-4,5 %	-8 %	-11 %	▪ **Single European Sky =>** route lengths are shorter => Reduced time. ▪ **Airport charges** should have a positive effect on the airport capacity management since they will be different according to peak / off peak, occupancy of capacity, etc… in this way, traffic will be more balanced, delays should decrease => Reduced time ▪ **New allocation of slots** => greater share of low cost => reduced time
EPATS	Transportation Unit Cost	1 %	3,5 %	1 %	Same reasons as for aircraft, except the new allocation of slots that does affect small airports.
	Travel Time	-2 %	-4 %	-8 %	**Single European Sly** will shorter flight routes

Table: Impact of scenarios on cost and time by 2020 and reason for each evolution

Source: Assess Assumptions

Policy measures implementation will also affect the passenger transport. The following table gives the number of pkm forecast in Europe by 2020, for each transport mode, for each trip reason and for each scenario (for a travelled distance above 50 km).

Number of passengers x km (for trips > 50 km), in millions				
EUROPE, 2020	Null	Partial	Full	Extended
CAR Leisure	2 937 669	2 935 881	2 970 282	2 694 492
CAR Business	739 190	738 658	744 420	756 131
AIRCRAFT Leisure	413 344	414 347	380 908	317 890
AIRCRAFT Business	194 226	194 592	189 022	182 499

Table: Number of passenger-km for trips above 50 km in Europe forecast in 2020

Source: Tremove

Number of passengers x km (for trips > 50 km), in millions				
FRANCE, 2020	Null	Partial	Full	Extended
CAR Leisure	442 462	442 462	453 490	410 877
CAR Business	87 494	87 494	89 448	88 557
AIRCRAFT Leisure	47 545	47 545	44 406	31 032
AIRCRAFT Business	7 673	7 673	7 061	6 386

Table: Number of passenger-km for trips above 50 km in France forecast in 2020

Source: Tremove

Annex 13 : EPATS aircraft characteristics

1. INTRODUCTION

EPATS aircraft fleet type structure and their main characteristics presented below are an outcome of the following analyses:
Aircraft and European airport Data Base (WP-1)
Initial approach to WP-4 tasks – concerning mission requirements and cost analysis.
The preliminary analysis of EU socioeconomic and interregional passenger mobility data – Task 2.1,
Assumptions under discussion in „EPATS ROADMAP VISION", Warsaw, June 2007
The provided data is intended for potential demand of EPATS aircraft estimation using *Indifference generalized costs curve calculation*, which was approved for the realization of Task T.2.2 *Potential transfer of passenger demand to personal aviation by 2020*. A personal car is a reference mode for this method, which on a contrary to train or airlines, similarly as EPATS may realize any direct interregional connection.
Data input may somewhat change in further realization of WP-4, especially in the area of costs and fuel consumption.

2. EPATS AIRCRAFT CLASSIFICATION AND USE CATEGORIES

The following definitions are consistent with Federal Aviation Administration. See *General Aviation 's Contribution to The U.S.Economy |May 2006*. Future European statistical survey concerning the uses of EPATS aircraft should be in accordance with the following classification and use categories

2.1 CLASSES OF EPATS AIRCRAFT

The EPATS Aircraft are grouped into the next classes of aircraft, that has been issued a certificate of airworthiness by EASA according to CS-23 Requirements:

Single-engine piston-powered airplanes, that are the most common Personal-Use aircraft, thanks to their relatively low acquisition cost. The single piston engine drives a single propeller,
Multi-engine piston-powered airplanes usually have two piston engines driving separate propellers.
Single-or Multi-engine Turboprop airplanes are powered by one or more turbine engines that drive propellers. Turboprop aircraft typically are larger, faster, and more expensive than piston aircraft. Turboprops are flown for a wide variety of purposes but are most often flown for business, corporate, and other professionally crewed purposes.
Jet airplanes have two or three turbofan engines and offer the greatest speeds and range capabilities of all EPATS aircraft. Due to the expense and professional requirements of their operation, jets are most commonly operated by corporate and government users.For purposes of this study,jets are further segmented by weight class into two categories (Very Light Jet and Light Jet,)to capture significant cost and use differences.

2.2 EPATS AIRCRAFT USE CATEGORIES

Personal – Aircraft flown for the personal purposes of the owner (in own or fractional ownership), that pilot it by themselves. The number of passenger seats include pilot seat. Operating under FAR 91
Business – These aircraft are flown by owner-pilots for individual or group use for business transportation without a professional crew. The number of passenger seats do not include pilot seat. Such owners are assumed to share a hangar with other users and pay a business insurance rate. They are assumed to purchase the commercial weather report service since travel is important to the conduct of their business and, on average, they fly more frequently than personal users. Operating under FAR 91
Corporate, – Usually in company or fractional ownership. For purposes of cost evaluation, this category includes all uses, which are assumed to use professional crews. The owners of these aircraft are assumed to rent a private hangar, pay the corporate insurance rate, and hire a professional crew (pay and benefits). Operating under FAR 91.
Air Taxi. – on-demand passenger operations operating under FAR 135.
Commuter – scheduled passenger service operating under FAR 135

2.3 VEHICLE REFERENCE AND EPATS AIRCRAFT TYPES TO BE ANALISED:

ACP-1- Single-Engine Piston - Personal
ACP-2 – Twin-Engine Piston - Business
ACT-1 – Single-Engine Turbo-prop – Air-Taxi
ACT-2 – Twin – Engine Turboprop - Commuter
ACJ-1 – Twin-Engine Very Light Jet (<5000 kg) – Air-Taxi
ACJ-2 – Twin-Engine Light Jet (< 7000 kg) – Corporate

***V-REF – Vehicle reference,** it is assumed to be a car mainly. The data in the table are given only as an example.

3. THE MOSTLY PROGNOSED USE OF EPATS AIRCRAFT*

	Single-Engine Piston	**Twin-Engine Piston**	**Turboprops**		**Jets**	
			Single-Engine	Twin-Engine	Very Light Jet	Light Jet
Personal	[dark blue]	[cyan]	[cyan]		[cyan]	
Business	[blue]	[dark blue]	[blue]	[cyan]	[cyan]	
Corporate	[cyan]	[cyan]	[blue]	[cyan]	[blue]	[dark blue]
Air-Taxi	[cyan]	[blue]	[dark blue]	[blue]	[dark blue]	[blue]
Commuter				[dark blue]		[cyan]

[dark blue]	Most commonly use
[blue]	Commonly use
[cyan]	Sometimes
[white]	Never or rarely

* In the case of Interactive Transportation System implementation each aircraft type of this system is considered as on demand aircraft.

4. EPATS AIRCRAFT MISSION'S CHARACTERISTICS

VEHICLE CHARACTERISTICS								
	Parameter	V-REF*	ACP-1	ACP-2	ACT-1	ACT-2	ACJ-1	ACJ-2
1	Crew	*1*	1	1	1	1	1	1
2	Pas. Seating (PS)	*3*	3	5	9	19	5	9
3	Max PayPayload [kg]		285	475	855	1805	475	855
4	Useful load [kg]		530	560	1850	2400	1100	2200
5	Takeoff weight [kg]		1300	2000	4500	7200	2700	6000
6	TO Field length [m]		600	600	1000	1200	800	1000
7	Initial gradient [m/m]		0,12	0,18	0,14	0,18	0,18	0,18
8	Cruise speed [km/h]		320	350	550	550	700	750
9	Climb speed/Cruise speed CC		0,5	0,5	0,55	0,55	0,6	0,6
10	Cruise altitude FL		100	250	250	250	350	350
11	Range [km]		1000	1000	1500	1500	2500	2500
12	ATM Capability:SESAR level		1	1	3	3	3	3
13	SFC [l/km]	*0,09*	0,10	0,20	0,30	0,55	0,30	0,55
14	Operational costs [Euros/h]	*0,5E/h*	200	300	1000	1300	1300	2000
15	Estimated Price [1000 Euros]	*30*	200	400	2000	4000	1500	3500
16	Certification basis		CS-23	CS-23	CS-23	CS-23	CS-23	CS-23
FIXED OPERATION TIME								
	Fixed flight Operation Time [min]							
1	Pre-flight Check-list Engine start warmup,		5	8	8	12	12	12
2	Embarquement		1	2	1	4	1	3
3	Taxi-out		1	1	1	1	1	1
4	Take-off		0,5	0,5	0,5	0,5	0,5	0,5
5	Climb to cruise level (CT)		10	20	20	20	20	20
6	Loiter		1	1	2	2	2	2
7	Approach		1	1	1	1	1	1
8	Landing		0,5	0,5	0,5	0,5	0,5	0,5
9	Taxi-in		1	1	1	1	1	1
10	Eng.Shutdown,parking		1	2	1	2	2	2
11	Debarquement		1	2	1	4	1	3
12	Fixed Flight Op.Time (FFOT)		23	27	37	48	42	46
13	Waiting & Boarding Time (WBT) [min]		10	12	15	20	15	18
14	**Total fixed operations time (TFOT) [min]**	*15*	**33**	**49**	**47**	**63**	**52**	**56**
OPERATIONAL FACTORS TO BE ASSUMED								
1	Average Load Factor (LF)*	*0,5*	0,7	0,7	0,7	0,7	0,7	0,7
2	Hours flown by year*		300	400	500	1400	400	400
3	Life Cycle [years]	*10*	20	20	20	20	20	20
4	Average Great Circle Distance of trip [km] (GCD)		400	400	700	700	1100	1200
5	Average throughout distance (D) of trip to Great Circle Distance (GCD) rate (R)	*1,2*	1	1	1,1	1,1	1,15	1,15
6	Airport access/egress time [min]		15	15	20	20	20	20

* In the case of Interactive Transportation System implementation the average Load factor and hours flown by year should be higher

5. DEFINITIONS AND EXPLANATIONS

Payload = seating x (passenger weight + baggage) = seating x (80 + 15)

Usefull load = Payload + Fuel

TO Field lenght - according to FAR-25 definition

Cruise speed V_{cr} – recommended cruise speed

Cruise altitude – recommended cruise altitude

Range – at full seats and cruise speed at cruise altitude with a fuel reserve equivalent to 45 min at long range cruise for piston airplane, and with a reserve for diverting to an 100 nm alternate for turbine airplane (to be discussed)

SFC – Specific Fuel Consumption at cruise speed and cruise altitude in [l/km]

Operational costs per hour (OCH)– it is the average costs of 1 hour of flight calculated from engine start to shut-down (Operation's Time). It is calculated on the basis of all expenses during the year and planned transportation flight hours and number of operations (trips) for typical distances (Average Great Circle Distance).
The given operational costs (OC) are calculated costs

Operational costs = Direct Operational Costs + Indirect Operational Costs (OC=DOC+IOC)
The cost elements taken into account in the Operational Costs calculation are listed in the tables below.

Hours flown by year – it is the sum of transportation flight hours and instructional flight hours (~ 0,5% of transportation flight)

Fixed flight Operation's Time (FFOT) = ESTT + Climb Time to Cruise altitude+ Loiter +ALTS
ESTT – Embarquement, Engine start and warm-up time, Taxi, Take-off
ALTS – Approach, Landing, Taxi, Engine Shutdown time, Debarquement`
Loiter – average statistical waiting time for landing

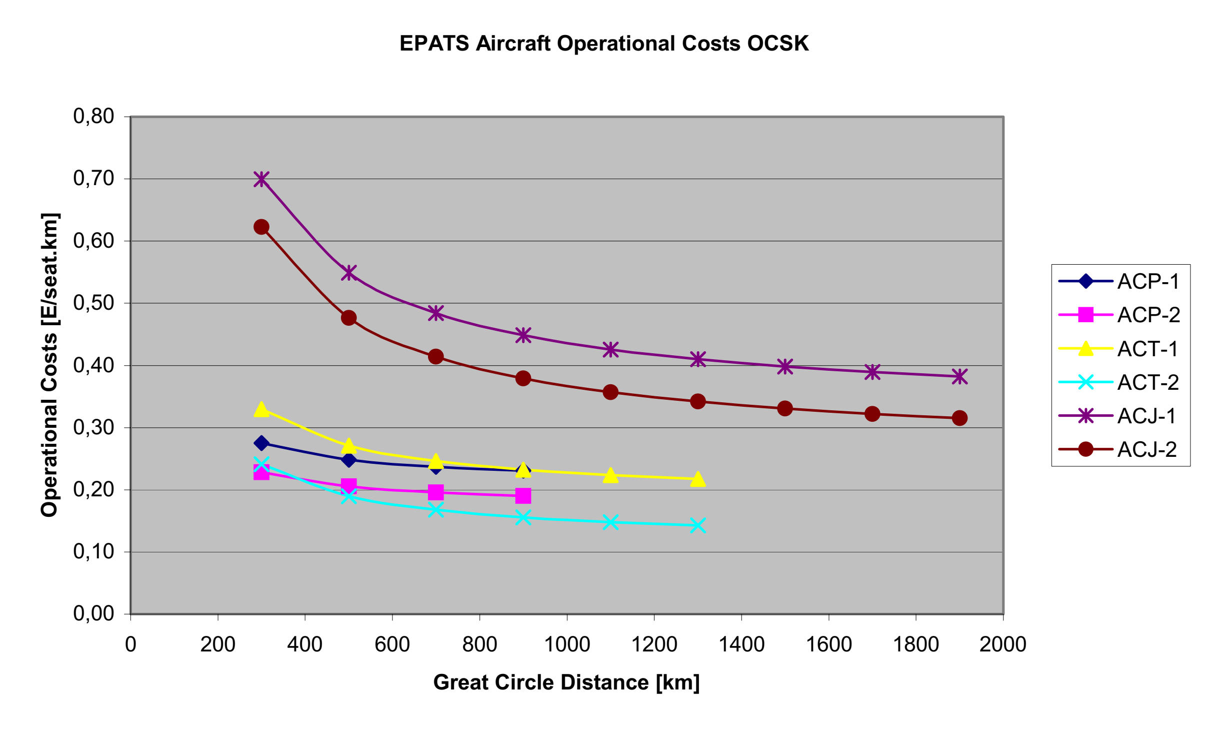
During Fixed Operation's Time the gone through distance throughout the climb to cruise altitude is assumed to be:
Climb Distance $D_{climb} = V_{climb}$ x Climb Time to cruise altitude,
where V_{climb} – means speed for best rate of climb
Approximatively we assume: $V_{climb} = CC \times V_{cruise}$ where CC is the statistical value of V_{cimb} / V_{cruise}

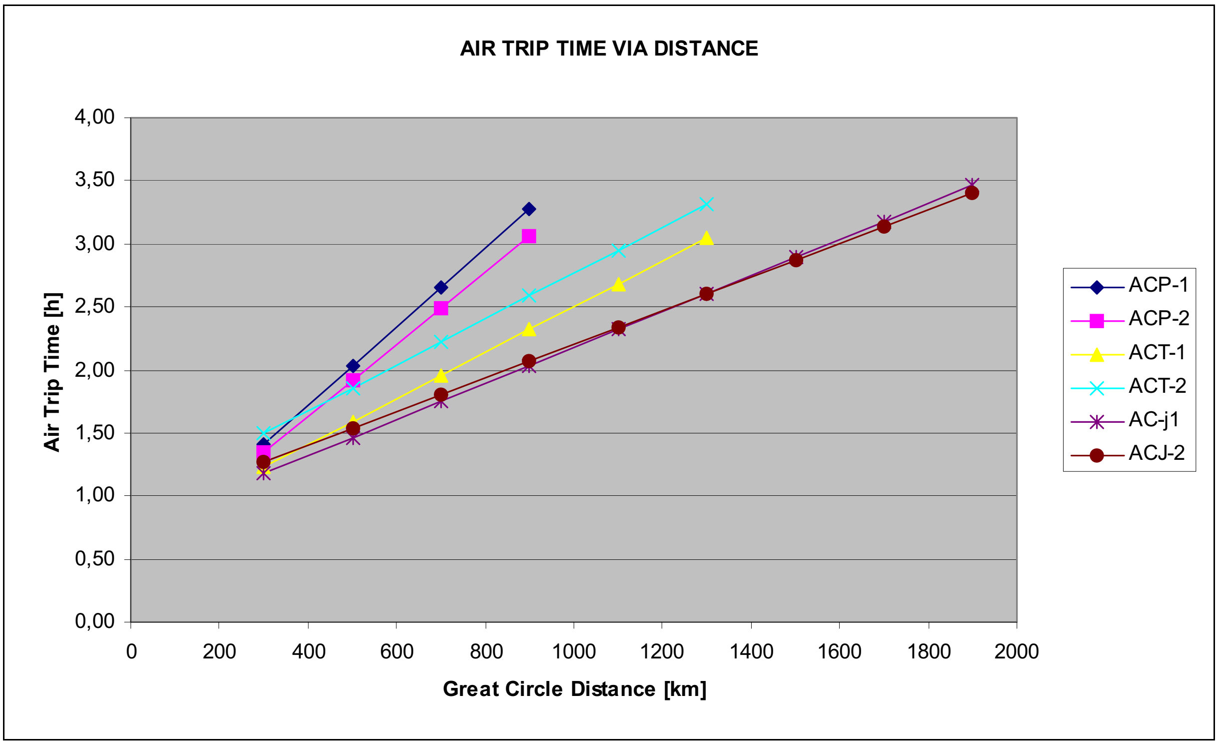
The Block Time and speed ares calculated as follow:
Block Time (BT) = Fixed Fliht Operation Time + (Trip Distance – Climb Distance)/V_{cruise}
where:
Trip Distance (D) = GCD x R
The total trip time (TT) = Block Time + Waiting & Boarding Time
Block speed (BS) = Great Circle Distance / Block time

The Operational Costs per seat kilometer (OCSK)
OCSK = OCH/(BS x seats)

The Operational Costs per passenger kilometer (OCPK)
OCPK = OCSK / LF

The results of calculations for Operational Costs per Seat. Kilometer (OCPK) and Air Trip Time via Great Circle Distance are given on the graph below.





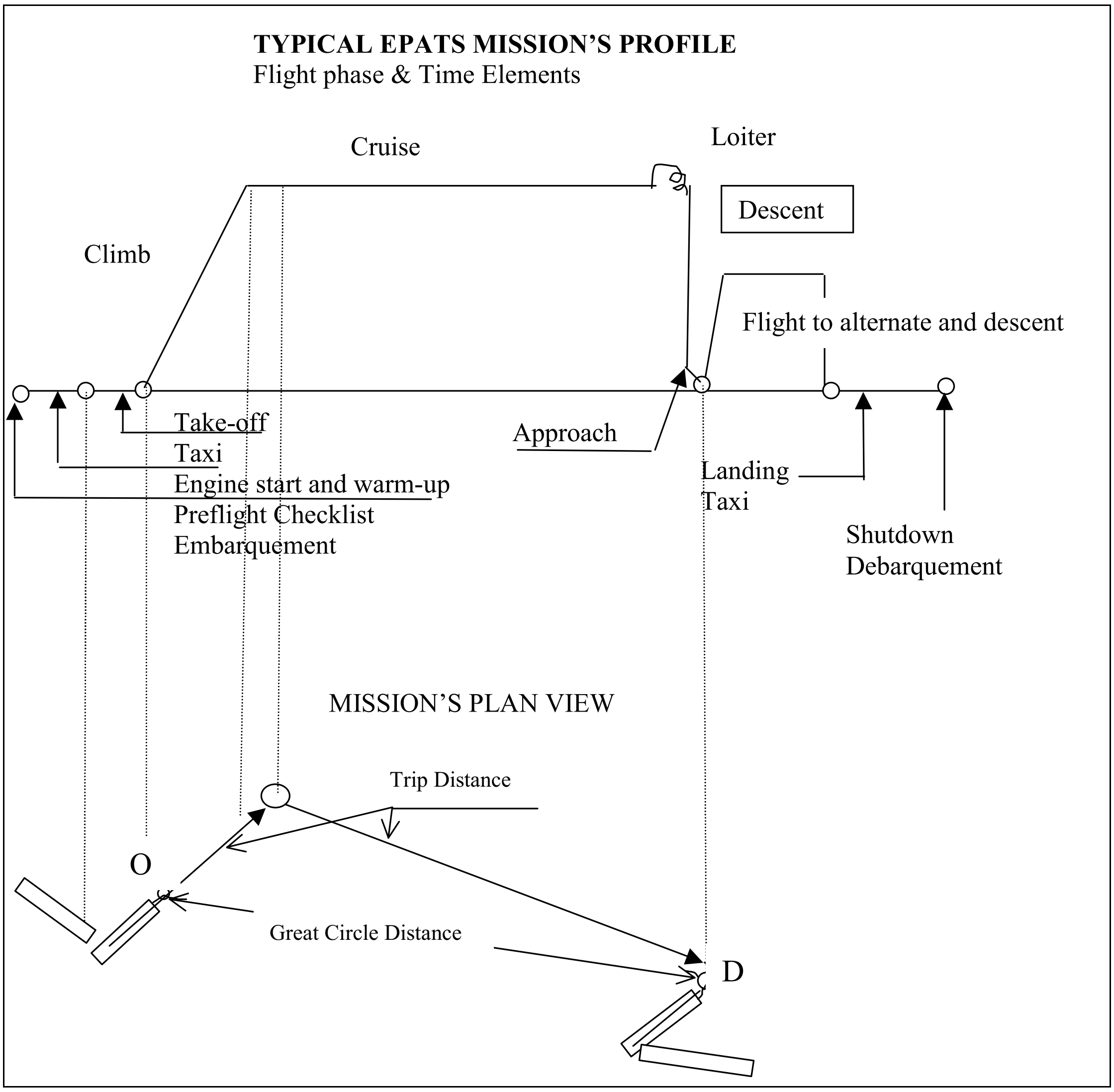
6. OVERVIEW OF DIRECT OPERATING COST (DOC)

DIRECT OPERATING COST (DOC)		AIRLINE	PERSONAL	BUSINESS	CORPORATE	AIR - TAXI	COMMUTER
DIRECT OPERATING COST INCLUDED IN CALCULATION							
DOC COMPONENTS	DOC ELEMENTS						
FLYING	crew	+	-	+	+	+	+
	fuel	+	+	+	+	+	+
	insurance	+	+	+	+	+	+
MAINTENANCE	airframe labor	+	+	+	+	+	+
	engine labor	+	+	+	+	+	+
	airframe materials	+	+	+	+	+	+
	engine materials	+	+	+	+	+	+
	applied maintenance burden	+	-	+	+	+	+
DEPRECIATION	airframe	+	+	+	+	+	+
	engine(s)	+	+	+	+	+	+
	prop(s)	+	+	+	+	+	+
	avionics	+	+	+	+	+	+
	airframe spare parts	+	-	+	+	+	+
	engine spare parts	+	-	+	+	+	+
LANDING & NAVIG, FEES, REGISTRY TAXES	landing fees	+	+	+	+	+	+
	navigation fees	+	+	+	+	+	+
	registry taxes	+	+	+	+	+	+
FINANCE		+	+	+	+	+	+

7. OVERVIEW OF INDIRECT OPERATING COST (IOC)

INDIRECT OPERATING COST (IOC)		AIRLINE	PERSONAL	BUSINESS	CORPORATE	AIR - TAXI	COMMUTER
INDIRECT OPERATING COST INCLUDED IN CALCULATION							
IOC COMPONENTS	IOC ELEMENTS						
PASSENGERS	meals	+	-	-	+	-	+
	insurance	+	+	+	+	+	+
	cabin attendants	+	-	-	+	-	+
	passenger handling, baggage handling, sales & reservations, security, misc	+	-	-	-	-	+
STATION	maintenance of ground equipm’t & facilities	+	-	+	+	+	+
	depreciation of ground equipm’t & facilities	+	-	+	+	+	+
AIRPLANE SERVICE, CONTROL AND FREIGHT	airplane service	+	+	+	+	+	+
	airplane control	+	-	+	+	+	+
	freight handling	+	-	-	-	-	+
PROMOTION, SALES AND ENTERTAINMENT	commissions to travel agencies,	+	-	-	-	-	+
	publicity and advertising,	+	-	+	-	+	+
	entertainment	+	-	-	-	-	+
GENERAL AND ADMINISTRATIVE	administrative, accounting and corporate staff + facilities	+	-	+	+	+	+

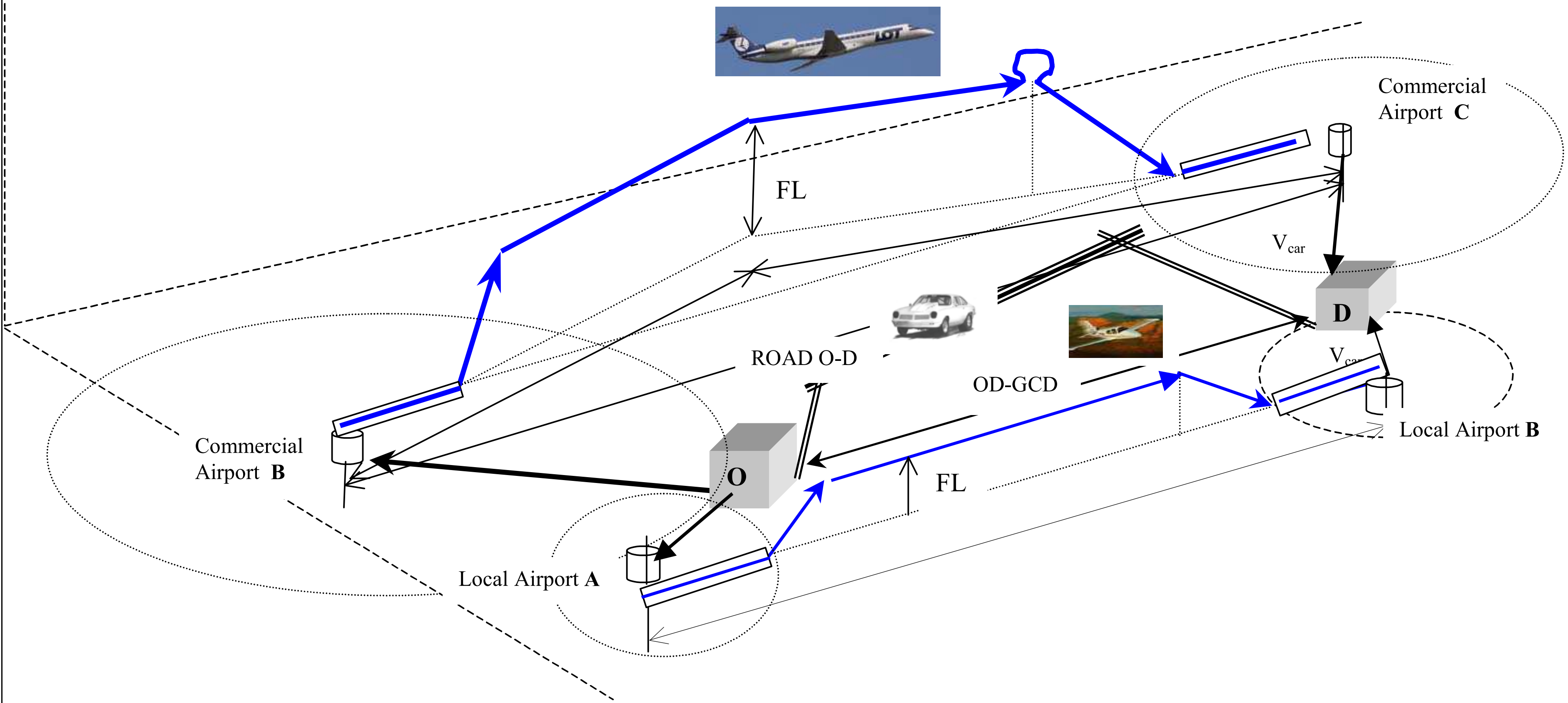
8. TYPICAL EPATS MISSION'S PROFILE



9. ORIGIN – DESTINATION VEHICLE TRIP DISTANCE

ORIGIN – DESTINATION VEHICLE TRIP DISTANCE

To be used for Origin-Destination time and costs trip calcul;ation



Annex 14: Estimated EPATS traffic in Europe (Partial Scenario)

TOTAL PKM	AT	BE	CH	CZ	DE	DK	ES	FI	FR	GR	HU	IE	IT	LU	NL	NO	PL	PT	SE	SI	UK
AT	330	0	0	92	126	21	219	11	429	155	22	29	1019	0	29	8	309	8	88	19	51
BE	0	0	0	0	5	0	16	2	99	1	0	41	7	0	6	9	0	4	7	0	80
CH	0	0	0	0	11	0	65	2	155	17	0	18	124	0	0	1	0	18	3	0	33
CZ	92	0	0	33	29	0	0	1	1	0	0	0	37	0	0	1	33	0	1	0	1
DE	126	5	11	29	907	57	194	96	917	76	3	236	647	0	165	101	991	23	524	0	412
DK	21	0	0	0	57	0	27	50	89	6	0	38	110	0	32	41	108	0	174	2	104
ES	219	16	65	0	194	27	26160	0	6534	0	0	47	1364	2	43	0	0	3583	9	0	408
FI	11	2	2	1	96	50	0	223	8	0	0	0	7	0	6	14	0	0	223	0	8
FR	429	99	155	1	917	89	6534	8	12304	32	0	318	2503	3	164	21	0	237	99	0	1425
GR	155	1	17	0	76	6	0	0	32	7952	0	0	916	0	2	0	0	0	2	0	0
HU	22	0	0	0	3	0	0	0	0	0	124	0	114	0	0	0	0	0	0	0	8
IE	29	41	18	0	236	38	47	0	318	0	0	0	79	0	87	3	0	0	32	0	1240
IT	1019	7	124	37	647	110	1364	7	2503	916	114	79	33093	0	49	9	177	49	91	20	175
LU	0	0	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0	0	0	0	3
NL	29	6	0	0	165	32	43	6	164	2	0	87	49	0	0	21	0	5	56	0	167
NO	8	9	1	1	101	41	0	14	21	0	0	3	9	0	21	11	0	0	113	0	57
PL	309	0	0	33	991	108	0	0	0	0	0	0	177	0	0	0	2692	0	0	0	61
PT	8	4	18	0	23	0	3583	0	237	0	0	0	49	0	5	0	0	1754	0	0	50
SE	88	7	3	1	524	174	9	223	99	2	0	32	91	0	56	113	0	0	1381	1	197
SI	19	0	0	0	0	2	0	0	0	0	0	0	20	0	0	0	0	0	1	0	1
UK	51	80	33	1	412	104	408	8	1425	0	8	1240	175	3	167	57	61	50	197	1	7206

Table 7-4: Estimated transferred traffic to EPATS in millions of Passengers-Kilometres

TOTAL PAX	AT	BE	CH	CZ	DE	DK	ES	FI	FR	GR	HU	IE	IT	LU	NL	NO	PL	PT	SE	SI	UK
AT	1034	0	0	204	181	15	141	5	393	102	51	15	1457	0	28	4	440	3	52	55	29
BE	0	0	0	0	6	0	11	1	149	0	0	41	4	0	14	5	0	2	5	0	104
CH	0	0	0	0	12	0	47	1	254	9	0	11	111	0	0	1	0	10	2	0	25
CZ	204	0	0	113	94	0	0	1	1	0	0	0	63	0	0	1	81	0	1	0	1
DE	181	6	12	94	2499	170	107	58	882	40	3	152	607	0	321	79	1763	10	503	0	298
DK	15	0	0	0	170	0	12	47	58	3	0	20	76	0	52	55	158	0	360	2	58
ES	141	11	47	0	107	12	61312	0	10291	0	0	21	932	1	24	0	0	7587	4	0	219
FI	5	1	1	1	58	47	0	417	4	0	0	0	3	0	4	14	0	0	382	0	4
FR	393	149	254	1	882	58	10291	4	30061	14	0	241	2612	4	182	11	0	171	52	0	1416
GR	102	0	9	0	40	3	0	0	14	29684	0	0	792	0	1	0	0	0	1	0	0
HU	51	0	0	0	3	0	0	0	0	0	546	0	144	0	0	0	0	0	0	0	4
IE	15	41	11	0	152	20	21	0	241	0	0	0	39	0	71	2	0	0	15	0	2472
IT	1457	4	111	63	607	76	932	3	2612	792	144	39	80116	0	35	4	169	23	48	34	91
LU	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	3
NL	28	14	0	0	321	52	24	4	182	1	0	71	35	0	0	14	0	2	51	0	160
NO	4	5	1	1	79	55	0	14	11	0	0	2	4	0	14	6	0	0	195	0	33
PL	440	0	0	81	1763	158	0	0	0	0	0	0	169	0	0	0	9104	0	0	0	33
PT	3	2	10	0	10	0	7587	0	171	0	0	0	23	0	2	0	0	7034	0	0	23
SE	52	5	2	1	503	360	4	382	52	1	0	15	48	0	51	195	0	0	4055	1	98
SI	55	0	0	0	0	2	0	0	0	0	0	0	34	0	0	0	0	0	1	0	0
UK	29	104	25	1	298	58	219	4	1416	0	4	2472	91	3	160	33	33	23	98	0	16712

Table 7-5: Estimated transferred traffic to EPATS in thousand of passengers

TOTAL FLIGHTS	AT	BE	CH	CZ	DE	DK	ES	FI	FR	GR	HU	IE	IT	LU	NL	NO	PL	PT	SE	SI	UK
AT	162 497	-	-	15 341	14 763	2 305	22 360	792	50 061	16 234	3 843	2 410	143 493	-	3 314	677	33 055	528	8 270	4 124	4 610
BE	-	-	-	-	467	-	1 677	136	11 824	49	-	4 578	600	-	1 060	867	-	353	744	-	8 976
CH	-	-	-	-	915	-	6 853	162	19 186	1 422	-	1 714	14 790	-	-	98	-	1 552	273	-	3 899
CZ	15 341	-	-	8 529	7 082	-	39	84	98	15	-	-	4 723	-	-	84	15 437	-	81	-	109
DE	14 763	467	915	7 082	340 578	12 819	17 019	9 239	106 086	6 284	223	24 135	73 900	-	24 100	11 765	167 441	1 599	62 080	-	46 515
DK	2 305	-	-	-	12 819	-	1 907	3 985	9 194	400	-	3 152	12 068	-	3 932	4 205	11 870	-	27 479	261	9 129
ES	22 360	1 677	6 853	39	17 019	1 907	7 024 641	-	865 700	-	-	3 354	144 170	227	3 801	-	-	593 370	640	-	34 708
FI	792	136	162	84	9 239	3 985	-	31 316	589	-	21	-	470	-	598	1 317	16	-	31 076	6	574
FR	50 061	11 824	19 186	98	106 086	9 194	865 700	589	3 900 393	2 281	-	33 668	281 940	270	18 066	1 697	-	24 110	8 234	-	164 663
GR	16 234	49	1 422	15	6 284	400	-	-	2 281	6 998 330	-	-	95 728	27	141	-	-	-	142	-	-
HU	3 843	-	-	-	223	-	-	21	-	-	155 987	-	10 820	-	-	14	-	-	4	-	636
IE	2 410	4 578	1 714	-	24 135	3 152	3 354	-	33 668	-	-	-	6 135	-	11 202	301	-	-	2 311	-	185 872
IT	143 493	600	14 790	4 723	73 900	12 068	144 170	470	281 940	95 728	10 820	6 135	11 661 605	-	5 620	617	20 357	3 634	7 691	2 578	14 523
LU	-	-	-	-	-	-	227	-	270	27	-	-	-	-	-	38	-	30	39	-	214
NL	3 314	1 060	-	-	24 100	3 932	3 801	598	18 066	141	-	11 202	5 620	-	-	2 278	-	374	5 846	34	18 666
NO	677	867	98	84	11 765	4 205	-	1 317	1 697	-	14	301	617	38	2 278	948	-	-	15 338	4	5 165
PL	33 055	-	-	15 437	167 441	11 870	-	16	-	-	-	-	20 357	-	-	-	1 386 787	-	-	-	5 260
PT	528	353	1 552	-	1 599	-	593 370	-	24 110	-	-	-	3 634	30	374	-	-	1 403 004	-	-	3 617
SE	8 270	744	273	81	62 080	27 479	640	31 076	8 234	142	4	2 311	7 691	39	5 846	15 338	-	-	673 259	127	15 517
SI	4 124	-	-	-	-	261	-	6	-	-	-	-	2 578	-	34	4	-	-	127	-	63
UK	4 610	8 976	3 899	109	46 515	9 129	34 708	574	164 663	-	636	185 872	14 523	214	18 666	5 165	5 260	3 617	15 517	63	1 689 527

Table 7-6: Estimated number of EPATS flights

Annex 15: Estimated EPATS traffic in France

Partial scenario	Unit of traffic	Ile de France	Champagne-Ardennes	Picardie	Haute Normandie	Centre	Basse Normandie	Bourgogne	Nord-Pas-de-Calais	Lorraine	Alsace	Franche-Comté	Pays de la Loire	Bretagne
Region	Millions of PKM	FR10	FR21	FR22	FR23	FR24	FR25	FR26	FR30	FR41	FR42	FR43	FR51	FR52
Ile de France	FR10	-	-	-	-	-	-	-	-	-	-	-	-	-
Champagne-Ardennes	FR21	-	-	-	-	4 505	2 153	63 760	-	-	-	-	3 777	4 563
Picardie	FR22	-	-	-	-	-	36 068	-	-	-	-	-	-	-
Haute Normandie	FR23	-	-	-	-	6 298	-	2 956	-	-	-	-	5 570	9 298
Centre	FR24	-	4 505	-	6 298	-	26 362	4 341	4 904	3 603	-	1 847	-	121 289
Basse Normandie	FR25	-	2 153	36 068	-	26 362	-	2 247	5 703	1 888	2 148	821	40 285	-
Bourgogne	FR26	-	63 760	-	2 956	4 341	2 247	-	-	75 640	-	-	3 960	4 673
Nord-Pas-de-Calais	FR30	-	-	-	-	4 904	5 703	-	-	-	-	-	-	-
Lorraine	FR41	-	-	-	-	3 603	1 888	75 640	-	-	-	-	3 304	3 928
Alsace	FR42	-	-	-	-	-	2 148	-	-	-	-	-	-	-
Franche-Comté	FR43	-	-	-	-	1 847	821	-	-	-	-	-	1 400	1 627
Pays de la Loire	FR51	-	3 777	-	5 570	-	40 285	3 960	-	3 304	-	1 400	-	-
Bretagne	FR52	-	4 563	-	9 298	121 289	-	4 673	-	3 928	-	1 627	-	-
Poitou-Charentes	FR53	-	2 247	2 308	3 231	-	3 577	2 544	2 729	1 977	3 539	1 152	82 352	54 191
Aquitaine	FR61	-	2 521	-	3 562	30 169	4 122	5 368	-	3 725	-	2 536	30 007	20 869
Midi-Pyrénées	FR62	-	2 334	-	2 111	11 535	2 374	5 171	3 142	2 869	-	2 589	13 251	10 225
Limousin	FR63	-	826	768	1 044	13 308	908	1 571	1 130	836	921	696	8 478	2 343
Rhone-Alpes	FR71	-	-	-	-	24 397	6 517	-	-	-	-	-	14 787	-
Auvergne	FR72	-	1 537	1 516	2 062	7 523	1 591	24 086	1 920	1 794	2 151	2 653	4 017	4 655
Languedoc Roussilon	FR81	-	1 309	-	1 477	2 971	1 261	5 729	-	1 777	-	2 747	3 654	4 491
Provence-Alpes-Cote d'Azur	FR82	-	4 203	-	-	8 030	4 944	18 196	-	-	-	-	11 885	13 211
Corse	FR83	-	178	-	115	336	109	462	-	340	-	361	249	248

Table 7-7: Estimated millions of PKM potentially transferred to EPATS on French domestic EPATS connections (1/2)

Partial scenario	Unit of traffic	Ile de France	Champagne-Ardennes	Picardie	Haute Normandie	Centre	Basse Normandie	Bourgogne	Nord-Pas-de-Calais	Lorraine	Alsace	Franche-Comté	Pays de la Loire	Bretagne
Region	Millions of PKM	FR10	FR21	FR22	FR23	FR24	FR25	FR26	FR30	FR41	FR42	FR43	FR51	FR52
Ile de France	FR10	-	-	-	-	-	-	-	-	-	-	-	-	-
Champagne-Ardennes	FR21	-	-	-	-	4 505	2 153	63 760	-	-	-	-	3 777	4 563
Picardie	FR22	-	-	-	-	-	36 068	-	-	-	-	-	-	-
Haute Normandie	FR23	-	-	-	-	6 298	-	2 956	-	-	-	-	5 570	9 298
Centre	FR24	-	4 505	-	6 298	-	26 362	4 341	4 904	3 603	-	1 847	-	121 289
Basse Normandie	FR25	-	2 153	36 068	-	26 362	-	2 247	5 703	1 888	2 148	821	40 285	-
Bourgogne	FR26	-	63 760	-	2 956	4 341	2 247	-	-	75 640	-	-	3 960	4 673
Nord-Pas-de-Calais	FR30	-	-	-	-	4 904	5 703	-	-	-	-	-	-	-
Lorraine	FR41	-	-	-	-	3 603	1 888	75 640	-	-	-	-	3 304	3 928
Alsace	FR42	-	-	-	-	-	2 148	-	-	-	-	-	-	-
Franche-Comté	FR43	-	-	-	-	1 847	821	-	-	-	-	-	1 400	1 627
Pays de la Loire	FR51	-	3 777	-	5 570	-	40 285	3 960	-	3 304	-	1 400	-	-
Bretagne	FR52	-	4 563	-	9 298	121 289	-	4 673	-	3 928	-	1 627	-	-
Poitou-Charentes	FR53	-	2 247	2 308	3 231	-	3 577	2 544	2 729	1 977	3 539	1 152	82 352	54 191
Aquitaine	FR61	-	2 521	-	3 562	30 169	4 122	5 368	-	3 725	-	2 536	30 007	20 869
Midi-Pyrénées	FR62	-	2 334	-	2 111	11 535	2 374	5 171	3 142	2 869	-	2 589	13 251	10 225
Limousin	FR63	-	826	768	1 044	13 308	908	1 571	1 130	836	921	696	8 478	2 343
Rhone-Alpes	FR71	-	-	-	-	24 397	6 517	-	-	-	-	-	14 787	-
Auvergne	FR72	-	1 537	1 516	2 062	7 523	1 591	24 086	1 920	1 794	2 151	2 653	4 017	4 655
Languedoc Roussilon	FR81	-	1 309	-	1 477	2 971	1 261	5 729	-	1 777	-	2 747	3 654	4 491
Provence-Alpes-Cote d'Azur	FR82	-	4 203	-	-	8 030	4 944	18 196	-	-	-	-	11 885	13 211
Corse	FR83	-	178	-	115	336	109	462	-	340	-	361	249	248

Table 7-8: Estimated millions of PKM potentially transferred to EPATS on French domestic EPATS connections (2/2)

Partial scenario	Unit of traffic	Ile de France	Champagne-Ardennes	Picardie	Haute Normandie	Centre	Basse Normandie	Bourgogne	Nord-Pas-de-Calais	Lorraine	Alsace	Franche-Comté	Pays de la Loire	Bretagne
Region	**Thousand of PAX**	**FR10**	**FR21**	**FR22**	**FR23**	**FR24**	**FR25**	**FR26**	**FR30**	**FR41**	**FR42**	**FR43**	**FR51**	**FR52**
Ile de France	FR10	-	-	-	-	-	-	-	-	-	-	-	-	-
Champagne-Ardennes	FR21	-	-	-	-	60	29	223	-	-	-	-	50	61
Picardie	FR22	-	-	-	-	-	126	-	-	-	-	-	-	-
Haute Normandie	FR23	-	-	-	-	84	-	39	-	-	-	-	74	124
Centre	FR24	-	60	-	84	-	92	58	65	48	-	25	-	425
Basse Normandie	FR25	-	29	126	-	92	-	30	76	25	29	11	141	-
Bourgogne	FR26	-	223	-	39	58	30	-	-	265	-	-	53	62
Nord-Pas-de-Calais	FR30	-	-	-	-	65	76	-	-	-	-	-	-	-
Lorraine	FR41	-	-	-	-	48	25	265	-	-	-	-	44	52
Alsace	FR42	-	-	-	-	-	29	-	-	-	-	-	-	-
Franche-Comté	FR43	-	-	-	-	25	11	-	-	-	-	-	19	22
Pays de la Loire	FR51	-	50	-	74	-	141	53	-	44	-	19	-	-
Bretagne	FR52	-	61	-	124	425	-	62	-	52	-	22	-	-
Poitou-Charentes	FR53	-	30	31	43	-	48	34	36	26	47	15	288	190
Aquitaine	FR61	-	34	-	47	401	55	71	-	50	-	34	399	278
Midi-Pyrénées	FR62	-	31	-	28	153	32	69	42	38	-	34	176	136
Limousin	FR63	-	11	10	14	47	12	21	15	11	12	9	30	31
Rhone-Alpes	FR71	-	-	-	-	324	87	-	-	-	-	-	197	-
Auvergne	FR72	-	20	20	27	100	21	84	26	24	29	35	53	62
Languedoc Roussilon	FR81	-	17	-	20	40	17	76	-	24	-	37	49	60
Provence-Alpes-Cote d'Azur	FR82	-	56	-	-	107	31	242	-	-	-	-	158	83
Corse	FR83	-	1	-	1	2	1	6	-	2	-	5	2	2

Table 7-9: Estimated thousands of passengers potentially transferred to EPATS on French domestic EPATS connections 51/2°

Partial scenario	Unit of traffic	Ile de France	Champagne-Ardennes	Picardie	Haute Normandie	Centre	Basse Normandie	Bourgogne	Nord-Pas-de-Calais	Lorraine	Alsace	Franche-Comté	Pays de la Loire	Bretagne
Region	Thousand of PAX	FR10	FR21	FR22	FR23	FR24	FR25	FR26	FR30	FR41	FR42	FR43	FR51	FR52
Ile de France	FR10	-	-	-	-	-	-	-	-	-	-	-	-	-
Champagne-Ardennes	FR21	-	-	-	-	60	29	223	-	-	-	-	50	61
Picardie	FR22	-	-	-	-	-	126	-	-	-	-	-	-	-
Haute Normandie	FR23	-	-	-	-	84	-	39	-	-	-	-	74	124
Centre	FR24	-	60	-	84	-	92	58	65	48	-	25	-	425
Basse Normandie	FR25	-	29	126	-	92	-	30	76	25	29	11	141	-
Bourgogne	FR26	-	223	-	39	58	30	-	-	265	-	-	53	62
Nord-Pas-de-Calais	FR30	-	-	-	-	65	76	-	-	-	-	-	-	-
Lorraine	FR41	-	-	-	-	48	25	265	-	-	-	-	44	52
Alsace	FR42	-	-	-	-	-	29	-	-	-	-	-	-	-
Franche-Comté	FR43	-	-	-	-	25	11	-	-	-	-	-	19	22
Pays de la Loire	FR51	-	50	-	74	-	141	53	-	44	-	19	-	-
Bretagne	FR52	-	61	-	124	425	-	62	-	52	-	22	-	-
Poitou-Charentes	FR53	-	30	31	43	-	48	34	36	26	47	15	288	190
Aquitaine	FR61	-	34	-	47	401	55	71	-	50	-	34	399	278
Midi-Pyrénées	FR62	-	31	-	28	153	32	69	42	38	-	34	176	136
Limousin	FR63	-	11	10	14	47	12	21	15	11	12	9	30	31
Rhone-Alpes	FR71	-	-	-	-	324	87	-	-	-	-	-	197	-
Auvergne	FR72	-	20	20	27	100	21	84	26	24	29	35	53	62
Languedoc Roussilon	FR81	-	17	-	20	40	17	76	-	24	-	37	49	60
Provence-Alpes-Cote d'Azur	FR82	-	56	-	-	107	31	242	-	-	-	-	158	83
Corse	FR83	-	1	-	1	2	1	6	-	2	-	5	2	2

Table 7-10: Estimated thousands of passengers potentially transferred to EPATS on French domestic EPATS connections (2/2)

Partial scenario	Unit of traffic	Ile de France	Champagne-Ardennes	Picardie	Haute Normandie	Centre	Basse Normandie	Bourgogne	Nord-Pas-de-Calais	Lorraine	Alsace	Franche-Comté	Pays de la Loire	Bretagne
Region	**Number of FLIGHTS**	**FR10**	**FR21**	**FR22**	**FR23**	**FR24**	**FR25**	**FR26**	**FR30**	**FR41**	**FR42**	**FR43**	**FR51**	**FR52**
Ile de France	FR10	-	-	-	-	-	-	-	-	-	-	-	-	-
Champagne-Ardennes	FR21	-	-	-	-	4 505	2 153	63 760	-	-	-	-	3 777	4 563
Picardie	FR22	-	-	-	-	-	36 068	-	-	-	-	-	-	-
Haute Normandie	FR23	-	-	-	-	6 298	-	2 956	-	-	-	-	5 570	9 298
Centre	FR24	-	4 505	-	6 298	-	26 362	4 341	4 904	3 603	-	1 847	-	121 289
Basse Normandie	FR25	-	2 153	36 068	-	26 362	-	2 247	5 703	1 888	2 148	821	40 285	-
Bourgogne	FR26	-	63 760	-	2 956	4 341	2 247	-	-	75 640	-	-	3 960	4 673
Nord-Pas-de-Calais	FR30	-	-	-	-	4 904	5 703	-	-	-	-	-	-	-
Lorraine	FR41	-	-	-	-	3 603	1 888	75 640	-	-	-	-	3 304	3 928
Alsace	FR42	-	-	-	-	-	2 148	-	-	-	-	-	-	-
Franche-Comté	FR43	-	-	-	-	1 847	821	-	-	-	-	-	1 400	1 627
Pays de la Loire	FR51	-	3 777	-	5 570	-	40 285	3 960	-	3 304	-	1 400	-	-
Bretagne	FR52	-	4 563	-	9 298	121 289	-	4 673	-	3 928	-	1 627	-	-
Poitou-Charentes	FR53	-	2 247	2 308	3 231	-	3 577	2 544	2 729	1 977	3 539	1 152	82 352	54 191
Aquitaine	FR61	-	2 521	-	3 562	30 169	4 122	5 368	-	3 725	-	2 536	30 007	20 869
Midi-Pyrénées	FR62	-	2 334	-	2 111	11 535	2 374	5 171	3 142	2 869	-	2 589	13 251	10 225
Limousin	FR63	-	826	768	1 044	13 308	908	1 571	1 130	836	921	696	8 478	2 343
Rhone-Alpes	FR71	-	-	-	-	24 397	6 517	-	-	-	-	-	14 787	-
Auvergne	FR72	-	1 537	1 516	2 062	7 523	1 591	24 086	1 920	1 794	2 151	2 653	4 017	4 655
Languedoc Roussilon	FR81	-	1 309	-	1 477	2 971	1 261	5 729	-	1 777	-	2 747	3 654	4 491
Provence-Alpes-Cote d'Azur	FR82	-	4 203	-	-	8 030	4 944	18 196	-	-	-	-	11 885	13 211
Corse	FR83	-	178	-	115	336	109	462	-	340	-	361	249	248

Table 7-11: Estimated number of EPATS flights on French domestic EPATS connections (1/2)

Partial scenario	Unit of traffic	Ile de France	Champagne-Ardennes	Picardie	Haute Normandie	Centre	Basse Normandie	Bourgogne	Nord-Pas-de-Calais	Lorraine	Alsace	Franche-Comté	Pays de la Loire	Bretagne
Region	Number of FLIGHTS	FR10	FR21	FR22	FR23	FR24	FR25	FR26	FR30	FR41	FR42	FR43	FR51	FR52
Ile de France	FR10	-	-	-	-	-	-	-	-	-	-	-	-	-
Champagne-Ardennes	FR21	-	-	-	-	4 505	2 153	63 760	-	-	-	-	3 777	4 563
Picardie	FR22	-	-	-	-	-	36 068	-	-	-	-	-	-	-
Haute Normandie	FR23	-	-	-	-	6 298	-	2 956	-	-	-	-	5 570	9 298
Centre	FR24	-	4 505	-	6 298	-	26 362	4 341	4 904	3 603	-	1 847	-	121 289
Basse Normandie	FR25	-	2 153	36 068	-	26 362	-	2 247	5 703	1 888	2 148	821	40 285	-
Bourgogne	FR26	-	63 760	-	2 956	4 341	2 247	-	-	75 640	-	-	3 960	4 673
Nord-Pas-de-Calais	FR30	-	-	-	-	4 904	5 703	-	-	-	-	-	-	-
Lorraine	FR41	-	-	-	-	3 603	1 888	75 640	-	-	-	-	3 304	3 928
Alsace	FR42	-	-	-	-	-	2 148	-	-	-	-	-	-	-
Franche-Comté	FR43	-	-	-	-	1 847	821	-	-	-	-	-	1 400	1 627
Pays de la Loire	FR51	-	3 777	-	5 570	-	40 285	3 960	-	3 304	-	1 400	-	-
Bretagne	FR52	-	4 563	-	9 298	121 289	-	4 673	-	3 928	-	1 627	-	-
Poitou-Charentes	FR53	-	2 247	2 308	3 231	-	3 577	2 544	2 729	1 977	3 539	1 152	82 352	54 191
Aquitaine	FR61	-	2 521	-	3 562	30 169	4 122	5 368	-	3 725	-	2 536	30 007	20 869
Midi-Pyrénées	FR62	-	2 334	-	2 111	11 535	2 374	5 171	3 142	2 869	-	2 589	13 251	10 225
Limousin	FR63	-	826	768	1 044	13 308	908	1 571	1 130	836	921	696	8 478	2 343
Rhone-Alpes	FR71	-	-	-	-	24 397	6 517	-	-	-	-	-	14 787	-
Auvergne	FR72	-	1 537	1 516	2 062	7 523	1 591	24 086	1 920	1 794	2 151	2 653	4 017	4 655
Languedoc Roussilon	FR81	-	1 309	-	1 477	2 971	1 261	5 729	-	1 777	-	2 747	3 654	4 491
Provence-Alpes-Cote d'Azur	FR82	-	4 203	-	-	8 030	4 944	18 196	-	-	-	-	11 885	13 211
Corse	FR83	-	178	-	115	336	109	462	-	340	-	361	249	248

Table 7-12: Estimated number of EPATS flights on French domestic EPATS connections (2/2)

Annex 16: Estimated EPATS traffic in Poland

Partial scenario		Dolnoslakie	Lubelskie	Lubuskie	Lodzkie	Malopolskie	Mazowieckie	Podkarpackie	Pomorskie	Slaskie	Warminsko-Mazurskie
Regions	Millions of PKM	PL01	PL03	PL04	PL05	PL06	PL07	PL09	PL0B	PL0C	PL0E
Dolnoslakie	PL01	0	0	0	90	45	180	75	0	0	0
Lubelskie	PL03	0	0	0	0	0	0	0	0	0	0
Lubuskie	PL04	0	0	0	0	0	91	0	56	0	0
Lodzkie	PL05	90	0	0	0	61	0	47	56	168	69
Malopolskie	PL06	45	0	0	61	0	725	0	90	0	102
Mazowieckie	PL07	180	0	91	0	725	0	170	294	388	429
Podkarpackie	PL09	75	0	0	47	0	170	0	0	297	0
Pomorskie	PL0B	0	0	56	56	90	294	0	0	89	0
Slaskie	PL0C	0	0	0	168	0	388	297	89	0	95
Warminsko-Mazurskie	PL0E	0	0	0	69	102	429	0	0	95	0
Wielkopolskie	PL0F	0	0	0	104	46	199	50	30	91	31

Table 7-13: Estimated millions of PKM potentially transferred to EPATS on Polish domestic EPATS connections

Partial scenario		Dolnoslakie	Lubelskie	Lubuskie	Lodzkie	Malopolskie	Mazowieckie	Podkarpackie	Pomorskie	Slaskie	Warminsko-Mazurskie
Regions	Thousand of PAX	PL01	PL03	PL04	PL05	PL06	PL07	PL09	PL0B	PL0C	PL0E
Dolnoslakie	PL01				393	171	501	176			
Lubelskie	PL03										
Lubuskie	PL04						203		166		
Lodzkie	PL05	393				246		150	139	801	205
Malopolskie	PL06	171			246		2 488		145		202
Mazowieckie	PL07	501		203		2 488		529	882	1 306	1 976
Podkarpackie	PL09	176			150		529			1 249	
Pomorskie	PL0B			166	139	145	882			160	
Slaskie	PL0C				801		1 306	1 249	160		185
Warminsko-Mazurskie	PL0E				205	202	1 976			185	
Wielkopolskie	PL0F				510	114	646	87	94	274	101

Table 7-14: Estimated thousands of passengers potentially transferred to EPATS on Polish domestic EPATS connections

Partial scenario		Dolnoslakie	Lubelskie	Lubuskie	Lodzkie	Malopolskie	Mazowieckie	Podkarpackie	Pomorskie	Slaskie	Warminsko-Mazurskie
Regions	Number of FLIGHTS	PL01	PL03	PL04	PL05	PL06	PL07	PL09	PL0B	PL0C	PL0E
Dolnoslakie	PL01				112 418	12 860	37 650	13 224			
Lubelskie	PL03										
Lubuskie	PL04						15 245		12 500		
Lodzkie	PL05	112 418				70 324		11 258	10 422	228 998	15 421
Malopolskie	PL06	12 860			70 324		187 054		10 891		15 172
Mazowieckie	PL07	37 650		15 245		187 054		39 746	66 333	98 169	564 451
Podkarpackie	PL09	13 224			11 258		39 746			356 755	
Pomorskie	PL0B			12 500	10 422	10 891	66 333			12 008	
Slaskie	PL0C				228 998		98 169	356 755	12 008		13 920
Warminsko-Mazurskie	PL0E				15 421	15 172	564 451			13 920	
Wielkopolskie	PL0F				145 779	8 539	48 547	6 553	7 047	20 614	7 607

Table 7-15: Estimated number of EPATS flights on Polish domestic EPATS connections