

Commission prospective

Comment volerons-nous en 2050 ?

or

« The challenges of air transport by 2050 »

(Alain GARCIA)

Toute reproduction interdite



Académie de l'Air et de l'Espace
Air and Space Academy

Objectives of the Foresight Commission

- To reflect on the challenges facing civil air transport by 2050, *calling on:*
 - Academy members
 - Other experts from aviation and space sectors
- To issue recommendations
 - Initial report published in June 2011 (for Paris air show)
 - Conference 2nd quarter 2012, followed by consolidated report

Thematic areas (sectors)

- Demographics, Society, Economics
- Market Volume
- Aircraft Manufacture
- Energy
- Environment
- Operating structures
- Air Traffic Management (ATM)
- Quality of Service (including Security)
- Contribution of Space to Aviation

Original approach: inter-sectoral study

Market Volume

A new approach to the market (passengers) for 3 reasons:

- *current forecasts optimistic as regards long-term trends*
- *correlation between air passenger turnover and world GDP*
- *integrating air traffic into all journeys (passengers)*

•Demographics

source: UN/ESA World Population Prospects

The 2010 revision - Medium variant

Populations

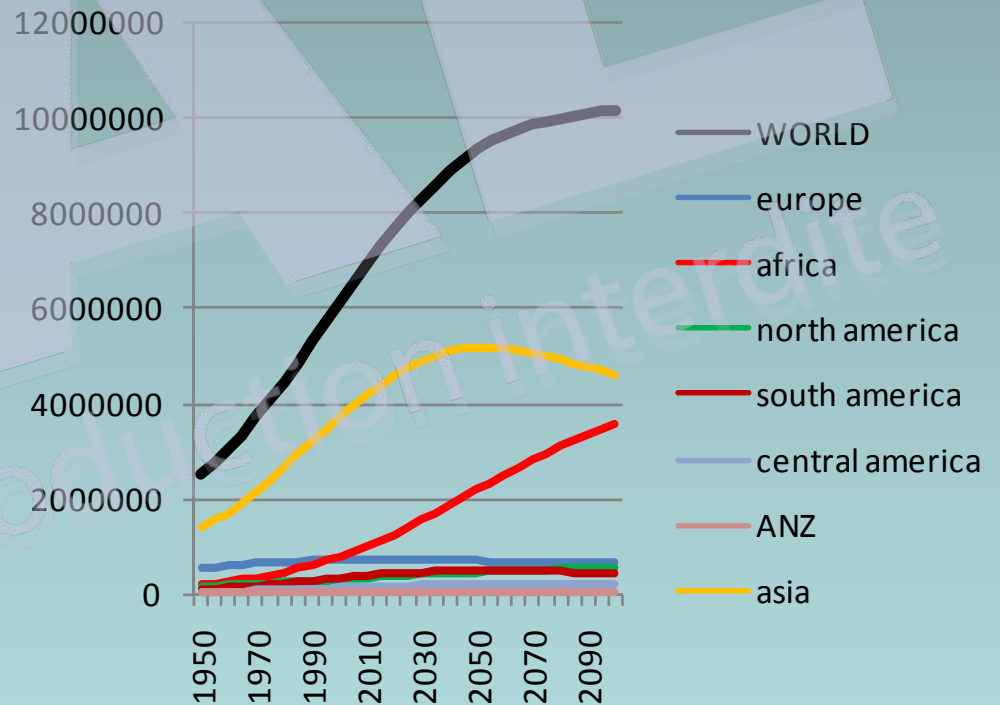
From now to 2100: 10
billions

Europe decreasing after
2020

North America still growing

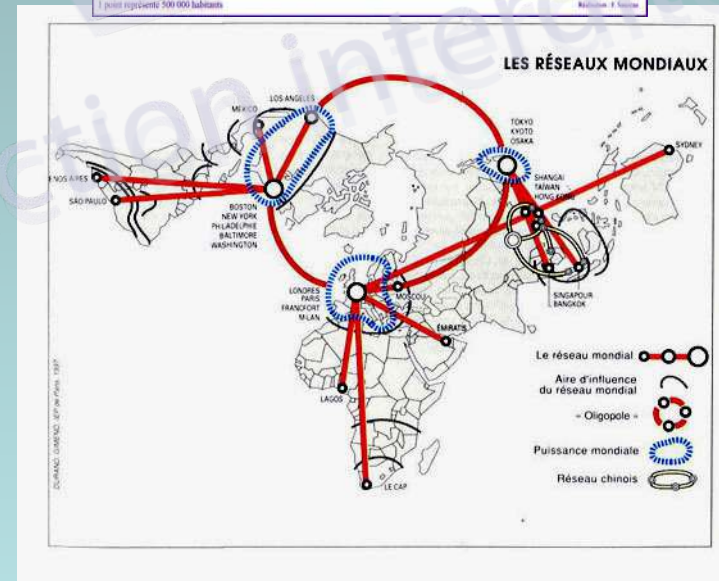
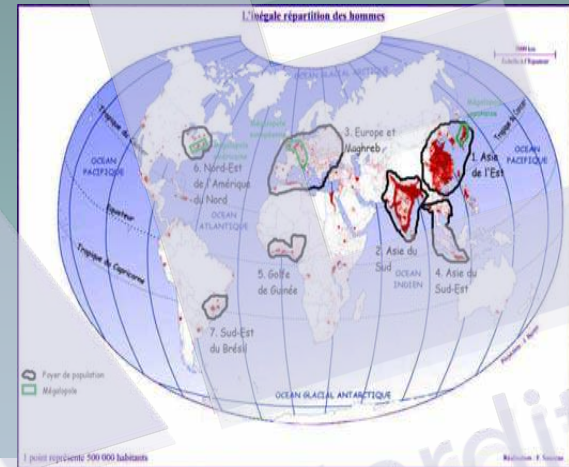
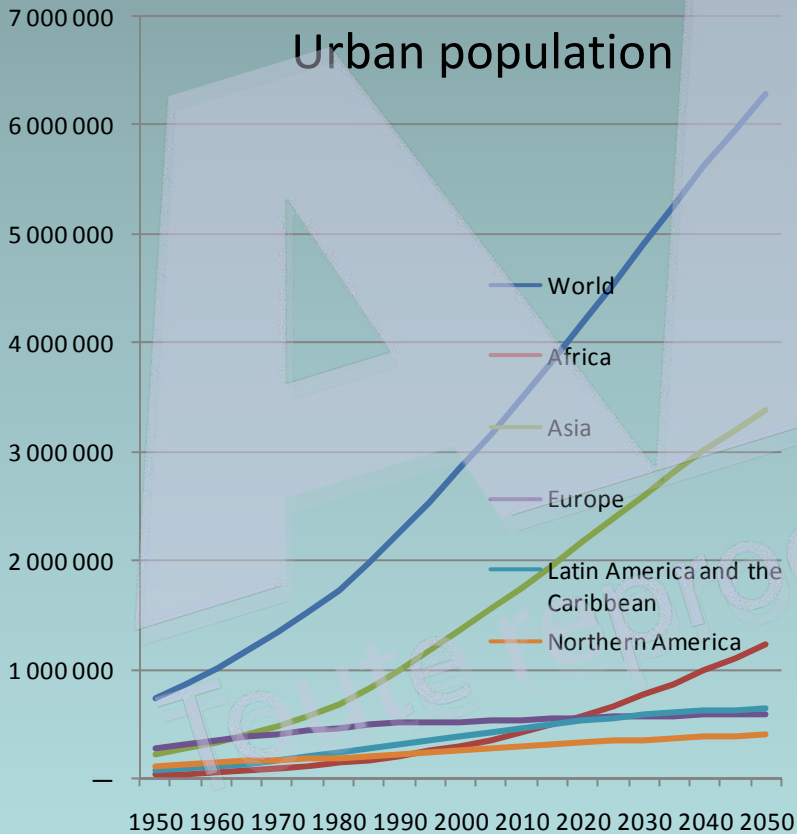
Asia decreasing after 2050

Africa almost 1/3 of the
world!



Society

Urbanisation and Megalopolises



2 – MODEL FOR SCHEDULED TRAFFIC

1 – Bases for models

- **air traffic integrated into all passenger journeys**
(in competition with other modes of transport for trips < 1000 km, in a quasi monopoly situation for routes > 1000 km)
- **traffic unit (all modes of transport): proportional to GDP per person.**
- **ratio of global passenger air transport turnover to GDP**

$$\text{Traffic}(PKT) = \frac{(\text{ratio.Avia.T.O} / \text{GDP}) \times (\text{GDP.in}.\$.ec2010)}{(\text{ticket.price.in}.\$.ec2010.\text{per.passenger} \times \text{km})}$$

with: - cf graph: $(\text{ratio} / \text{GDP})\text{in}\% = 0,85 - 0,1 \times e^{-0,03 \times (T-2010)}$

- evolution in GDP indicated below

- ticket price reflecting cost-effectiveness measures and oil prices

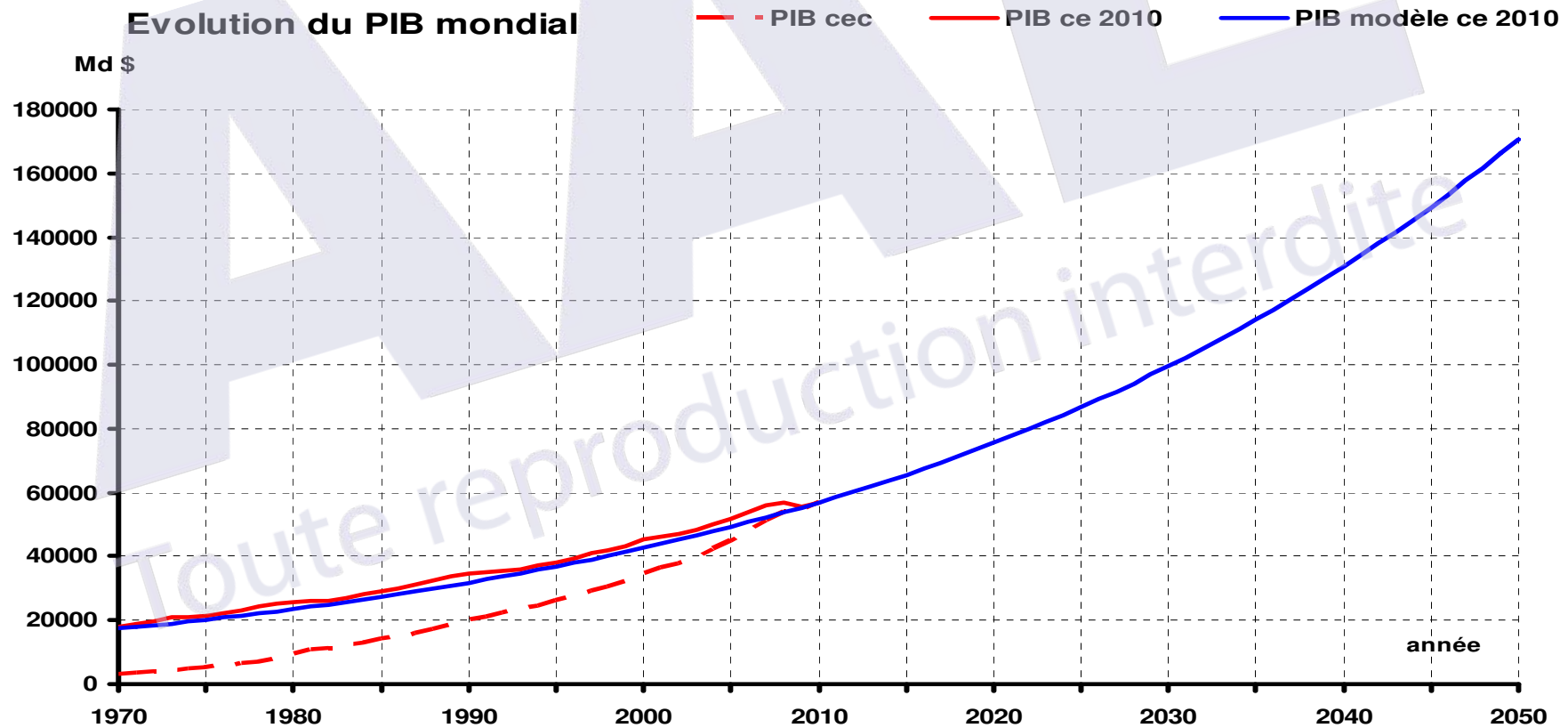
2 – MODEL FOR SCHEDULED TRAFFIC

1 - Model Bases:

- **evolution of global GDP (World Bank): economic conditions for 2010, multiplying factor of:**

3.1 observed between 1970 and 2010 (2.9% on average per year)

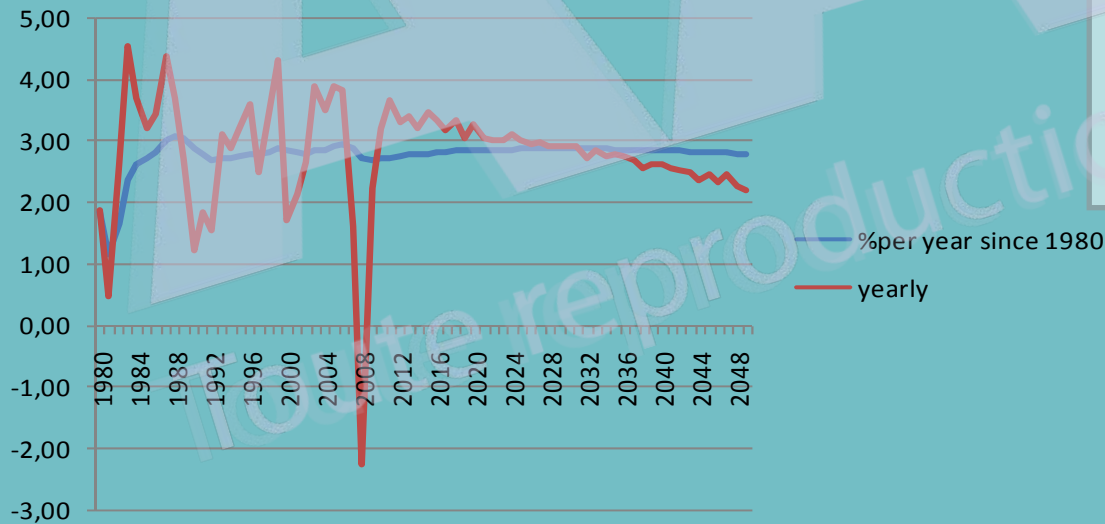
3.0 forecast between 2010 and 2050 (2.8% on average per year)



The world economy in 2050: a tentative picture

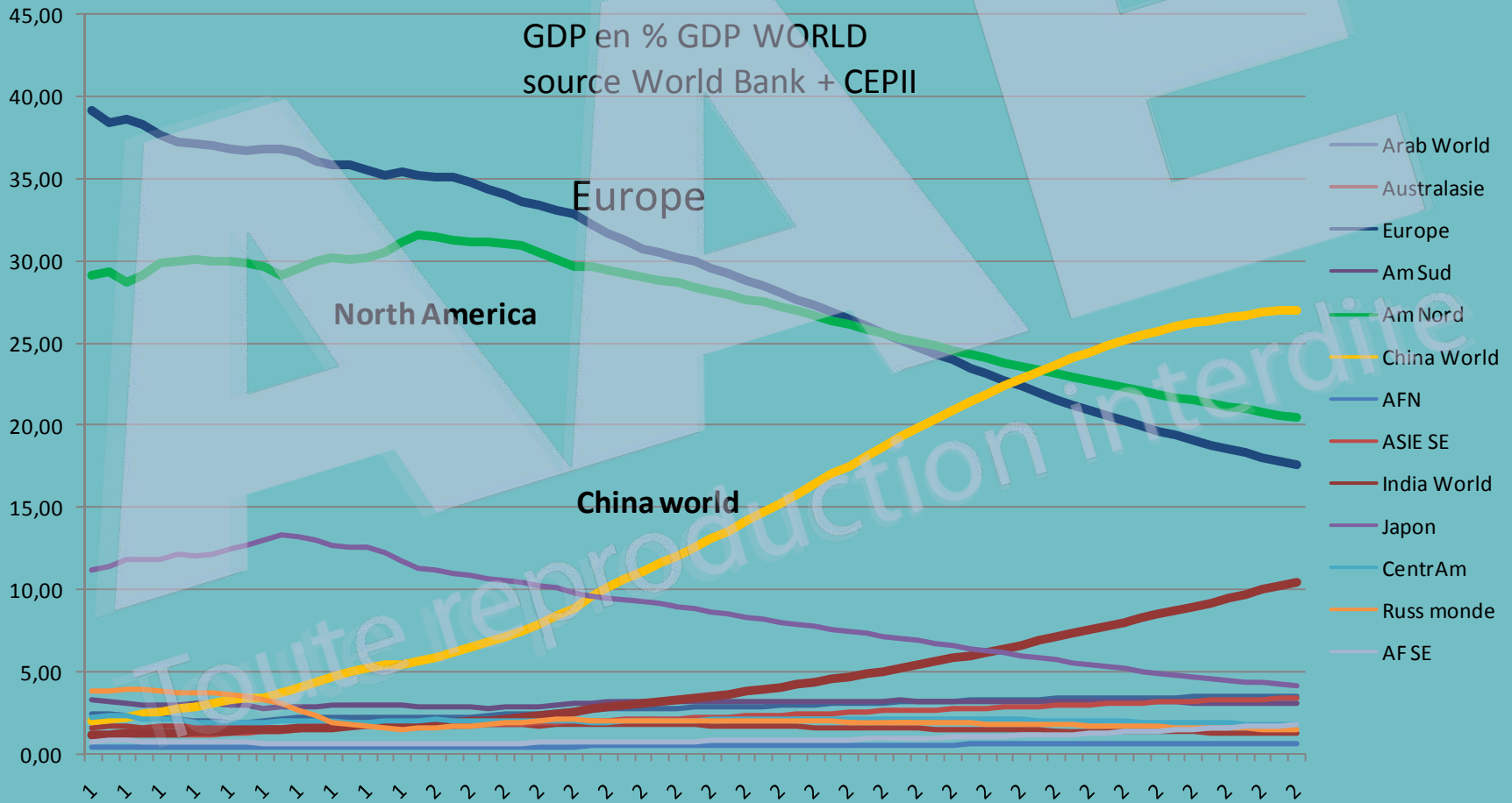
Jean Fouré, Agnès Bénassy-Quéré & Lionel Fontagné

**World GDP growth
%per year since 1980
% per year
(source WB+ CEPII)**



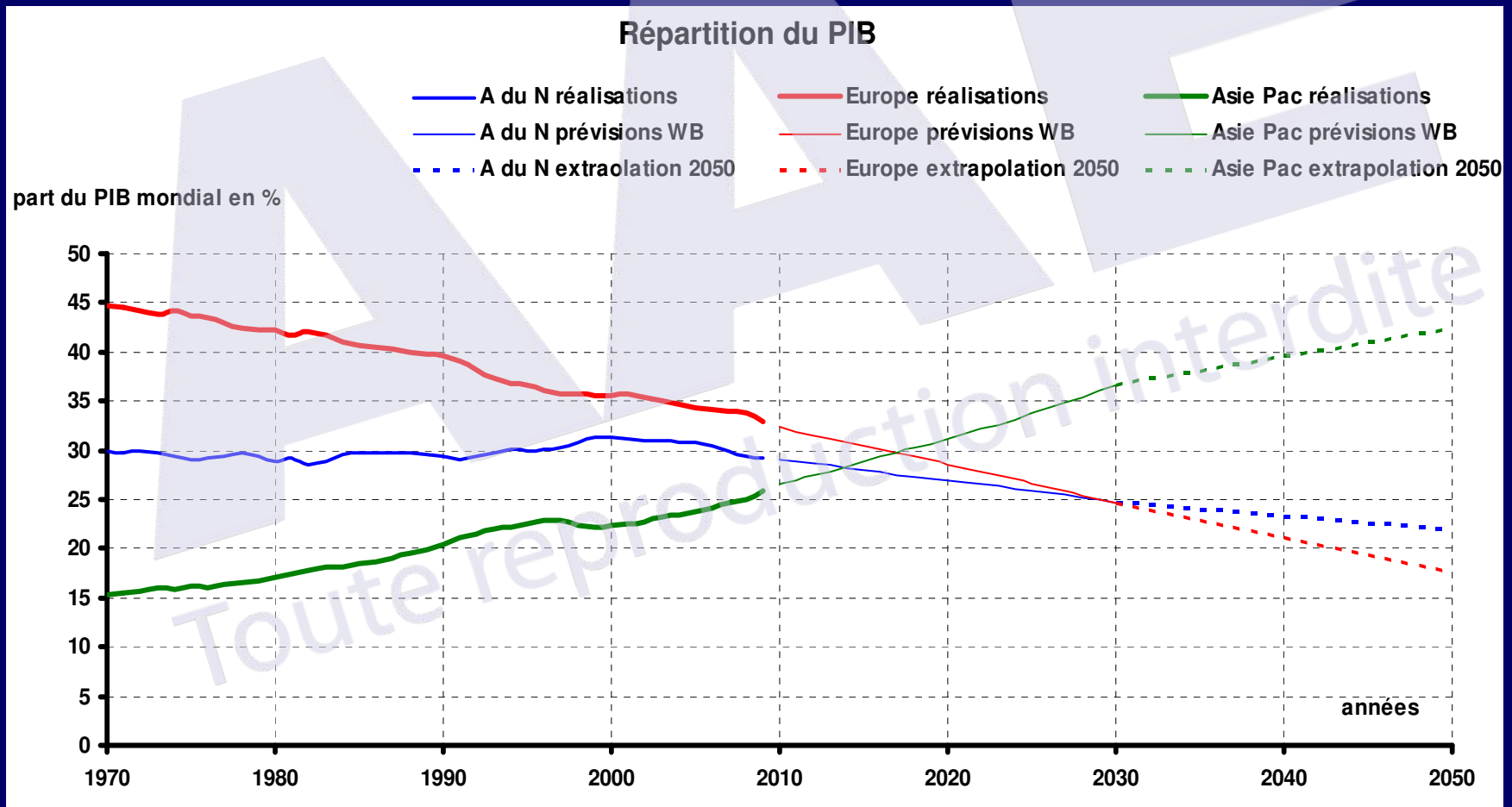
**2050/2010
x3 or 2.8% y**

The relative weight of GDP in different zones is important for the traffic



2 - MODEL FOR SCHEDULED TRAFFIC

- **geographic spread** according to "WB+CEPII" till 2030 and by extrapolation between 2030 and 2050; a relative slowdown of Europe is obvious with an average growth of around 1%



2 – MODEL FOR SCHEDULED TRAFFIC

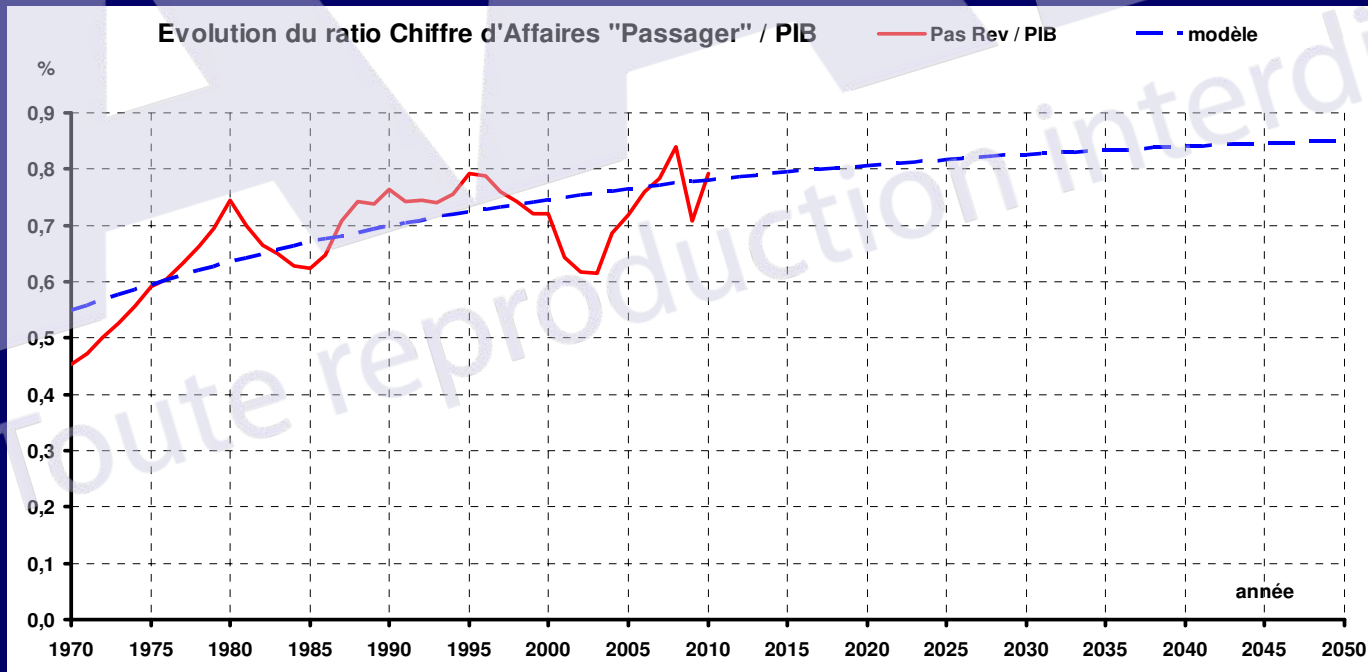
1 - Model Bases

- Ratio of global passenger air transport turnover to GDP

The ratio represents around 0.85 of GDP. This result can be observed:

- on a global scale,
- on a regional scale.

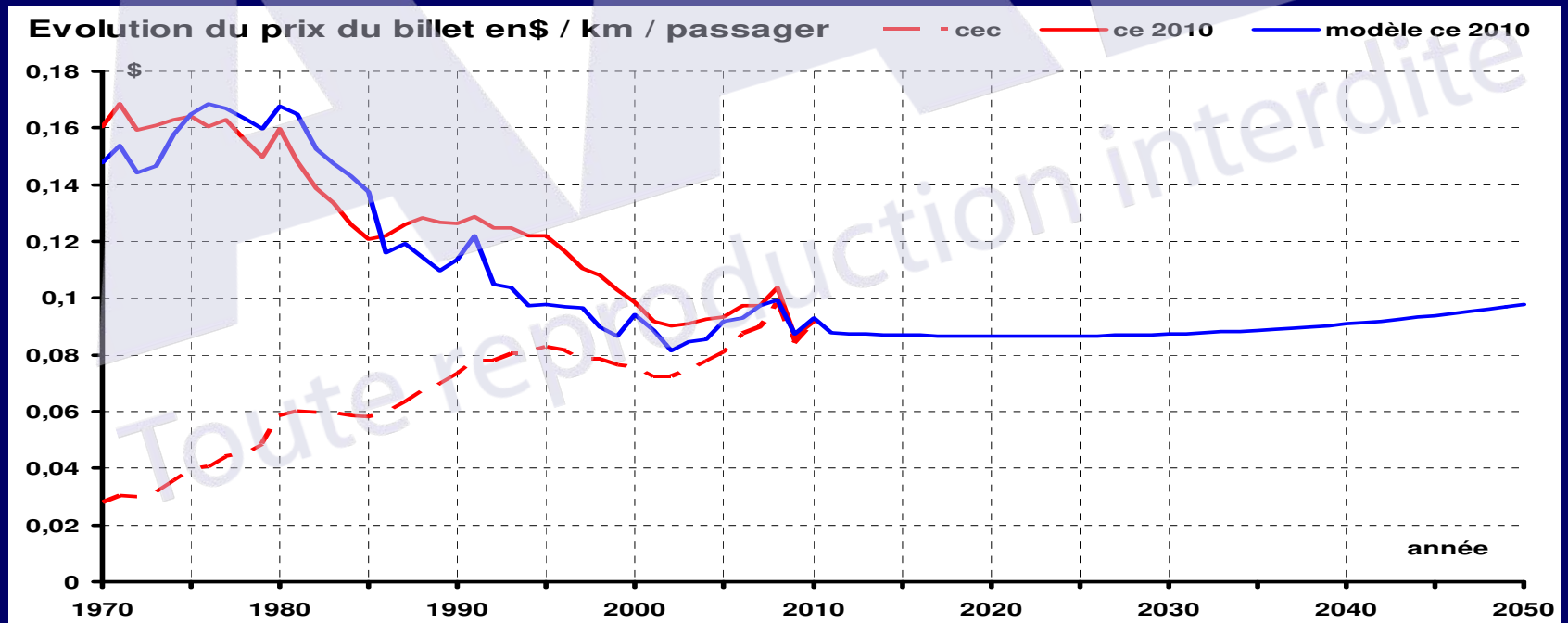
These figures were provided by Boeing.



2 – MODEL FOR SCHEDULED TRAFFIC

- Ticket price in \$ / km / pax

- average value = turnover / PKT in 2010
- multiplication by 0.6 between 1970 and 2010 (-1.3% per year)
- model taking into account improved cost effectiveness and the changing price of petrol



3 – RESULTS

2 - Evolution in traffic

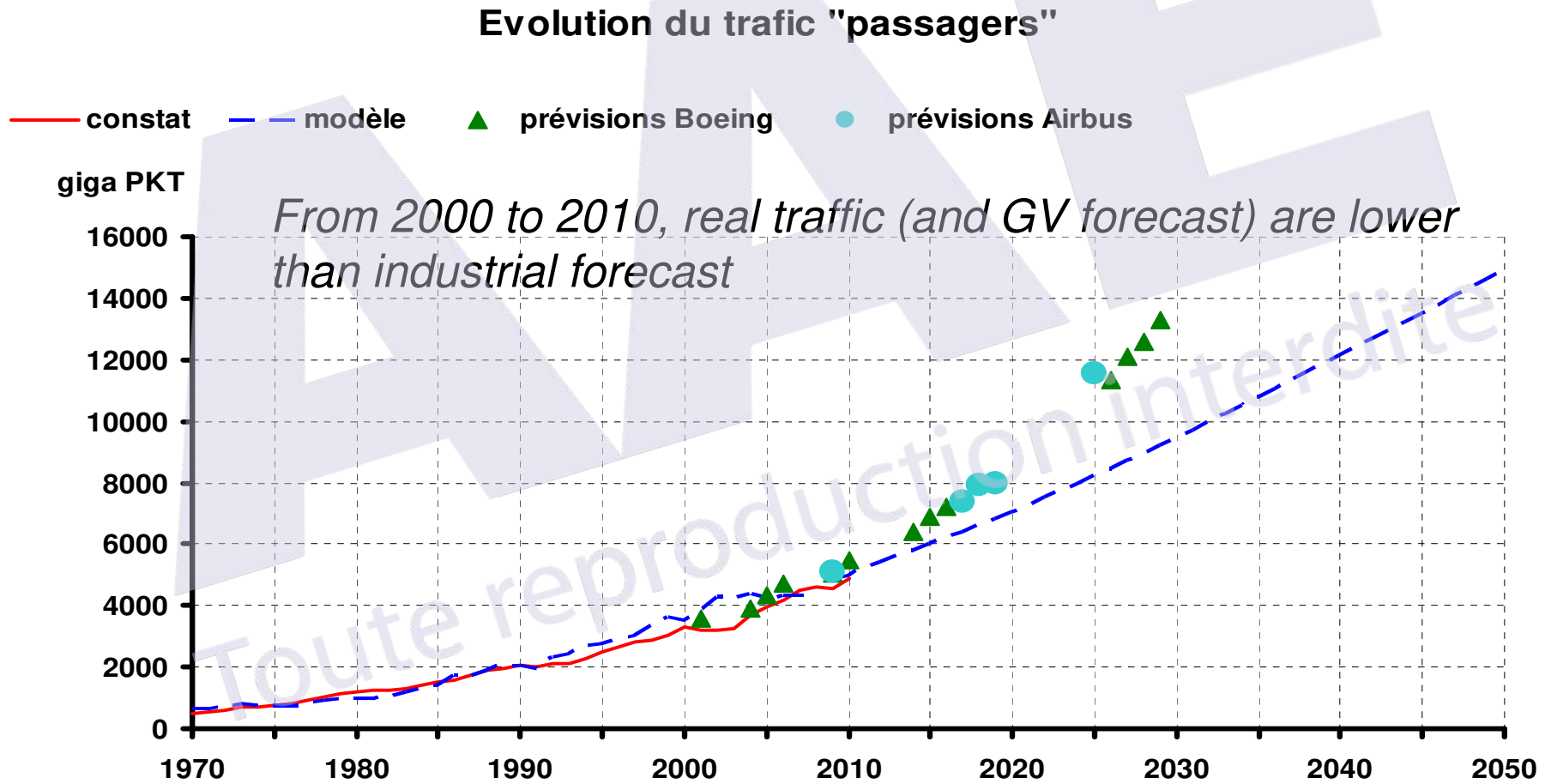
	2010 Observation (model)	2030 Boeing (model)	2050 Estimated (model)
Hypotheses			
Income comp. % of GDP	0,79 (0,78)	0,825	(0,85)
World GDP in giga \$2010	56 (57)	(170)	(170)
Europe GDP in %	33%	(24,6%)	(17,5%)
Oil price (barrel in \$)	80 (80)	(130)	(250)
World traffic			
Traffic (in Trillion RPK)	4,9 (4,8)	13,3 (9,5)	(14,9)
Average distance (km)	1850(1860)	(2000)	(2300)
Number of flights (1000)	27000 (26000)	(50000)	(52000)
Average capacity (seats)	120 (120)	(145)	(150)
European traffic			
Traffic (in Trillion RPK)	1,4	(2,15)	(2,25)

* the low level of traffic in Europe is due to:

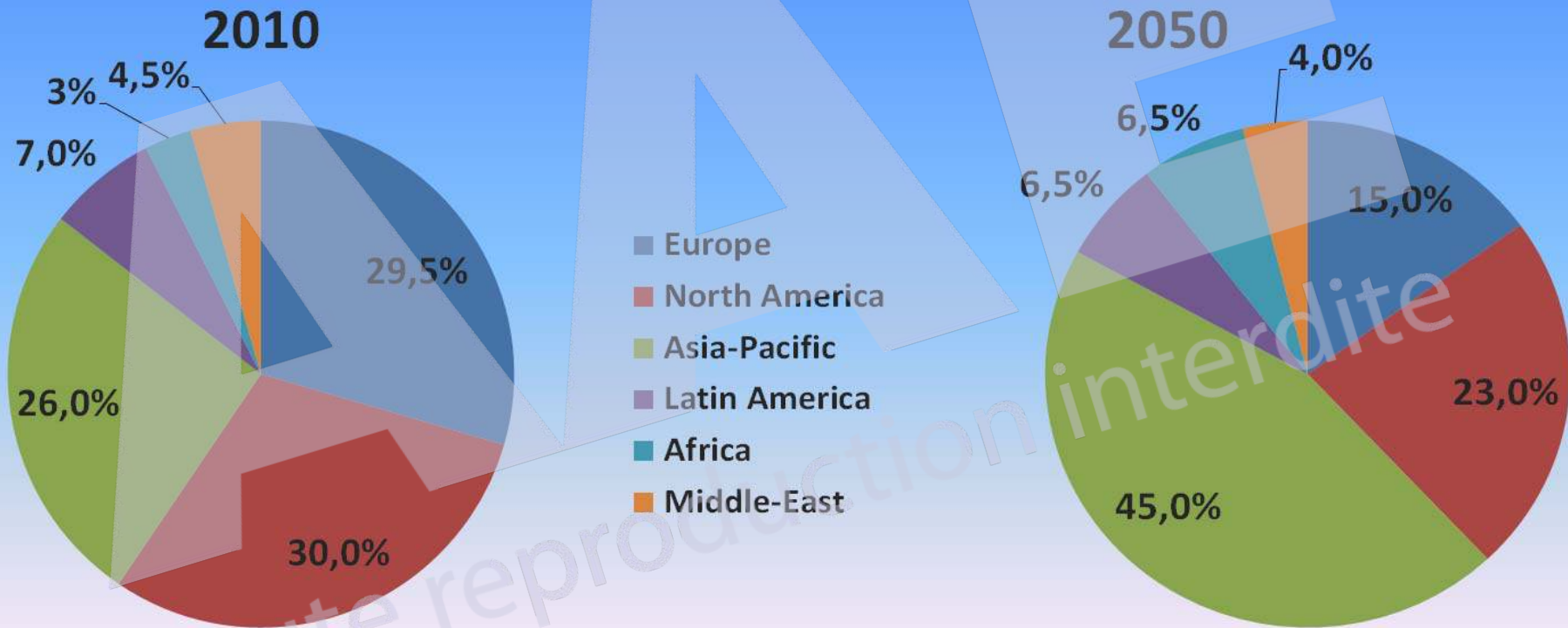
- limited GDP growth (1% per year),
- competition from ground transport (high-speed rail)

3 – Result in Initial Report (2011)

3 – Yearly «passenger» traffic in RPK:



Distribution of air traffic per region

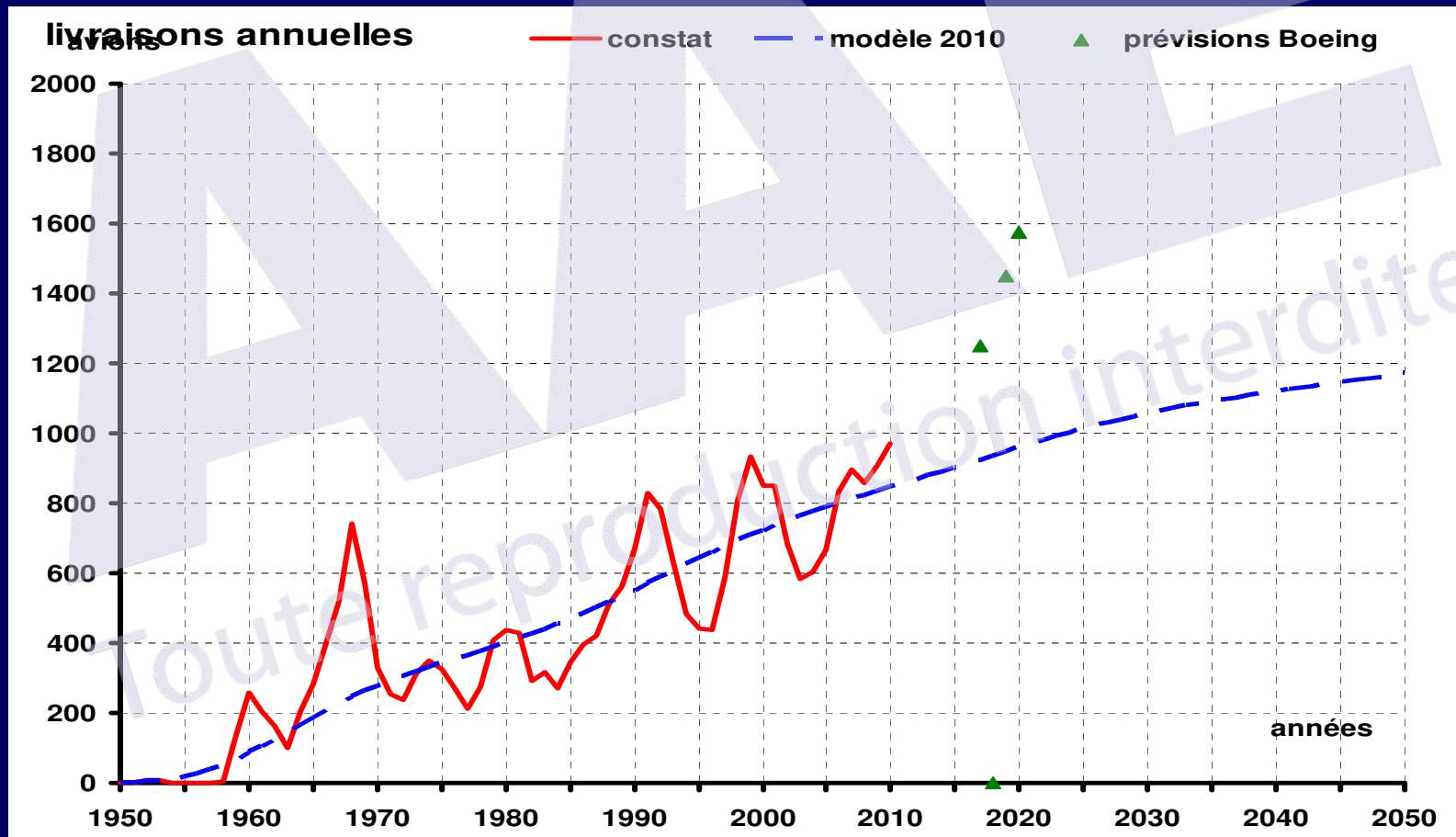


* 2009 distribution used as reference

3 – RESULTS

4 - Evolution in deliveries (airliners)

- Please note:
- - strong fluctuations due to economic disturbance exacerbated by players' actions (airlines and manufacturers)
- - impact of forecast traffic growth hypotheses.



AAE

AIRCRAFT MANUFACTURE

Toute reproduction interdite

Aircraft manufacture theme

The Fleet in 2050

- Due to current fleet replacement level and properties of alternative solutions, planes flying in 2050 will be similar to current planes although with the following advantages:
 - progress in propulsion systems
 - drag reduction due mainly to increased fineness ratio
 - weight reduction.
- The 2050 fleet will carry 3 times more PKT than in 2010
 - for a **doubling of fuel consumption**
 - for an **overall noise energy level lower** than today
 - with **nitrogen dioxide emissions close** to current rates.

Aerodynamic efficiency asymptotic trend

Potential Cruise Drag Improvement

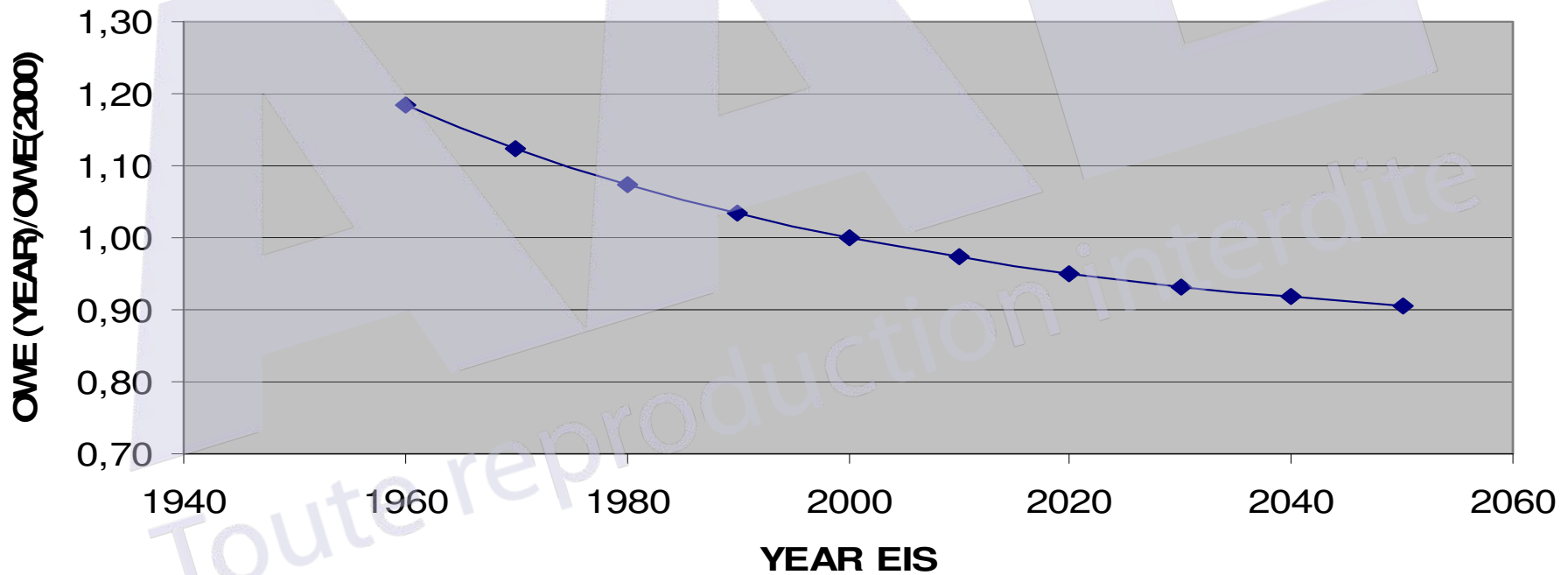
- Laminar : could affect 10% of cruise drag
30% of potential assumed ~ 3%
- Induced : selection of a 20% higher aspect ratio
- Parasitic: work harder
- Compressibility: improved profile and thinner profile

	SR TP	SR TF	MR	LR	VLA
Drag Improvement Typical cruise condition %					
Laminar	2,9	3,2	2,9	3,0	3,2
Induced	3,8	3,4	5,3	5,8	7,7
Parasitic	4,9	5,0	1,2	2,1	0,4
Compressibility	0	1,7	2,7	2,9	3,8
Total	11,6	13,2	12,1	13,8	15,1
L/D ref	13,8	14,6	18,0	21,7	20,8
L/D improved	15,6	16,8	20,5	25,2	24,5

12 to 15% lift over drag ratio potential improvement

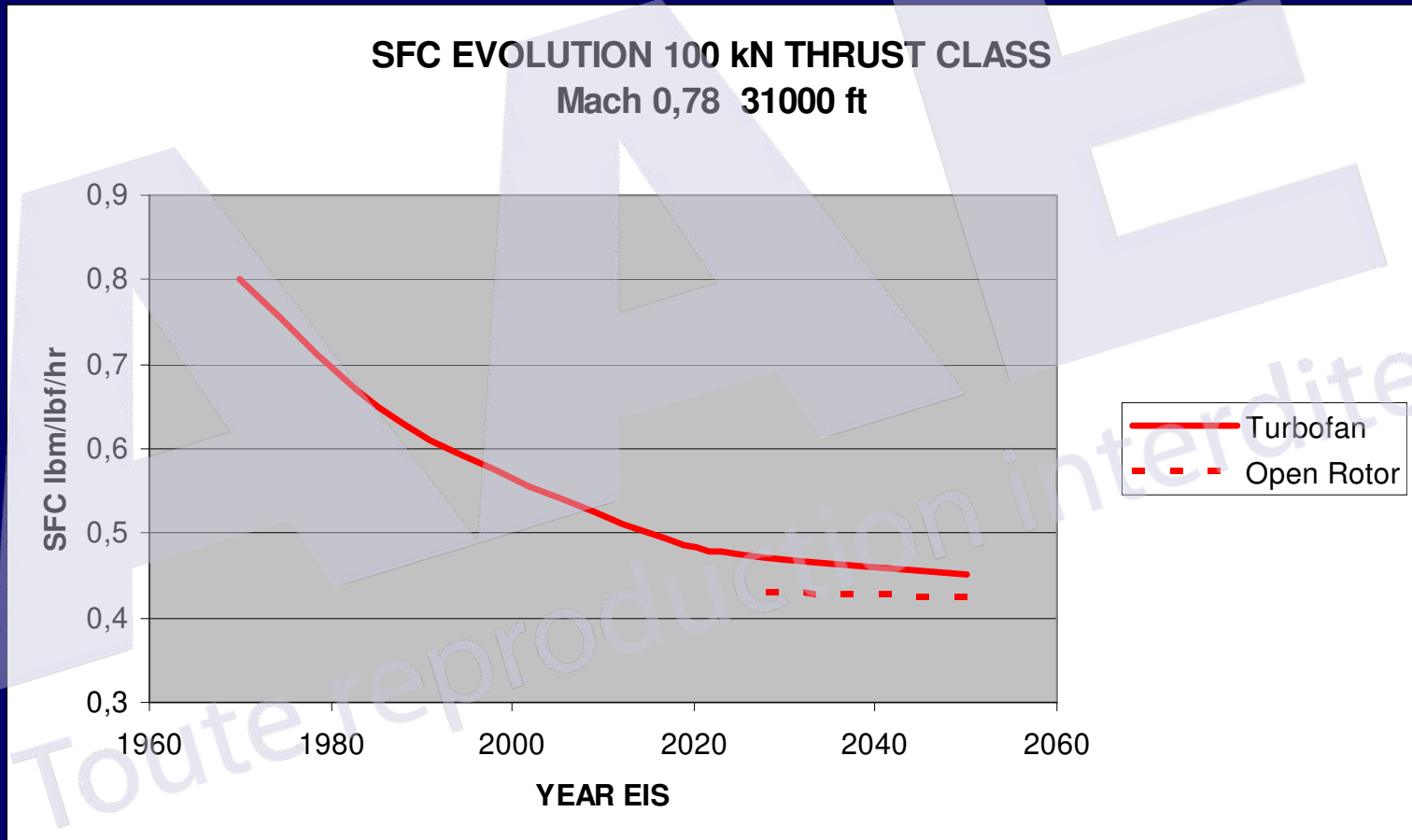
Relative evolution of empty weight Asymptotic trend

OWE Improvement Tendancy GV



Specific fuel consumption by engines

Asymptotic trend



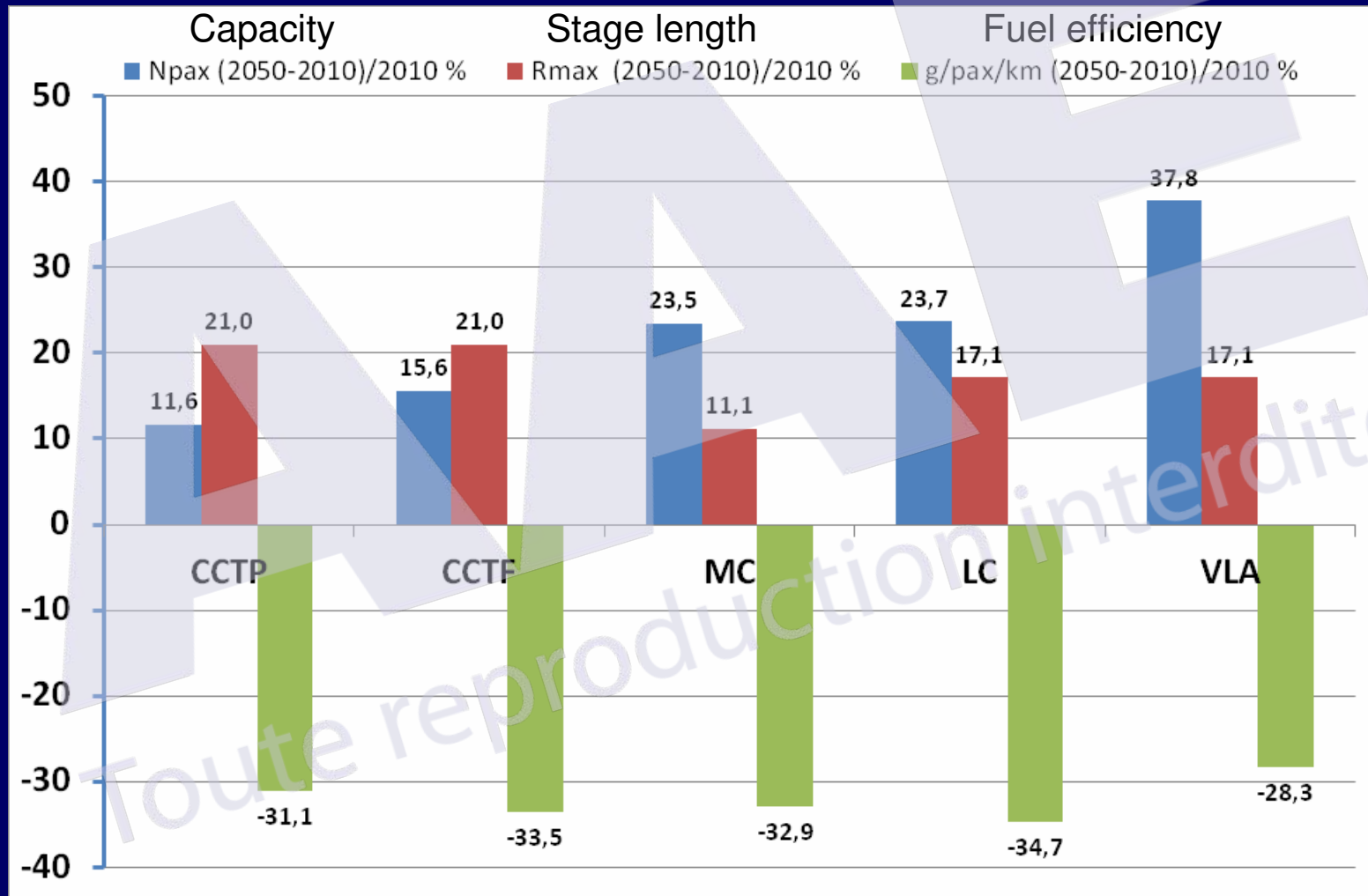
Aeronautics construction theme

The fleet in 2050

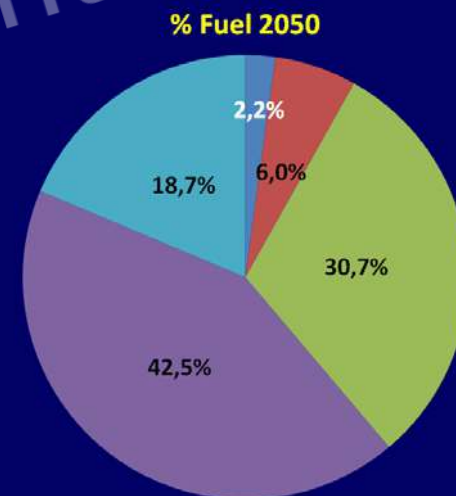
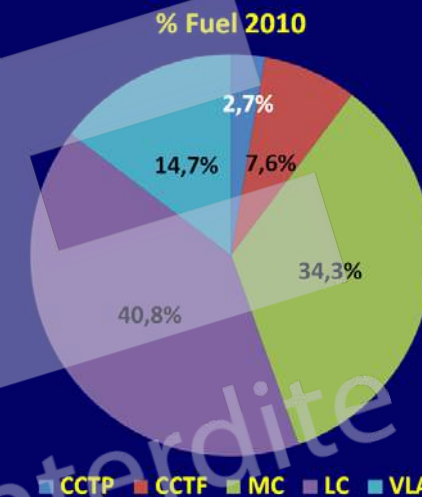
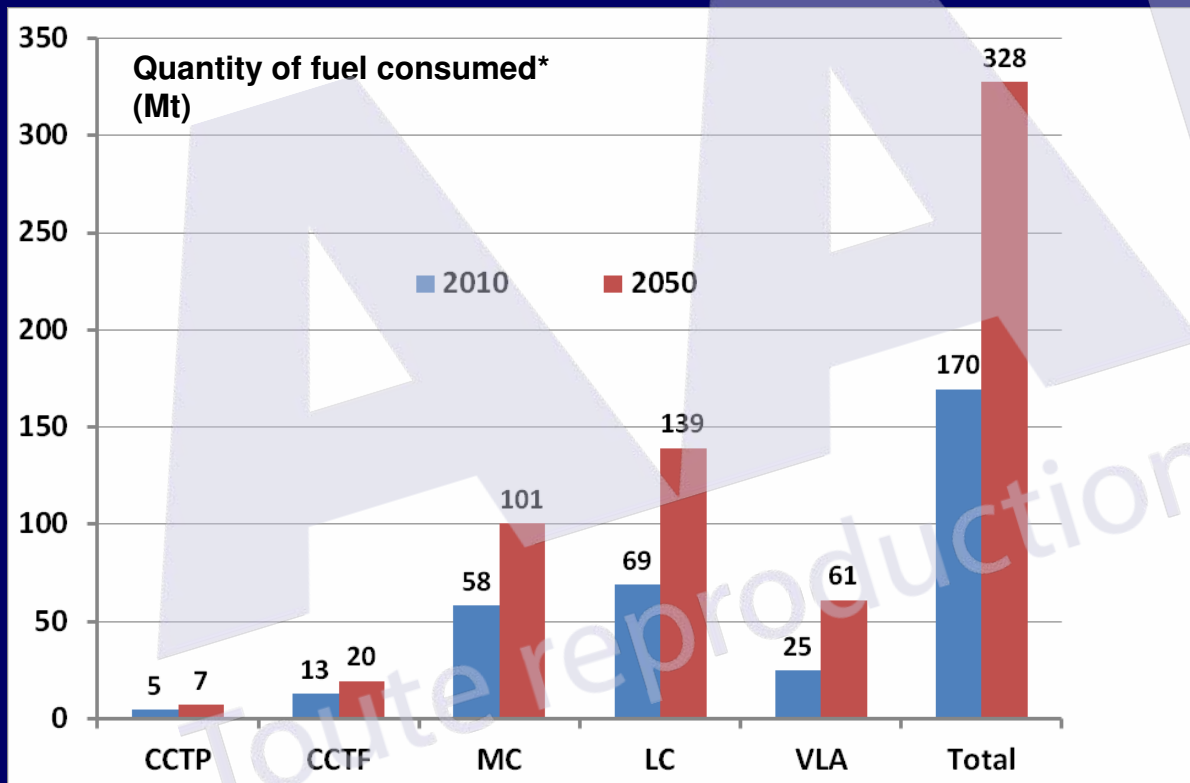
Improved aircraft performance, ATM and operations will enable a **drop in consumption for an average fleet in the order of 35% per PKT**

- Technological effects: 25 to 26% gain from fleet **renewal** (asymptotic gains around 45%, 8% weight, 12.5% drag, 25% specific fuel consumption engines and optimisation configuration)
- Effects from ATM and operations: 3 %
- Effects from passenger load factor: 10 %

Evolution in characteristic parameters



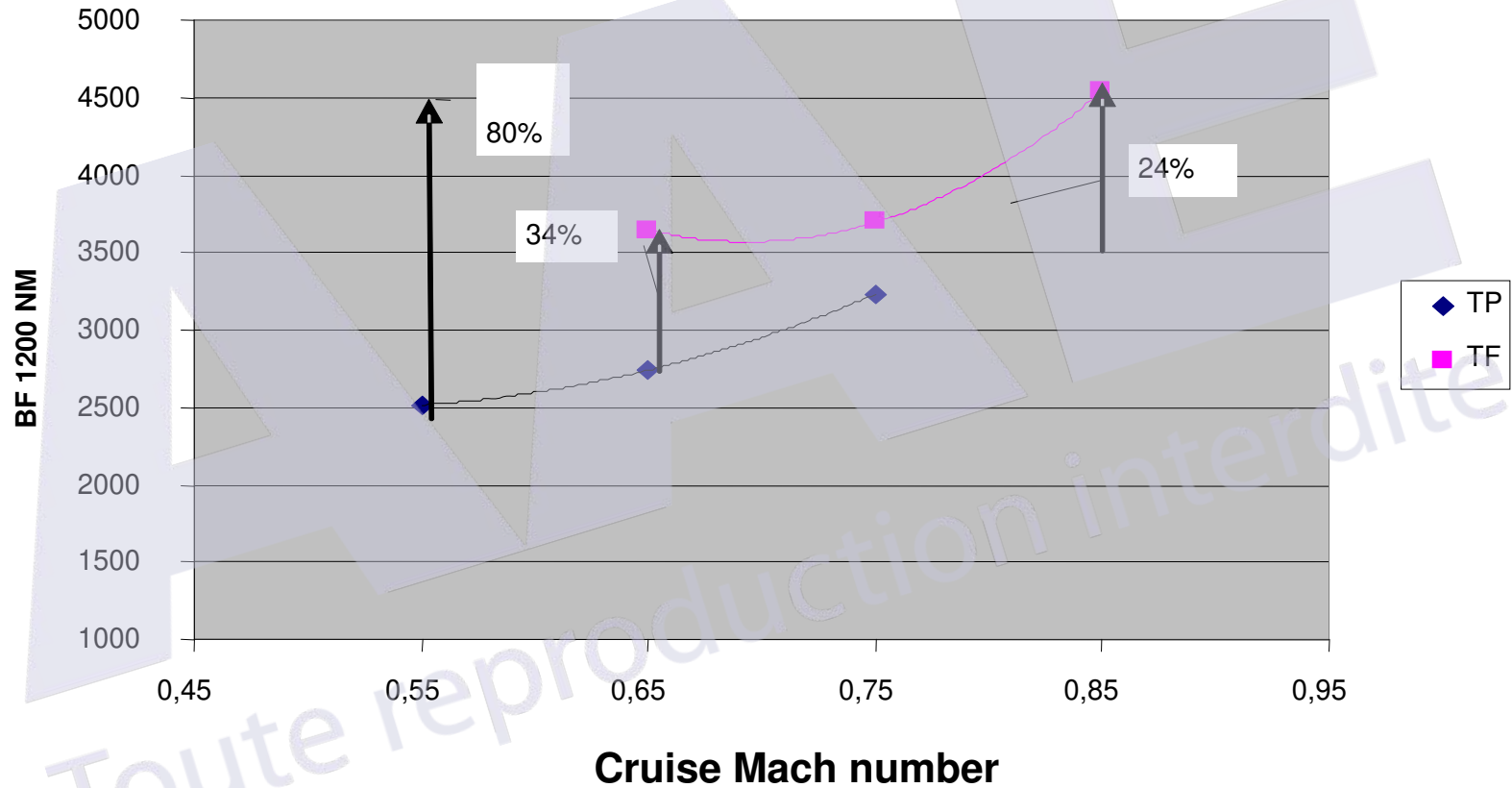
Estimated fuel consumption per segment



Incorporates a navigation coefficient improvement

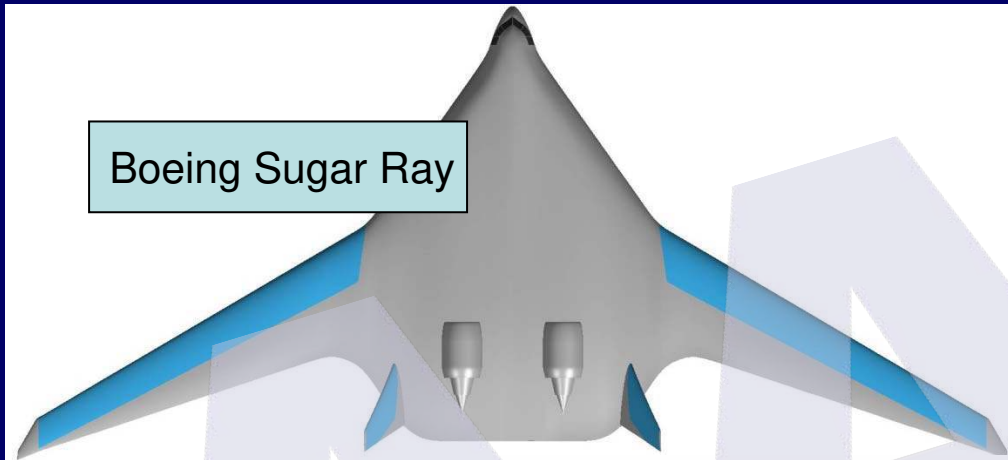
Reduced speed effect

Short range Turbofan / TurboProp Block fuel comparison



Similar trend will affect medium and long range aircraft.
Similar effect will result from cruise altitude optimisation.

Futuristic concepts



Boeing Sugar Ray



H2 Lapcat Mach 5



Bauhaus Munchen Dr Mirko Hornung

These « promising futuristic » concepts have been presented for 50 years
None have passed the « TRL0.5 » milestone. Why?

Emerging concepts



Technological evolutions will not be revolutions

- **Greater use will be made of automated systems** and their enhancement as well as the **notion of a ground management team** for decision support
 - This does not signify total automation
 - Radical change in task sharing between ground and air
 - **Freight drones could move towards total automation. Interest studies should be launched rapidly.**
- **Satellite Navigation and Telecommunications systems will** continue to be developed and **used more and more by aeronautics**
 - **Convergence of space systems, exploration of new possibilities, pursuit of research and experimentation**

Aeronautics construction theme

Maintaining know-how

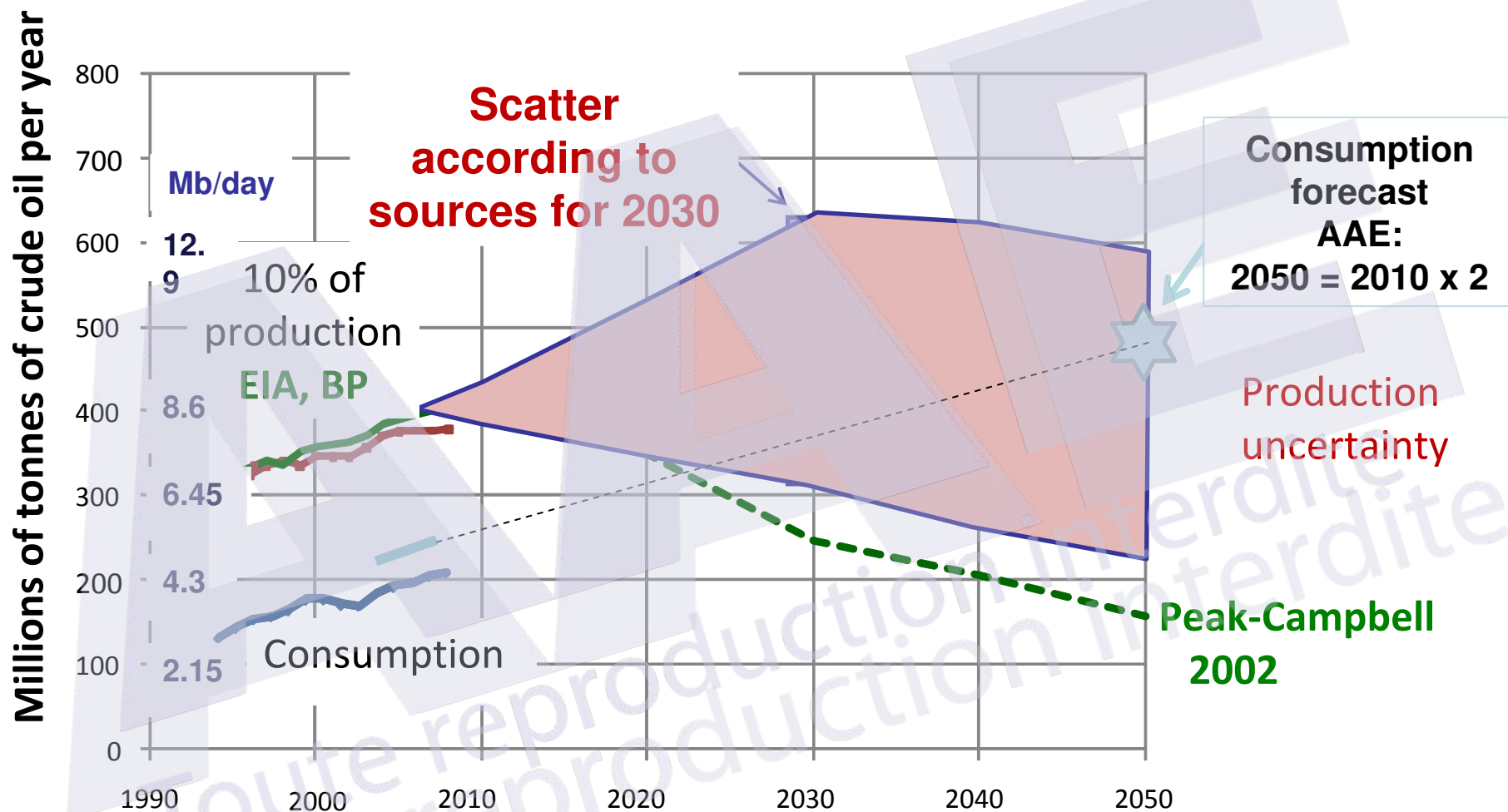
- The European aeronautics industry
 - must consolidate training of its engineers/technicians/pilots through a **continuous recruitment policy** reinforcing educational branches, rather than using the current "stop and go" system based on short term optimisation of EBITs
 - must continue its quest for **innovation and cost effectiveness** in order to increase competitiveness within a context of ever stiffer global competition
- The European aeronautics industry must seek to **minimise/optimize aeronautic technology transfers** used today
 - to sell planes
 - to cut costs by offshoring production.
- The European aeronautics industry must be able to work on the **basis of fair competition** as to state subsidies and grants.

AAE

ENERGY

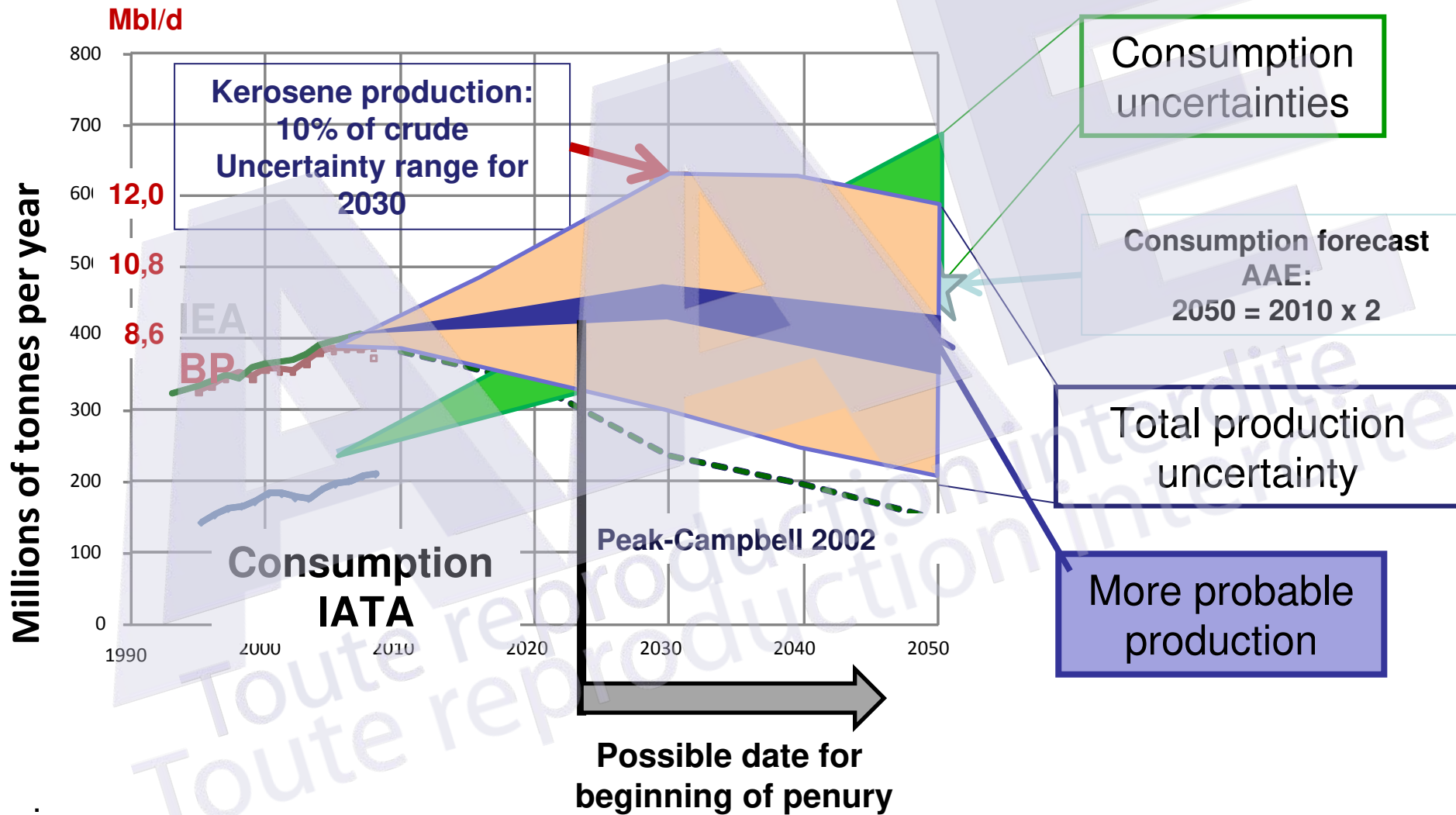
Toute reproduction interdite

Jet fuel *availability* vs AAE predicted consumption

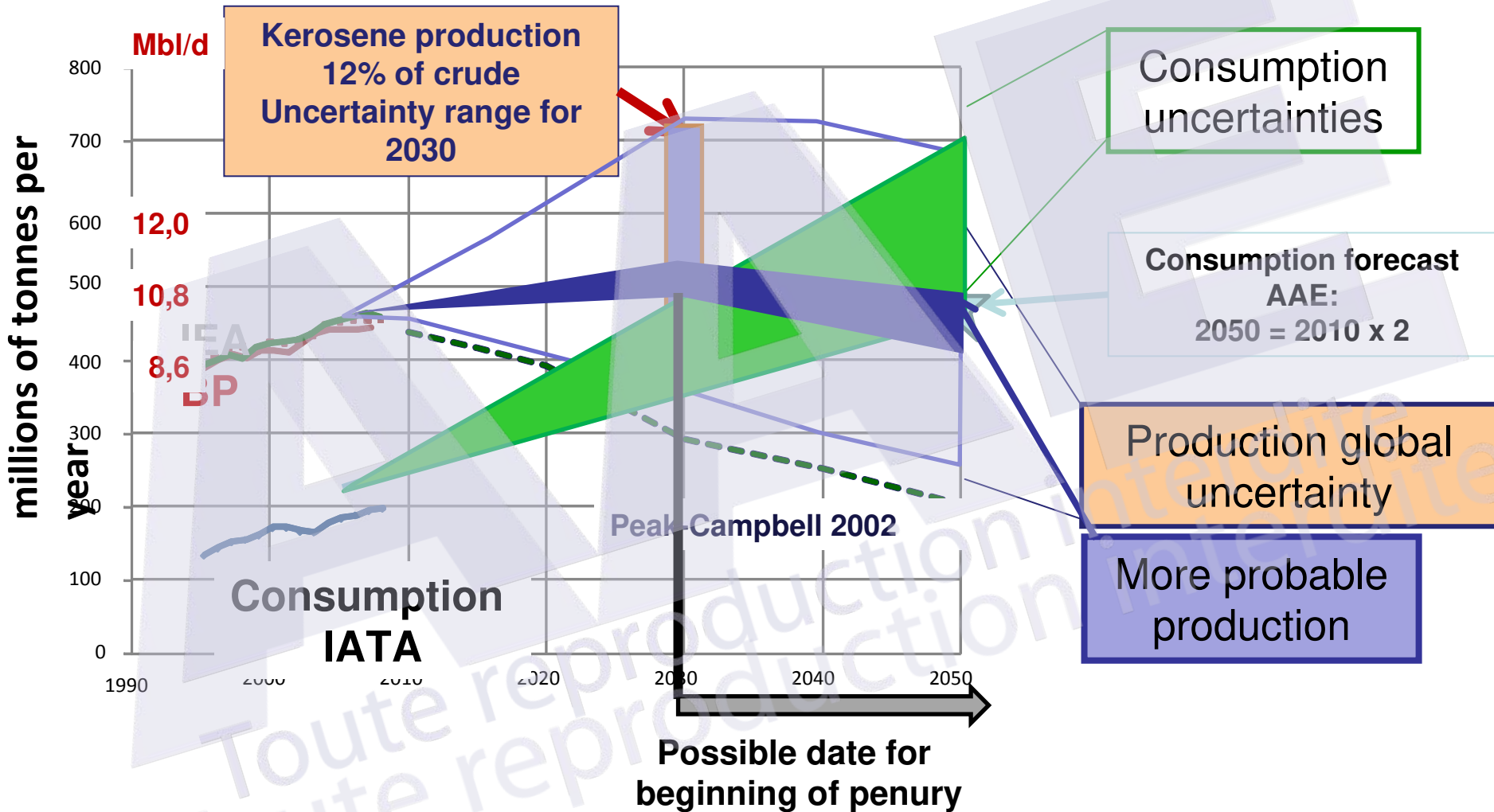


- Jet fuel production today represents about 6% of crude oil production
- Assuming crude oil production remains constant and jet fuel/crude oil ratio can reach 10%, *consumption* as predicted by AAE would be covered up to 2030-2040+

Jet fuel *availability* vs AAE predicted consumption



Jet fuel *availability* vs AAE predicted consumption



A modification in refining techniques enabling production to be increased to 12% of oil would put the risk of penury back ten or so years.

Energy will be scarce and expensive

- In order to avert a potentially major crisis for aviation in the long run, it is crucial to set up a consulting Observatory early enough:
 - to assess the availability of kerosene and its substitutes at a reasonable price*
 - * The laws of the market will lead to production decisions which will have to precede needs.
 - involving all players, from geologists to airlines:
 - E.g.: IATA with oil companies

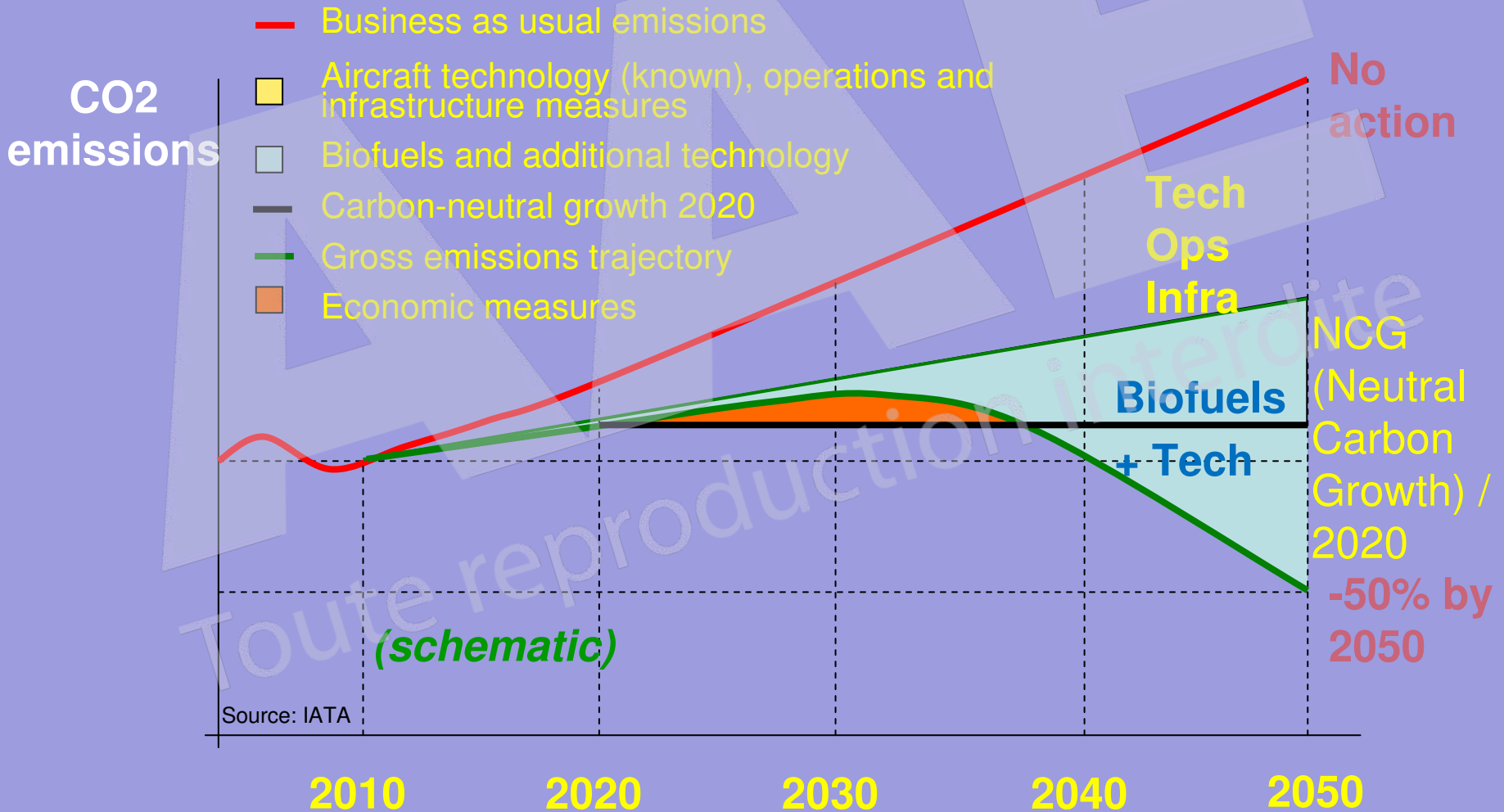
AAAE

ENVIRONMENT

Toute reproduction interdite

The environment

CO2 Emissions Reduction Roadmap



Environmental demands will not be met simply through technical progress (1)

- *Increased demands → environmental efficiency will be an important key to competitiveness → gas and noise emissions will have to be reduced*
- Despite slower traffic growth than forecast, technological progress alone will not make it possible to meet the different bodies' goals: neutral carbon growth by 2020 and 50% fewer CO₂ emissions by 2050
 - Alternative fuels, used in a realistic way, will not be enough to fill in the gap
 - As a complement, carbon compensation mechanisms are being studied by the authorities.

Accident rates must be reduced

- For the absolute number of accidents not to go up, the accident rate must be cut by 4 by 2050.
 - Regional rates must be brought progressively up to the best level
 - All stakeholders and the various links in the chain must be associated with safety goals, with equivalent certification processes.
- Transnational agencies should be created (e.g. EASA)
 - Need for an internationally recognised body charged with technical investigations, the conclusions of which would serve as a basis for possible legal proceedings.
 - A body which would work with NTSB, BEA and similar authorities from the main regions

Complementary viewpoint of operating structures

- Necessary extensions to airports should be anticipated as soon as possible
- An airport's limits should be conceived in terms of ecological footprint and not numbers of flights
- Policies should be implemented to maintain competitiveness and fair competition in air transport, with environmental reciprocity, no extra taxes and no deregulation without social minima

Congestion of infrastructures will call for a reassessment of priorities

- technical progress should be combined with institutional evolution, alternative methods of funding and more efficient work organisation
- *the single entity controlling the air traffic network set up by the EU must manage demand AND capacity and have real authority; it should have access to all information on traffic and capacities and more sophisticated weather forecasting tools*
- a research programme focusing on airspace and traffic flow management must also be promoted and should contain a *sizeable aeronautics meteorology component, as well as an industrial research programme on fundamental techniques (ground to air links and information loop).*
- *All management should be made more efficient and studies launched into priorities in the event of congestion.*

Anti-terrorist measures will need to be reinforced, whilst respecting individual liberties

- **Harmonise** regulations and security checks on a European and international level, for all **public transport**
- Make **controls reliable but less disruptive and intrusive**, respecting the **traveller's intimacy, privacy and dignity**
- **Reflections must be launched into security from the point of view of ethics and individual liberties**

Quality of service must be significantly improved

- A **charter for passengers treatment** should be rapidly drawn up, detailing their rights in terms of quality of service on ground and onboard, and monitored by ad hoc instances.
- All air transport players must be required to provide passengers with **clear, comprehensive, customised information, particularly during disruptions.**
- Greater use of automated systems for communicating with passengers must not rule out **human interfaces**, which are better adapted to cultural differences and can help and reassure passengers in all circumstances.
- The issue of **baggage handling** (which leaves all stakeholders unsatisfied) should be rethought.

Summary of proposals

- **1. Growth in traffic will doubtless be lower than predicted by the main airlines and manufacturers, with a tripling of activity only by 2050.**
- **2. Technological evolutions will not usually be revolutions; they will bring about a reduction in consumption for an average fleet of around 35% per PKT, with greater use of automated systems and satellite navigation and telecommunications systems.**
- **3. Measures must be taken to maintain European know-how and make commercial regulations fairer.**
- **4. Energy will be scarce and expensive; a monitoring centre must be set up to ensure its availability and the emergence of alternative sources.**
- **5. Environmental demands will not be met simply through technical progress.**

Summary of proposals (cont.)

- **6. Accident rates must be divided by 4 with fewer disparities between continents.**
- **7. Airlines must adapt their business model.**
- **8. Congestion of infrastructures will make it necessary to re-assess utilisation priorities, and space will play a more important role.**
- **9. The fight against terrorist actions will need to be reinforced, whilst respecting individual liberties.**
- **10. Service quality must be significantly improved for passengers and freight, respecting a quality charter that has yet to be created.**

Air and Space Academy

✓ International Conference

30-31 May 2012

**HÔTEL DE RÉGION MIDI-
PYRÉNÉES**

TOULOUSE - FRANCE

**Académie de l'Air et de
l'Espace**

Air and Space Academy

www.air-space-academy.org

Objectives:

Submit this work in progress to
international expert opinion
(including American)



Results

What remains to be done:

- 1) Conference proceedings on AAE website October 2012.
- 2) FC report: early 2013. AAE Dossier: mid 2013.
- 3) Submission of recommendations to policy makers.
- 4) Phase II activities of FC:
 - Take into account effects of more radical hypotheses for evolution (economic scenarios such as China's entrance as a player in aircraft manufacturing).
 - Take into account technical advances such as:
 - The contribution of full electrification
 - New materials (nanotechnologies for instance).
 - The contribution of biofuels.
 - New configurations.

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*THANK YOU FOR
YOUR ATTENTION*



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Air and Space Academy

25/01/2013

AAE-FC Alain Garcia