



# Alternative Fuels in Aviation – Embraer View

## Workshop on Aviation Alternative Fuels

**ICAO – Montréal, Canada**

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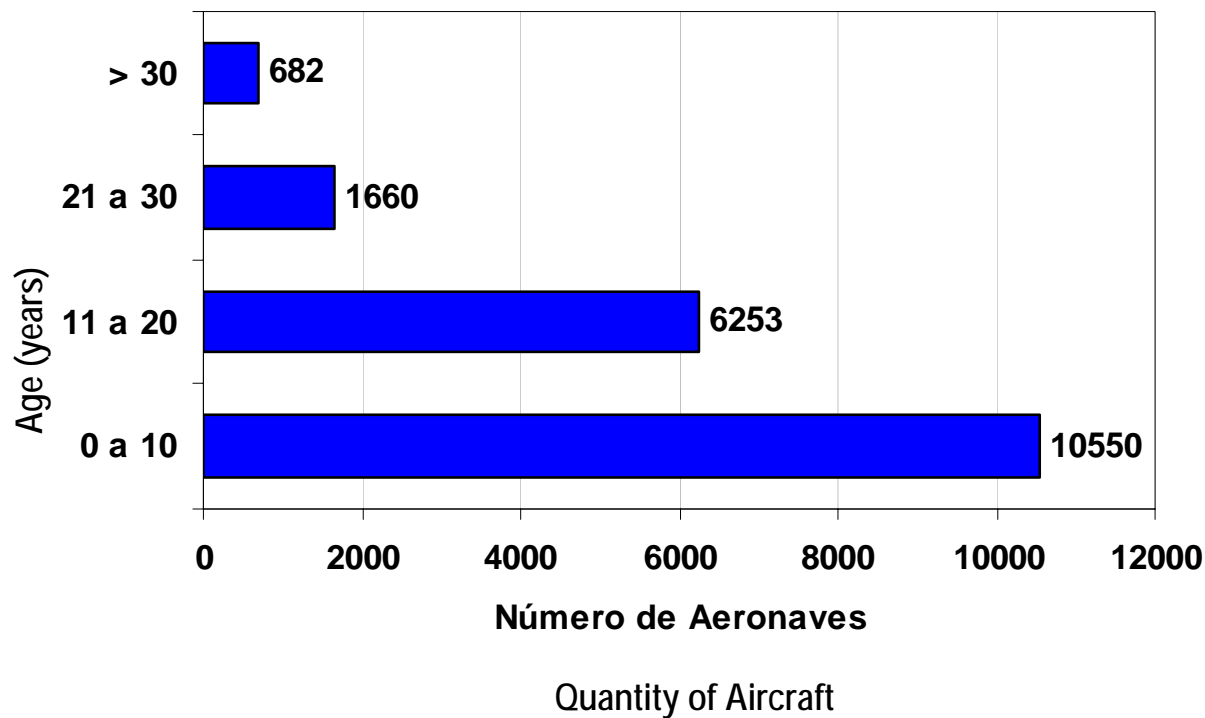
EMBRAER

- Today's Aviation Fuel
- Motivation for Alternative Fuels
- Embraer Alternative Fuels Project
- Brazilian Biofuels - Background
- The Ethanol Ipanema Aircraft
- Final Comments

# Commercial Aircraft Fleet Profile



**Regular Flights, Passenger Configuration, in Service : 19.145 aircraft**



Region	# Acft.	Average Age
North America	7025	11
Latin America	1277	15
Europe	4150	10
Russia & CIS	1282	23
Africa	711	16
Middle East	617	10
Asia - Pacific	2822	11
China	1261	7
<b>World</b>	<b>19145</b>	<b>12</b>

Source: BACK (Dez/07)

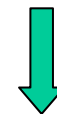
# Aviation Fuel (Jet Fuel)



- Aviation have been powered by petroleum fuels for more than 60 years;
- Meet International Standards (Joint Operated System, ASTM 1655, DEF Stan 91-91, ANP 03/2006-QAV1) requirements;
- Meet distribution chain requirements.

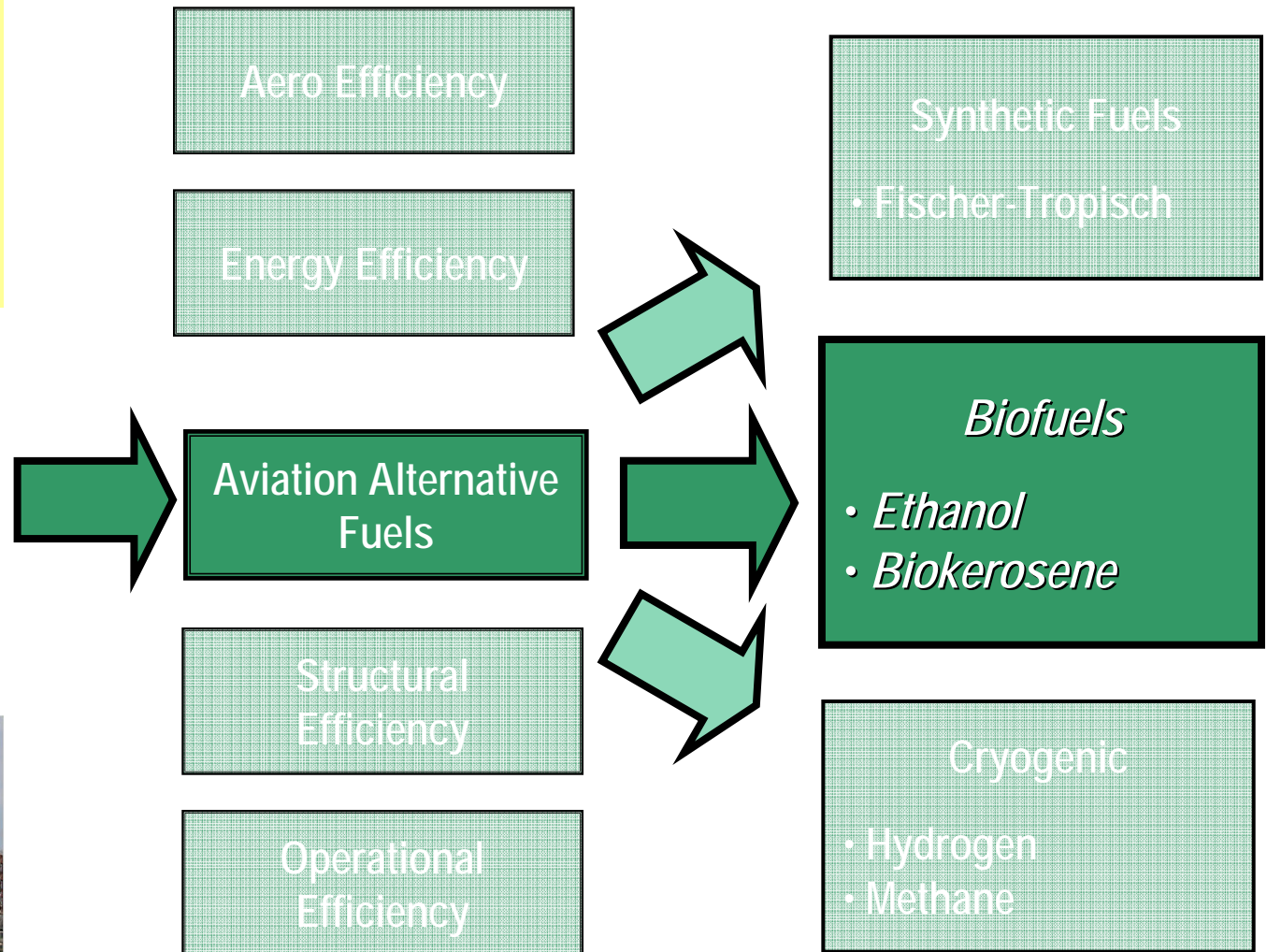
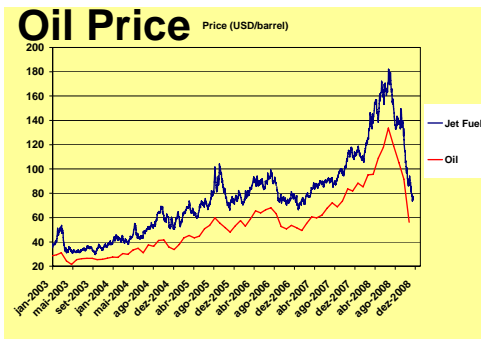


New fuels shall comply with "Guidline for Qualification and Approval of New Turbine Fuels"

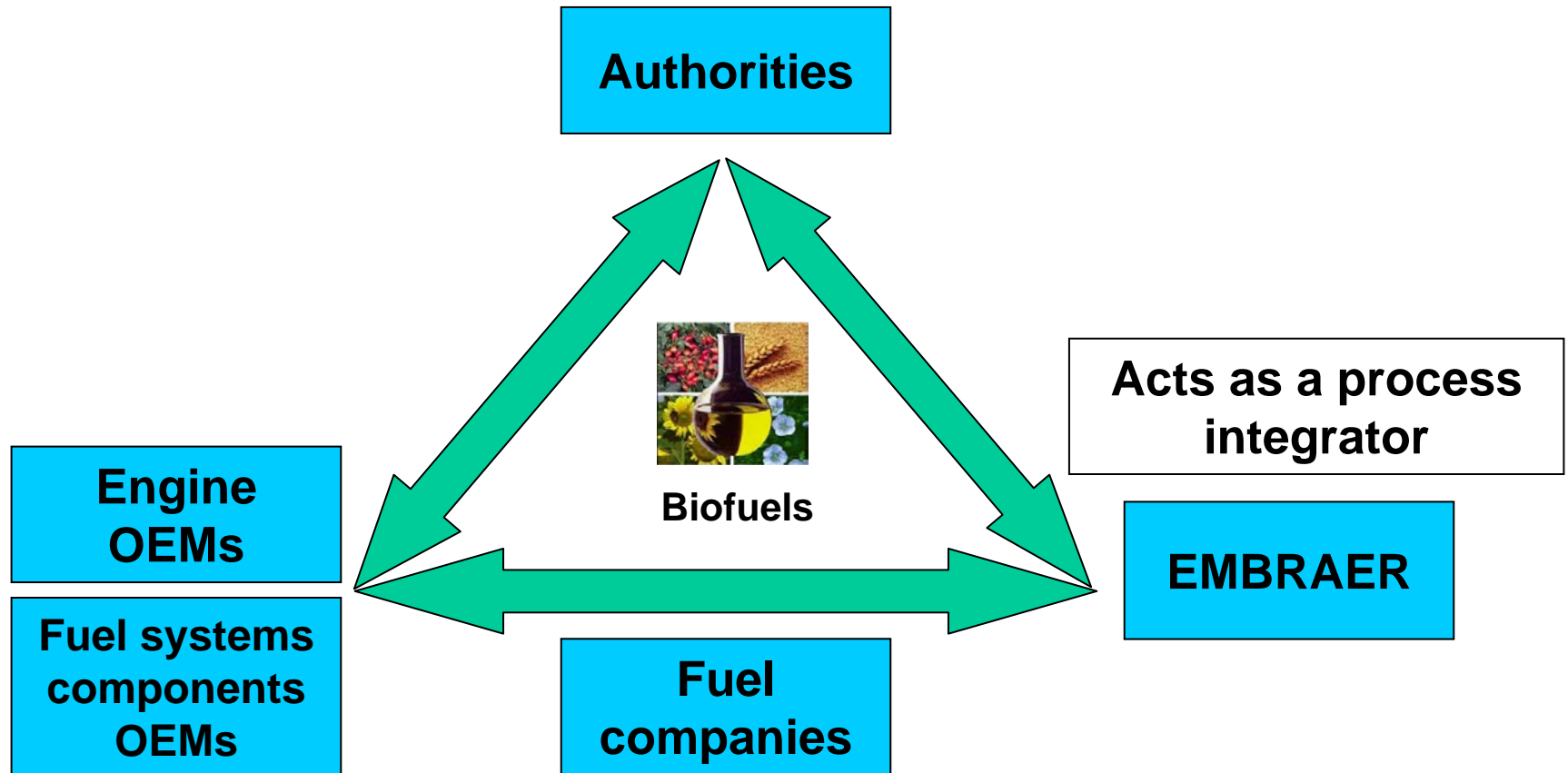


**Drop-in fuel**

# Alternative Fuels in Aviation: Drivers



## Technical Investigation of Sustainable Aviation Biofuels





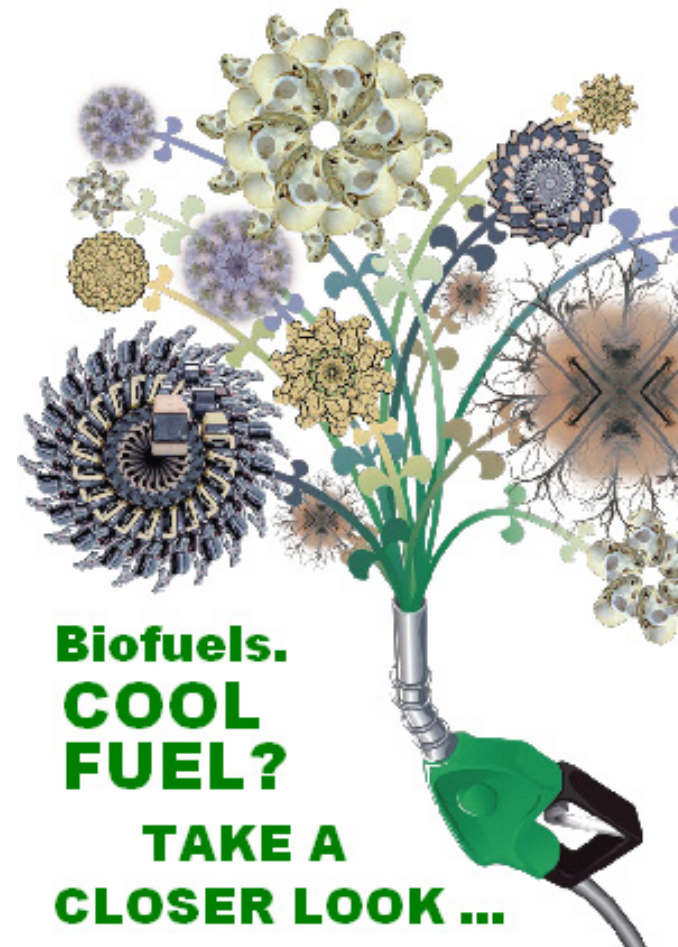
# Benefits of Biofuels

- Economical Viability
  - Biojet fuels will become as economically viable as crude oil prices rise.
- Reduce dependence on crude oil
  - Homeland security implications.
- Burns cleaner
  - Sulfur-free and reduced emissions.
- Social Concerns
  - Use of raw-material from low-income Brazilian farmers;
  - Employment of a Integrated Bioenergy System.



## Technical / Quality:

- Product Scale x Sustainability;
- Different performance & life-cycle emissions;
- Lack of technical data, operational experience and standards.





# Brazilian Biofuels - Background



- 1975 – PROÁLCOOL implementation
- 1980 – PROSENE (biokerosene) - First patent for biodiesel and biokerosene production;
- 1984 – A successful flight using the biokerosene in an Embraer turboprop.



# Bandeirante Flight with Biokerosene



Demo flight on October 23rd, 1984 (São José dos Campos to Brasília – 1100km). One engine was fed with biokerosene.

# Ethanol in Brazil



- In 1979 the first car was sold fueled by ethanol;
- In the 80', Brazil replaced the lead in the automotive gasoline by ethanol;
- In the 90' government decision to add a higher proportion of ethanol in the gasoline;
- 2003 First flexible fuel vehicle was launched;
- Nowadays:
  - Almost 90% of the cars sold in Brazil are flexible;
  - Refueling pumps only have gasoline (or E25) and E100.



**Brazil's flex  
fuel program**

# Embraer Ipanema Ethanol



**First OEM to develop a 100% ethanol powered aircraft**



# Ethanol & Aviation - Embraer's Ipanema

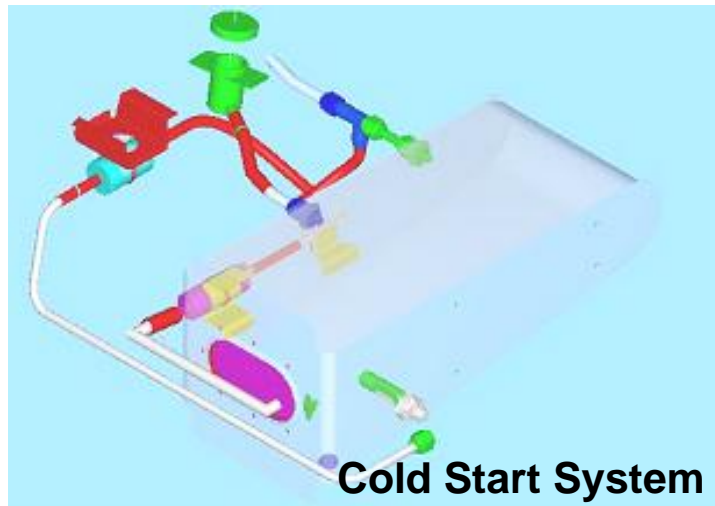


- 1972: Ipanema Type Certification
- 1985: Embraer started a market study - without go ahead
- 00': New study, with the following drivers:
  - Excellent ethanol availability due to the car industry;
  - Avgas distribution in country side: availability, high prices;
- 2002: Program launch
- 2004: Certification;
- 1,069 Ipanema airplanes sold:
  - 64 new aircrafts
  - 177 retrofits

**Total Ethanol Powered Aircraft: 241**

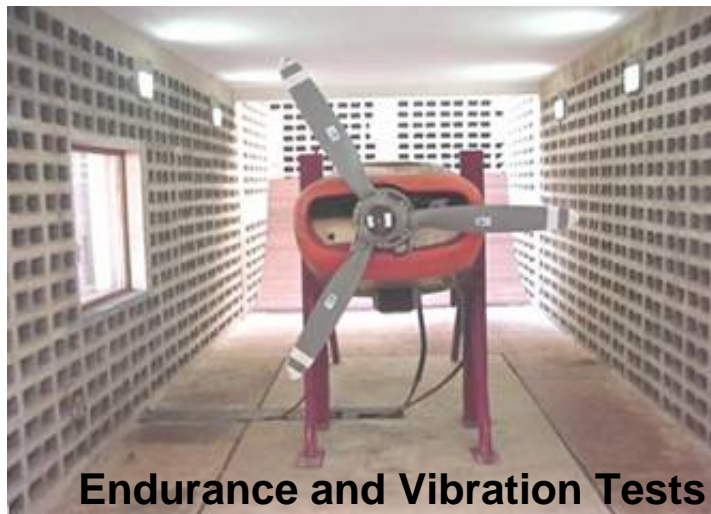


# Main Modifications – Engine and Airframe



**Cold Start System**

- Cold Start System;
- New Injection System;
- New Materials;
- Anti-corrosion protective coats / materials.



**Endurance and Vibration Tests**

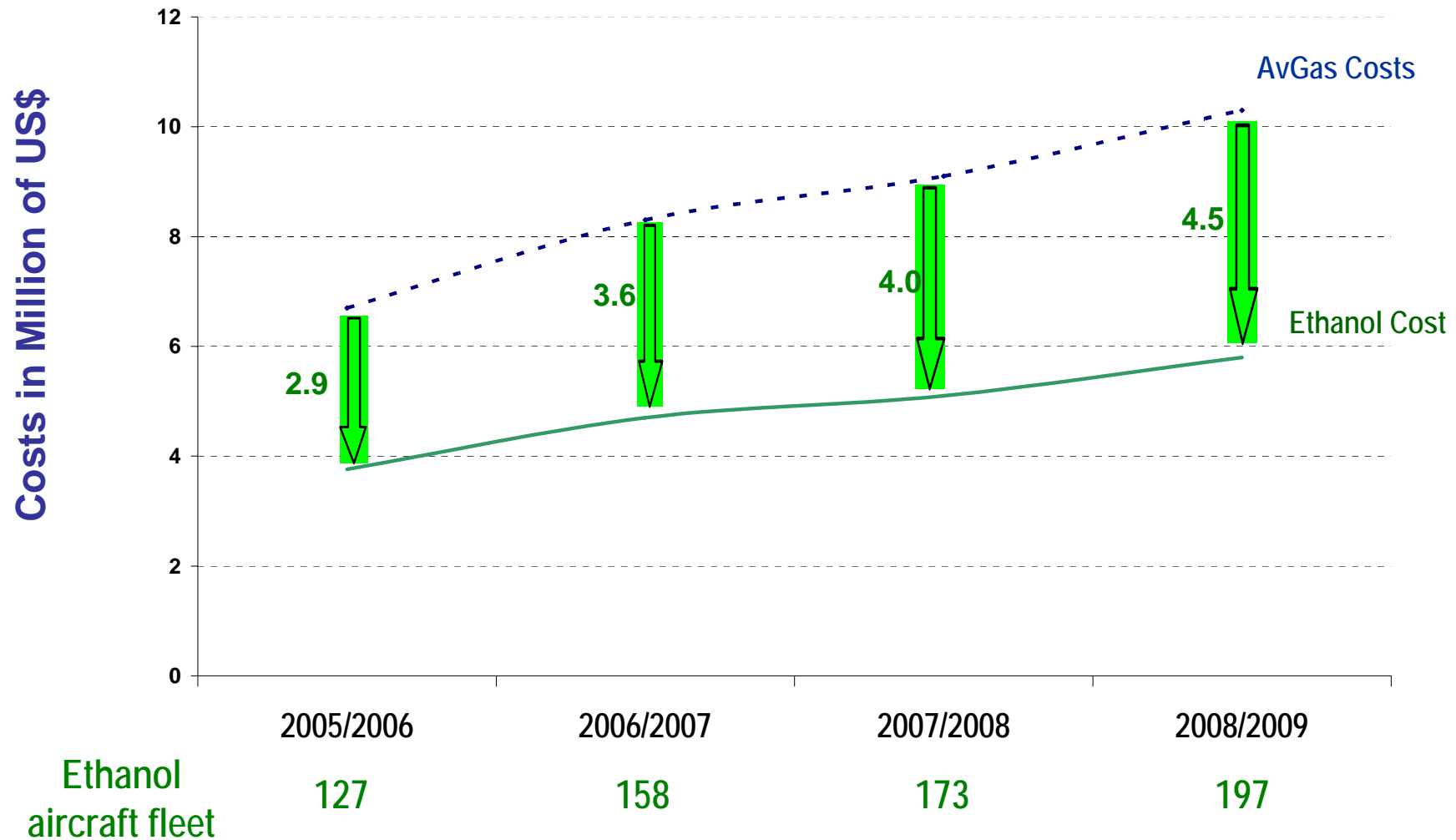


# Uses for the Ipanema



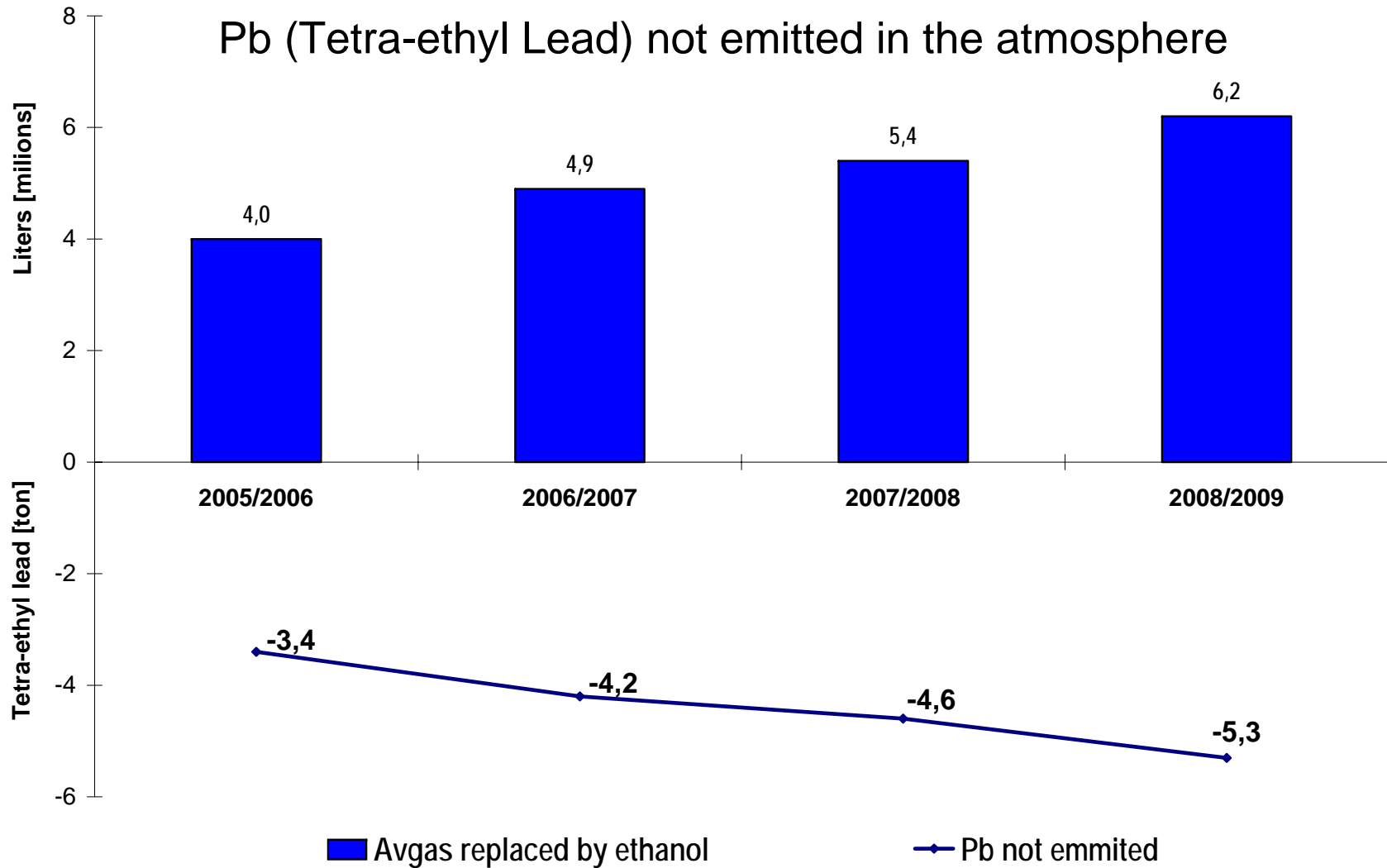
- Ipanema has been used in:
  - Agricultural operations: application of fertilizers, pesticides and fungicides;
  - Fire fighting;
  - Combat of endemic disease vectors;
  - Cloud nucleation.
- 1<sup>st</sup> Crop Season: 2005/2006
  - 144 ethanol fueled aircraft (127 retrofits);
  - More than 60,000 flight hours with ethanol;
  - More than 6,0 mi liters of ethanol used;
  - More than 4,0 mi liters of Avgas replaced.

# Efficiency in Costs per Season



(Forecast: 2008/2009)

# Environmental Advantages over the use of AvGas



# Ipanema – National and International Awards



**SCIENTIFIC  
AMERICAN**

Scientific American Award as  
the Top 50 2005 innovations

**WINNER: EMBRAER**



*Embraer subsidiary Neiva received Brazilian type certification for an ethanol-powered version of its Ipanema utility aircraft*

**Achievement:  
Ipanema  
alcohol-  
powered  
aircraft**

With oil prices at record levels, pollution penalties in place at many airports and the threat of emission control regulation hanging over its head, global aviation has good reason to embrace any alternative fuel technology. One such cost-effective, environmentally friendly alternative fuel is alcohol. This year, Industria Aeronautica Neiva, a wholly-owned Embraer subsidiary, has achieved what others have only dreamed of and produced the world's first alcohol-powered aircraft.

Neiva received type certification from the Brazilian authorities in 2004 for a version of its Ipanema piston-single agricultural utility aircraft powered by ethanol extracted from sugar cane.

Neiva registered the name Aviation Alcohol (AVAlc) for use in Brazil. The achievement is a natural progression for Brazil as its automobiles have been running on this type of fuel for more than 20 years.

Not only is ethanol three to four times cheaper than aviation gasoline and a cleaner energy source, it is also capable of improving the aircraft's overall performance. The new Ipanema engine also brings other advantages such as lower maintenance costs and a 20% reduction in operating costs. This should have a positive impact on the competitiveness of Brazil's agribusiness – the primary source of the country's export earnings.

Neiva says conversion of existing avgas engines is not only feasible but also cost-effective. The company has so far received 100 orders for this service. Conversion kits are also being offered.

The Ipanema is Neiva's best-selling aircraft with more than 30 years of uninterrupted production. The 1,000th example was sold in 2004. Developed in the late 1960s with funds from the Brazilian Ministry of Agriculture, it is a low-wing monoplane used for crop dusting and seeding.

Flight International Aerospace Industry  
Award in the General Aviation Category.

# Ethanol – Challenges to Spread



- Presently used in general aviation;
- May find limited application for jet;
- Lack of worldwide supply and distribution structure;
- Presents challenges and limitations.

# Final Comments



- Industry integration will foster technology deployment;
- Life Cycle Analysis will drive industry choice;
- Regional solution must worldwide requirements;
- Ethanol is a good solution for aviation niche.





*Thank you!*