AVIATION AND PEAK OIL

Why the Conventional Wisdom is Wrong

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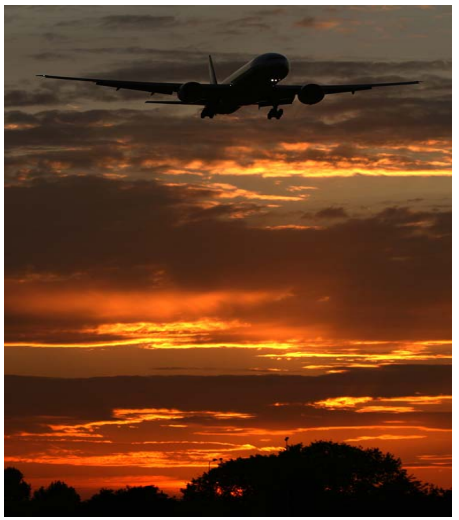
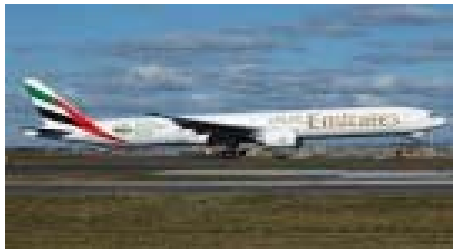
THIS PRESENTATION

- Summarize current long-range aviation forecasts
- Assess major drivers of the forecasts
- Analyze potential impacts of oil constraints on future of aviation
- “Reverse engineer” current aviation forecasts to derive alternate forecasts
- Assess potential aviation responses
- Discuss future of aviation after peak oil
- Identify the likely issues





CONVENTIONAL WISDOM: RAPID AVIATION GROWTH

- We reviewed the major long-range aviation forecasts: FAA, IATA, Boeing, Airbus, Bombadier, etc.
- Without exception, they all say "the sky is the limit"
- **All aspects of aviation forecast to grow very rapidly everywhere over next 25 years:**
  - -- Passenger traffic: Regional, domestic, international
  - -- Freight and cargo: Regional, domestic, international
  - -- Charters, business jets, air taxis, etc.
  - -- Aviation miles and revenues
  - -- New aircraft: Small planes, large planes, private jets, etc.
  - -- Airports, airport industrial parks, convention centers, hotels & restaurants, infrastructure, etc.
  - -- Many cities betting future on aviation growth
  - -- Airlines planning to expand; new airlines being started
- Forecasts compete in projecting how fast everything will grow

EXAMPLE: FAA U.S FORECAST, 2006-2020

average annual growth

6%
5%
4%
3%
2%
1%
0%
-1%
-2%

GDP

Passenger Traffic

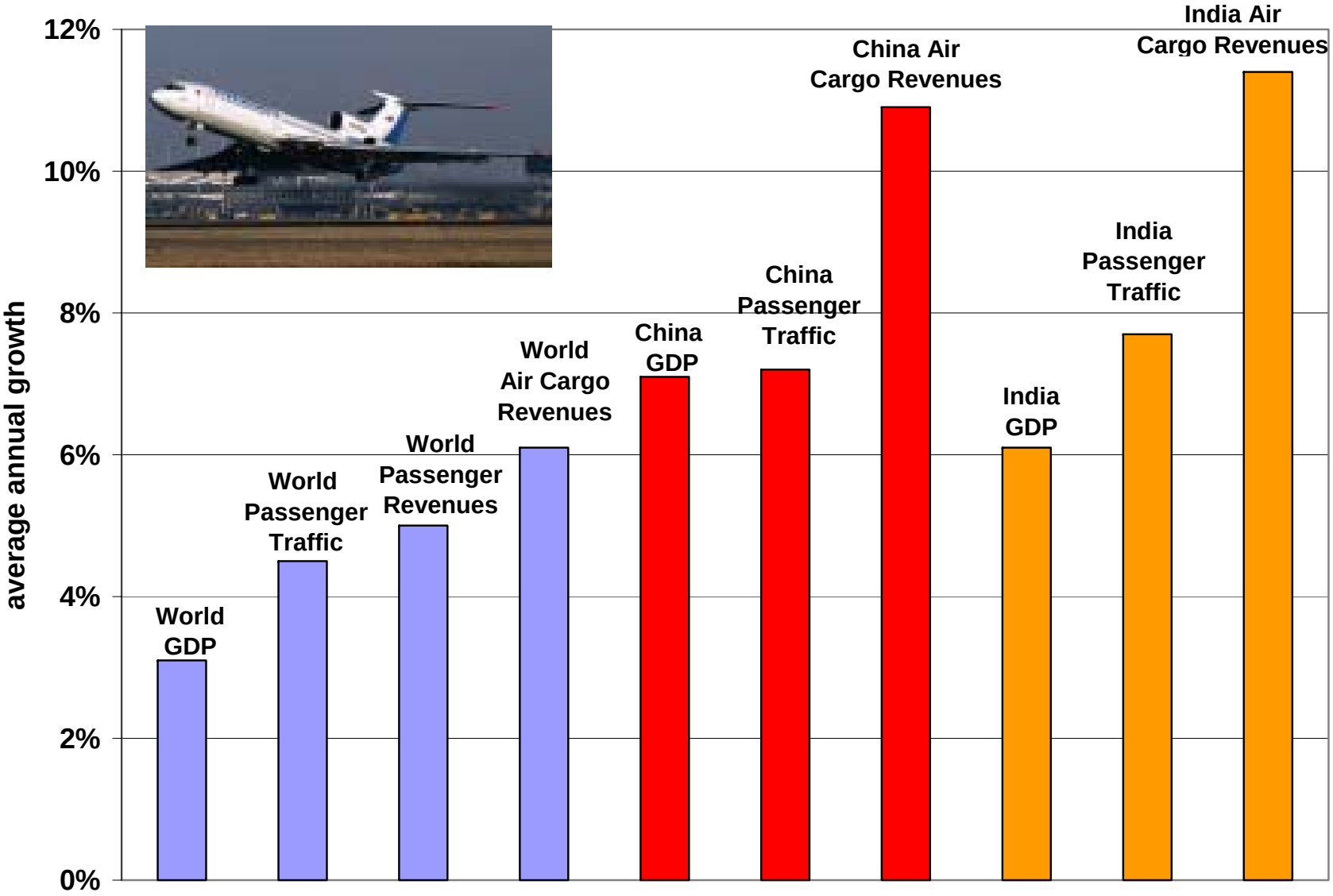
Passenger Revenue Miles

Air Cargo Revenues

Aviation Fuel Consuption

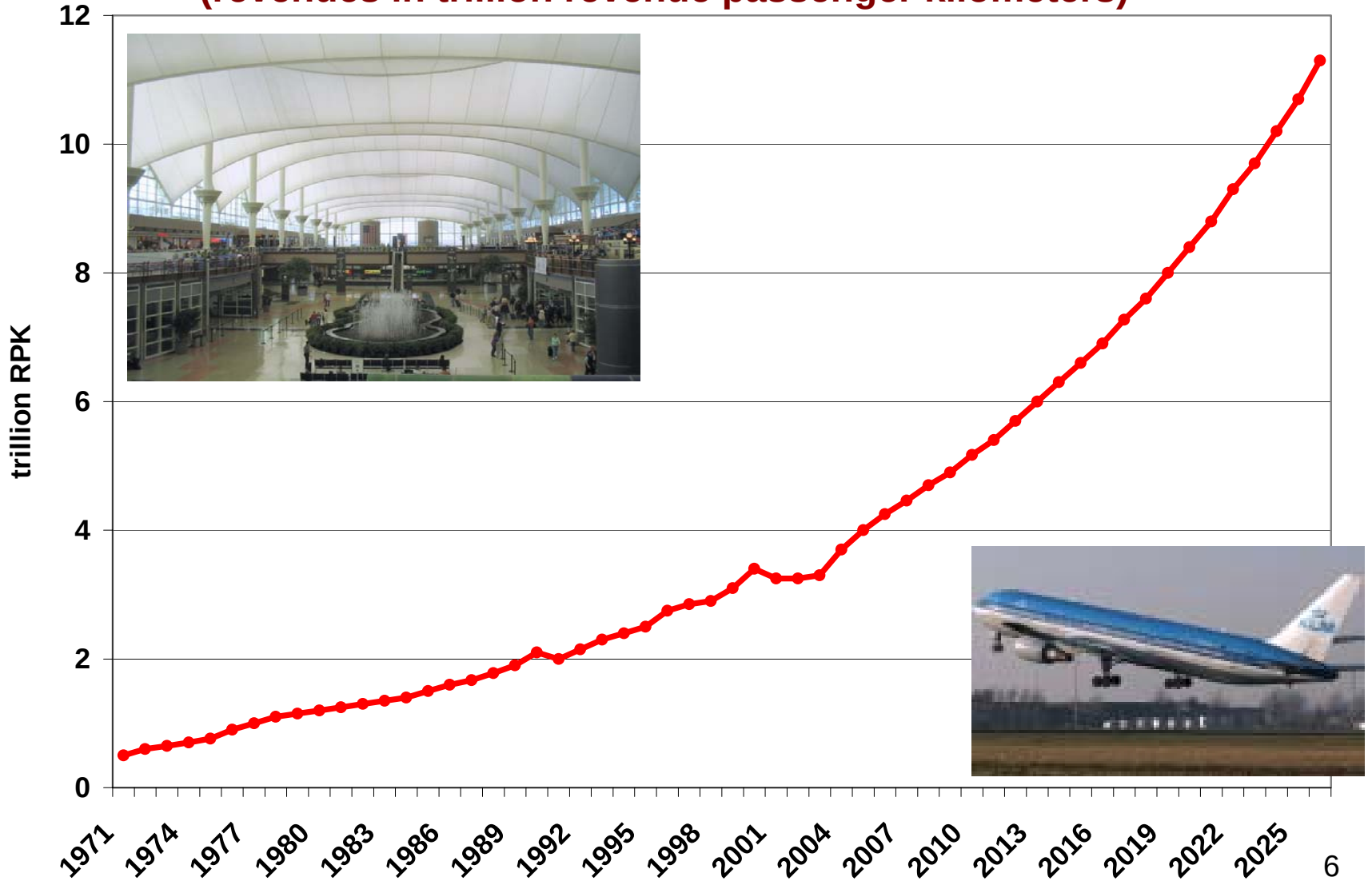
Aviation Fuel Cost

EXAMPLE: WORLD FORECASTS, 2006 - 2026
Up, Up, and Away!



WORLD AIR TRAVEL: HISTORICAL AND FORECAST

(revenues in trillion revenue passenger kilometers)



WILL PEAK OIL DESTROY AVIATION INDUSTRY?

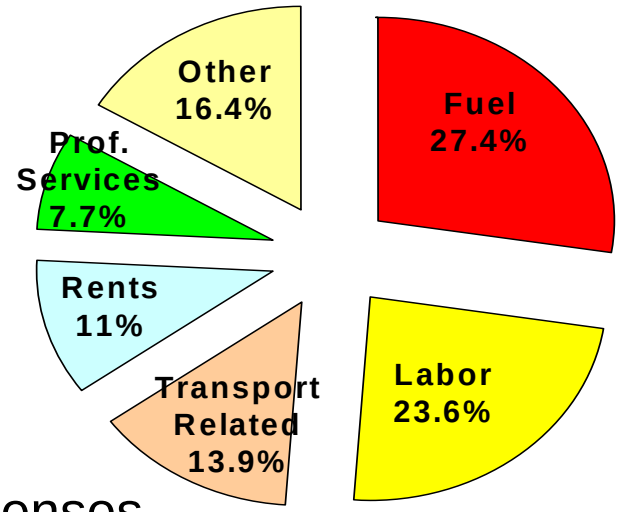
- **Is aviation the "canary in the coal mine"?**
- Will oil price increases devastate aviation industry?
- "Our children will not fly"
- Massive shifts in travel away from aviation?
- Economic collapse of aviation sector?
- No more "fresh strawberries in February"

Drastic remedies suggested by some in the literature:

- Regulatory limits on air travel
- Limiting new airports and infrastructure
- Restriction of flights to > 500 miles
- Elimination of first & business class
- Redirection of air cargo to other transport modes
- Massive fuel conservation: revised ground operations, improved traffic control, more efficient routing, retire less efficient aircraft, etc.

COMMERCIAL AIRLINES ARE VERY CONCERNED ABOUT RISING FUEL PRICES

U.S. Airlines Costs in 2006

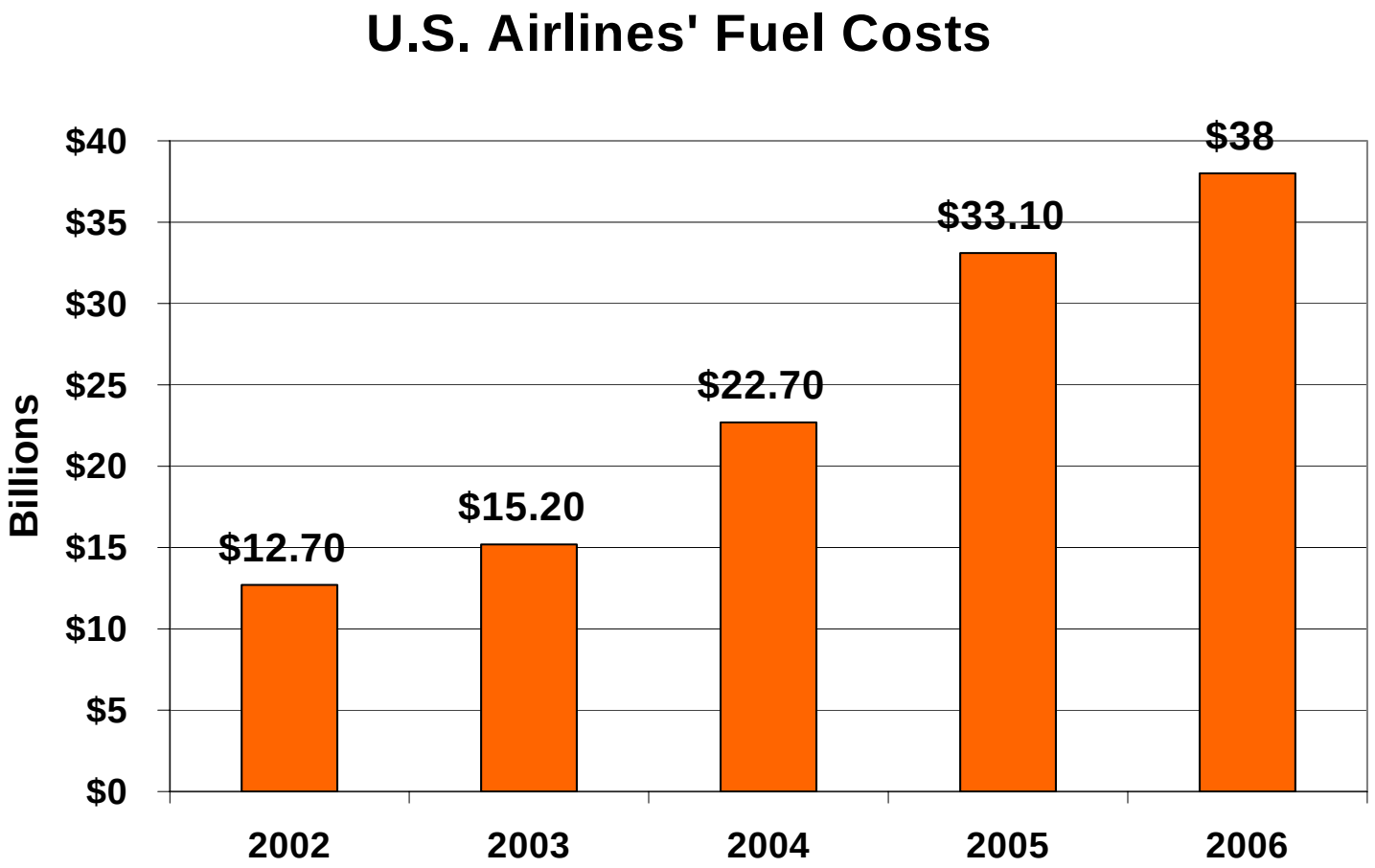


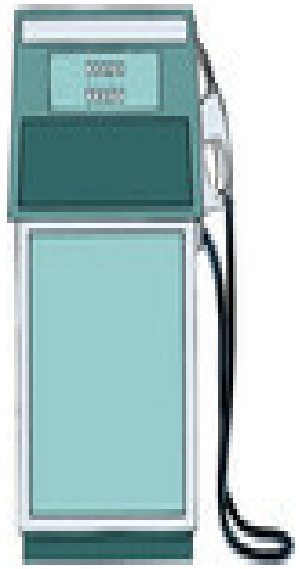
- **Fuel has overtaken labor as the largest operating expense** for airlines
- Fuel now constitutes 25–30% of total airline operating costs – twice the historical average
- When the price per gallon of jet fuel increases by just one cent/gal., it costs U.S. airlines an additional $195 million in annual operating expenses
- American Airlines, which uses more oil annually than the country of Ireland, in 2006 paid $2.4 billion more (34%) for fuel than in 2004

Unlike other modes of transport, **aircraft currently have no alternative source of energy**

AVIATION FUEL COSTS HAVE RISEN RAPIDLY

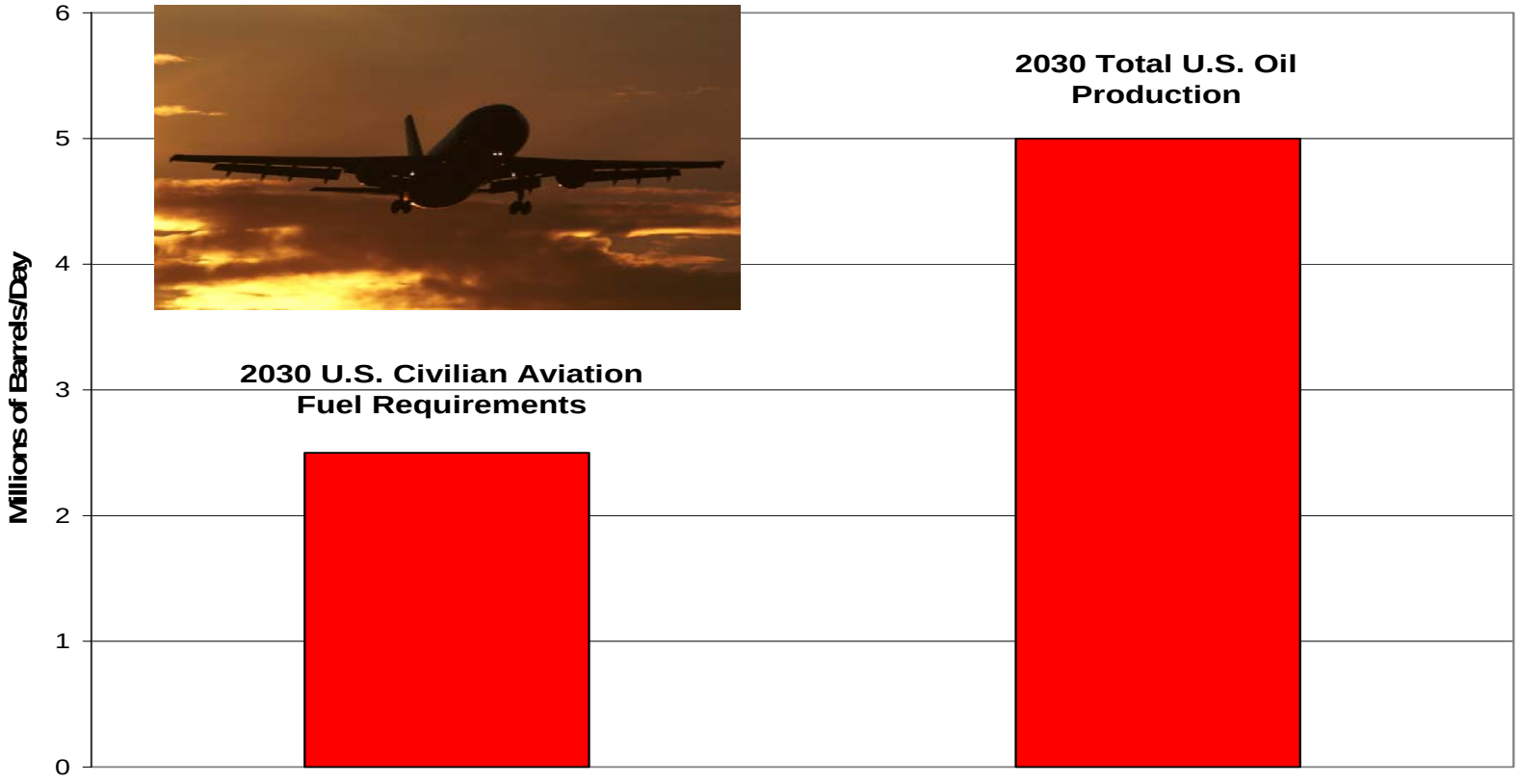
Jet fuel costs have tripled in 4 years





U.S. AIRLINES CONCERNED ABOUT FUTURE FUEL AVAILABILITY

According to EIA, fuel requirements for civilian aviation are increasing rapidly; by 2030 may be equivalent to nearly half of total U.S. domestic oil production



BUT, CONTRARY TO PERCEPTION THAT HIGH OIL PRICES WILL DESTROY AVIATION INDUSTRY….

- **Aviation is currently "one healthy canary":**
  - -- Air travel growth in past 3 years is strongest recovery in history
  - -- Aviation growth in China is unprecedented
  - -- Airlines have returned to profitability
  - -- New airlines being started and some (e.g. Ryanair) have grown spectacularly
  - -- Boeing's 787 is the best selling aircraft in history
  - -- Airport industrial parks and infrastructure are very powerful and profitable economic and job development machines
  - -- Current problem is excess demand
  - -- Aviation infrastructure straining to satisfy growing demand
- **All this has occurred over a period when aviation fuel prices have tripled and some contend that oil has already peaked!**
- So, what is going on?

HARD REALITY ABOUT AVIATION AND FUEL PRICES

- Even at current levels, **fuel costs are modest percentage of total airline costs** ~ 25% – 30%
- Doubling of fuel prices may only increase ticket prices by < 30%
- Today one can fly roundtrip nonstop from D.C. to West Coast for $150 (or less) – normal reserved seat requiring no special deal
- If fuel prices double, ticket price may increase to ~ $190
- This would still be a very low price
- Other factors (airline cost structures, airport charges, overhead, taxes, capacity factors, etc.) are at least as important as fuel prices
- Only aviation growth slumps in past 50 years resulted not from fuel price increases, but from 1991 Gulf War and from 9-11 and SARS

Thus: **Focusing on the direct impact of increased fuel prices on aviation is "looking through the wrong end of the telescope"**

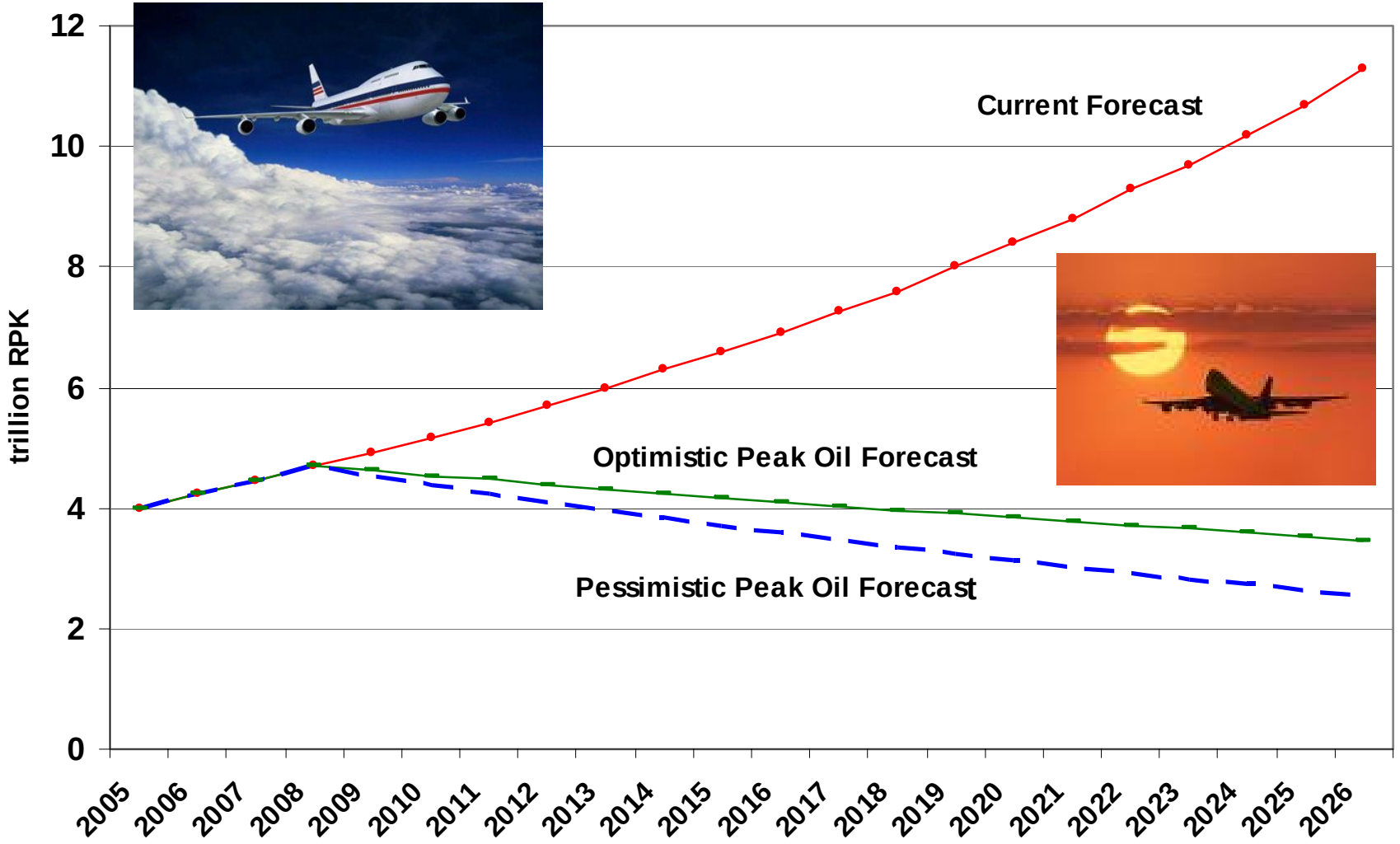
THE REAL ISSUE

- **STUDIES FIND THAT AVIATION GROWTH IS DRIVEN PRIMARILY BY DEMAND: GDP, BUSINESS REVENUES, DISPOSABLE INCOME, ETC.**
- **As long as these are rising, forecasts predict that demand for air travel will grow rapidly**:
  - -- Passenger traffic will grow faster than GDP
  - -- Passenger revenues will grow faster than passenger traffic
  - -- Air cargo will grow faster than passenger traffic or revenues
  - -- New aircraft orders will increase rapidly
- However, **causality works in both directions**:
  - -- If GDP growth lessens, or goes negative, aviation will be disproportionately affected adversely
  - -- **It is the peak oil-induced economic effects that will do the greatest damage to the aviation industry**
- **This is the real importance of peak oil for aviation**

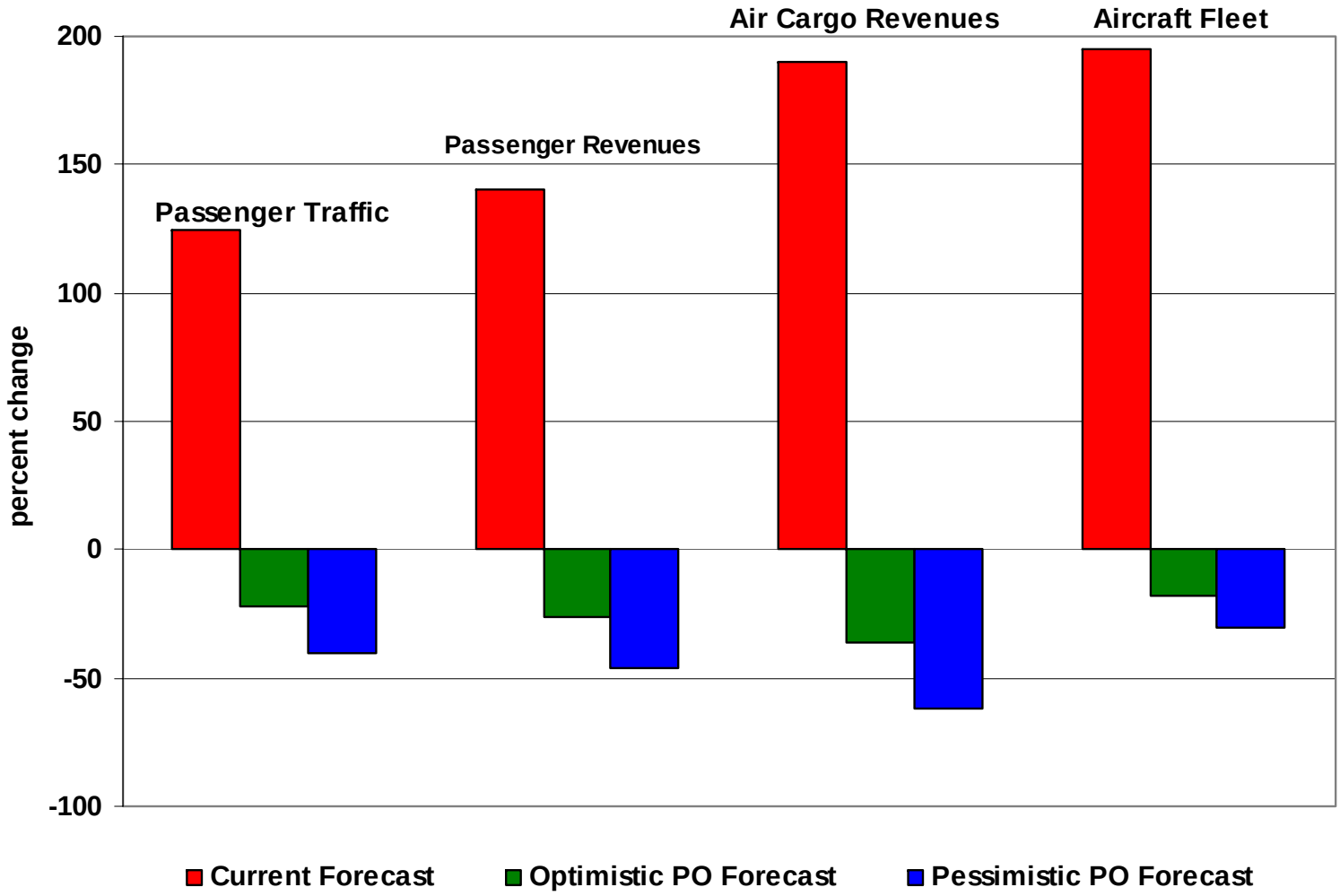
TWO ALTERNATE SCENARIOS

- **We "reverse engineered" the current aviation forecasts**
- Assumed oil peaking in 2008 (not a prediction!)
- Assumed that the decline in oil production after peaking would be ~2% per year and that GDP would decline by about the same %
- We **developed 2 scenarios: "Optimistic" and "pessimistic"**
- "Optimistic scenario": After peaking GDP declines ~ 1% annually
- "Pessimistic scenario": After peaking GDP declines ~ 2% annually
- In both scenarios, we assume relationship between aviation and GDP changes remains similar to historical and currently forecast
- Thus, in both scenarios, passenger traffic declines faster than GDP, passenger revenues decline faster than traffic, and air cargo declines faster than passenger traffic or revenues

WORLD PASSENGER REVENUES AFTER PEAK OIL



WORLD AVIATION FORECASTS, 2008 – 2026, UNDER THREE SCENARIOS



IMPLICATIONS FOR AVIATION INDUSTRY

- **Impact of peak oil on all aspects of aviation industry will be severe due to GDP impacts**
- **Aviation will be transformed from a rapidly growing industry to one in decline**
- Chaos likely throughout industry
- Chronic, continuing excess capacity in all aviation sectors
- $100s of billions of investments will be “stranded”
- Some airlines will disappear or may have to be rescued by governments
- Airport and aviation infrastructure projects will be cancelled
- Bonds for airports, airport industrial parks, infrastructure projects, etc. will likely default, cascading throughout financial sector
- Pressure will mount for re-regulation of aviation
- **However, problems will cascade well beyond aviation sector**

IMPLICATIONS FOR TRAVEL-DEPENDENT SECTORS

- What are the implications of a declining aviation sector?
- A lot less people than anticipated will be traveling
- This has **ominous implications for travel-dependent industries & regions**, which are supposed to be rapidly growing, such as:
  - -- Tourism
  - -- Recreation
  - -- Theme parks
  - -- Destination resorts
  - -- Gaming industry
  - -- Cities and regions dependent on travel, such as Orlando, Las Vegas, Vail, Hawaii, etc.

- These industries and regions will lose trillions of $ in revenues and millions of jobs
- **But it gets even worse**

"IT'S THE GDP, STUPID!"

- The **most important implication of a declining aviation industry is the factor that is causing it: Peak oil-induced declining GDP**
- **This is what we must be concerned about**
- Every major industry will be adversely affected, many of which are more critical than aviation:
  - -- Agriculture
  - -- Healthcare
  - -- Manufacturing
  - -- Emergency and protective services
  - -- Etc.

- Will these be given priority for available liquid fuels? What is more important: Food or cheap air fares to Las Vegas and Vail?
- If so, implications for aviation are even more severe; e.g., available liquid fuels may end up being used in other sectors – due to either price or allocation

CONCLUSIONS

- **Current aviation forecasts are unrealistic**
- Direct effects of fuel prices much less important for aviation than impact on GDP and travel and cargo demand
- Aviation sector must accelerate fuel efficiency and synfuel alternatives; however, these are necessary but not sufficient
- **Peak oil will transform aviation sector from a rapidly growing to a declining industry**
- Some aviation firms will survive and adapt; others will not
- Implications are dire for aviation and all travel dependent industries
- Implications for world economies of declining GDP are severe
- **Nevertheless, a large aviation industry will survive**, and "forecasts of its death have been greatly exaggerated"
- We will still be able to get "fresh strawberries in February" – but they will be fewer and much more expensive

RECOMMENDATIONS

- More research required on the drivers of aviation growth
- More research required on relationship between peak oil and GDP
- Governments should increase transportation fuel efficiency and initiate substitute liquid fuels mitigation options:
  - -- On the demand side, governments should stress transportation efficiency and enhanced fuel efficiency standards for all modes of transportation.
  - -- On the supply side, governments should encourage and pursue all viable options: Coal-to-liquids, oil shale, oil sands, enhanced oil recovery, heavy oil, gas-to-liquids, biomass, diesel, hybrids, electric vehicles, rail, etc.

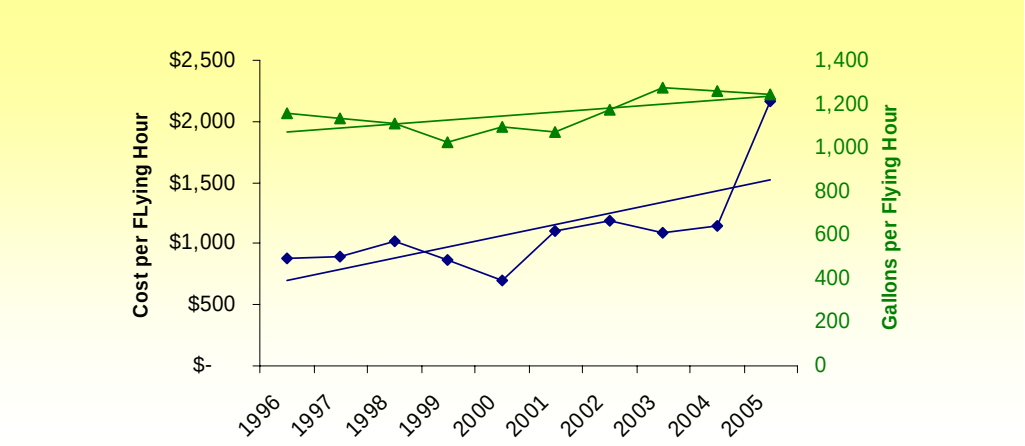
Viable mitigation options exist to lessen impacts of peak oil on GDP and the aviation sector

However, these must be instituted well in advance of oil peaking to be effective

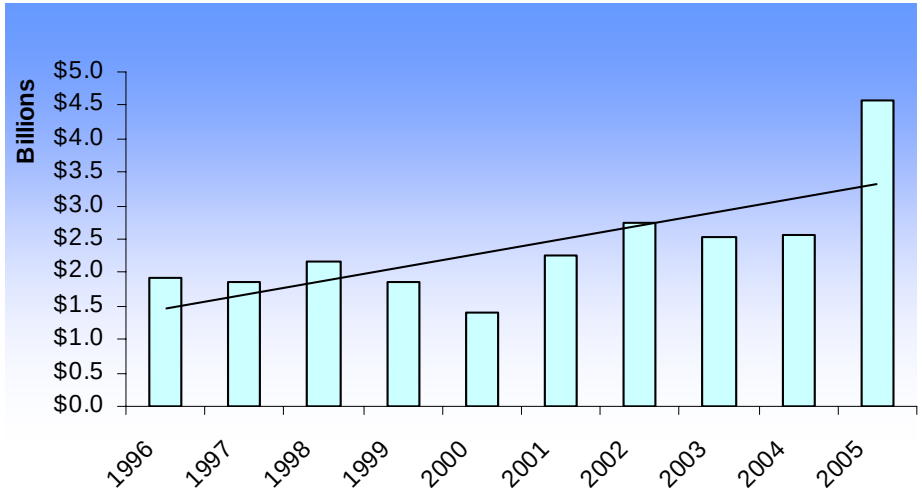
APPENDIX SLIDES

US AIR FORCE FUEL COSTS HAVE ALSO INCREASED

Fuel Cost (TY$) and Gallons Per Flying Hour



Total aviation fuel costs (TY$)



IN RESPONSE, AVIATION SECTOR IS ENCOURAGING SYNFUEL DEVELOPMENT

Air Transport Association of America & individual airlines are encouraging synfuel development

- **JetBlue**
- **Federal Express**
- **Virgin Airlines**
- **ATA Commercial Aviation Alternative Fuels Initiative begun** in October 2006 to assess alternative aviation fuels & address rising fuel prices & supply instability
- Coal-based “JP900” fuel could be used in commercial jetliners. Superior performance characteristics & could reduce U.S. requirements for petroleum-based aviation fuels by 75%

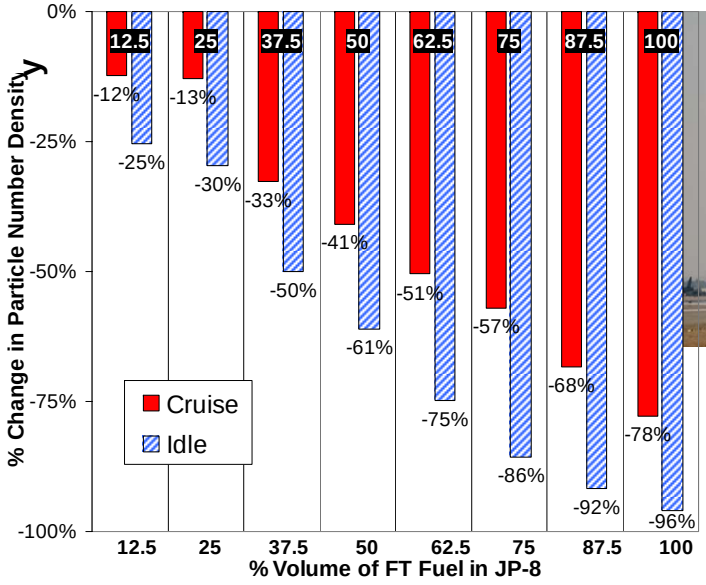
THE EXAMPLE OF FEDEX

- **A major player in aviation and transportation**
- $32 billion in revenues, 250,000 employees, >700 aircraft, 50,000 vehicles
- In 2006, spent $3.5 billion for fuel
- **FedEx actions, micro:**
  - -- Abandoned fuel price hedging; utilizing fuel surcharges
  - -- Seeking more fuel efficient and hybrid vehicles
  - -- Exploring use of alternative aviation fuels
- **FedEx actions, macro:**
  - -- Co-chair Securing America's Future Energy, dedicated to reducing U.S. imports and increasing energy security
  - -- Encouraging Federal govt. development of alternate fuels
  - -- Promoting U.S vehicle fuel efficiency standards

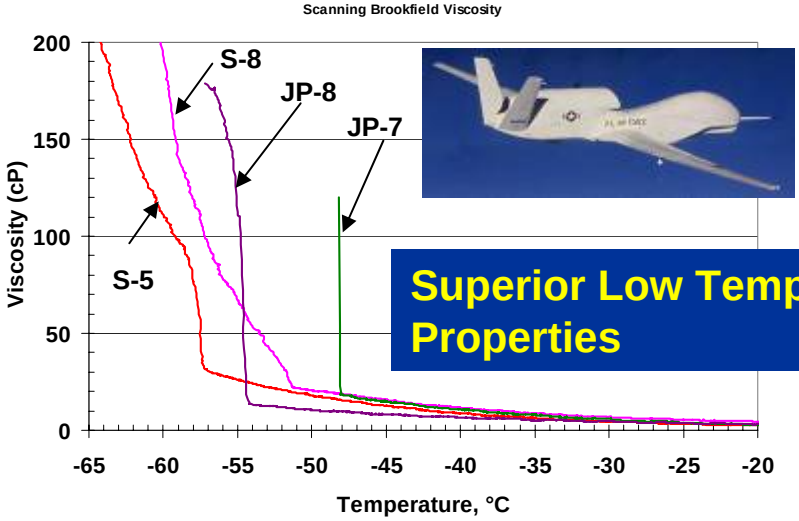
CTL PROVIDES AN ALTERNATIVE FUEL

- **Aircraft have highly specialized demands for fuel**
- **Synfuel using CTL technology offers great promise as an alternative aviation fuel**
- It can meet current specifications and no aircraft redesign is required
- **CTL can provide a "drop-in" replacement for jet fuel**
- Bio-fuels are not currently compatible with aircraft requirements
- **Synthetic aviation fuels derived from coal are currently being used in South Africa**

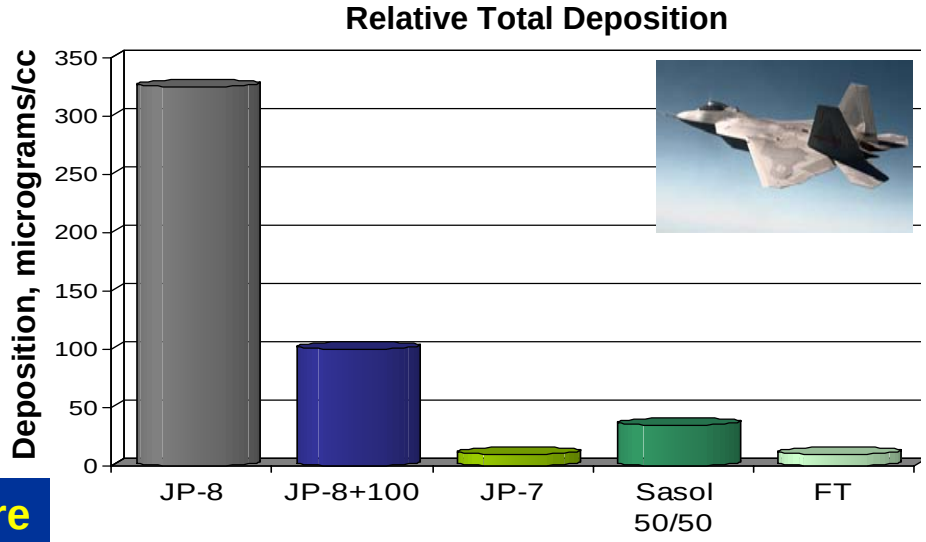
FISCHER-TROPSCH SYNFUEL BENEFITS



Significantly Reduced Emissions



Superior Low Temperature Properties



Excellent Thermal Stability at High temperature