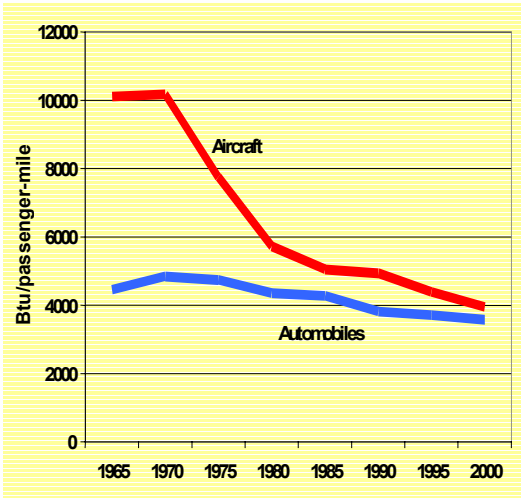
1.1.5 AVIATION

Technology Description

GE90 High Bypass Turbofan

Boeing 777

Today's airplanes are 300 times more energy efficient than early jets.

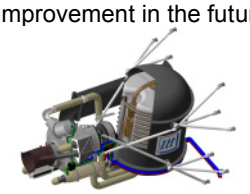


The energy intensity of aircraft and automobiles has improved substantially during the past several decades. Automobile energy intensity has fallen by almost one-fifth, while aircraft energy intensity has fallen by three-fifths during the same period.

LNG Buses at LAX

New technologies reduce ground emissions

…. and revolutionary new concepts offer opportunity for continued improvement in the future.



Humans benefit from the ability to move people and products all over the globe – quickly and safely. Aviation contributes to our quality of life – allowing us to visit friends and relatives, to travel, to experience new places, to shrink the borders of the world. The statistics are impressive. In 1903, Earth's population was 1.6 billion. Today, more than 1.6 billion people use the world's airlines. The Air Transport industry provides 28 million direct, indirect, and induced jobs worldwide. And aircraft carry about 40% of the value of all world trade, providing the "just in time" deliveries critical to productivity improvements. Aircraft use conventional hydrocarbon fuels, and contribute about 10% of greenhouse gas emissions from the transportation sector. Also,

emissions from aircraft engines are unique in the aspect that they are deposited directly throughout the upper atmosphere. Subsonic aircrafts emit gases and particles directly into the lower stratosphere and upper troposphere, while emissions from supersonic aircrafts are deposited at higher altitudes. These aircraft emissions perturb the atmosphere by changing the background levels of trace gases and particles, and by forming contrails.

The Federal Aviation Administration (FAA) and the National Aeronautics and Space Administration (NASA) – together with industry, academia, and other Federal agencies – are pursuing strategies to improve aviation fuel efficiency and reduce its impact on global climate.

System Concepts

- Optimized Operations – more efficient operations to reduce fuel burn.
- Optimize Propulsion – advanced turbine engine technologies to reduce fuel burn.
- Reduce airframe weight and drag – airframe technologies that reduce fuel consumption.
- Alternative vehicles – ground support equipment, airframe concepts, propulsion systems, and fuels that dramatically reduce or completely eliminate emissions from civil aircraft.

Representative Technologies

- Alternate fuel Ground Support Equipment (GSE) and airport ground access vehicles (e.g., electricity, natural gas, propane, fuel cells) reduce ground-based aviation greenhouse emissions.
- Advanced propulsion concepts greatly reduce greenhouse gas and other harmful emissions.
- New materials and design practices continue to reduce aircraft empty weight, enhancing fuel efficiency.
- Information technology and management science advances enable more efficient air traffic management and ground operation procedures.

Technology Status/Applications

- New engine and airframe technologies in today's jets have led to a 70%-80% improvement in fuel burn per seat mile since the early 1960s.
- Airports and airlines are adopting low-emissions technologies available for ground-support equipment and airport access vehicles – substantial progress in replacing gasoline and diesel-powered airport ground vehicles with new vehicles running on cleaner alternative fuels, primarily electricity and compressed natural gas (CNG).
- Enhanced operational procedures offer opportunities for near-term greenhouse gas emissions reductions.
- Continued advances require continued breakthroughs in more efficient engine and airframe technologies; and aircraft technology development and capital turnover follow relatively long cycles, which limits the pace of fundamental changes in design.
- Airborne fuel cells and other alternative-fueled air vehicles have the potential for significant emissions reductions, but are far-term (25 years or more) options.

Current Research, Development, and Demonstration

RD&D Goals

- FAA goal – improve aviation fuel efficiency per revenue plane-mile by 1% per year through 2008, as measured by a three-year moving average, beginning with the three-year average of calendar years 2000-2002.
- NASA technology goals – new technologies with the potential to reduce CO_2 emissions of future aircraft by 25% within 10 years and by 50% within 25 years (using 1997 subsonic aircraft technology as the baseline).

RD&D Challenges

- Developing new technology that reduces emissions while still being affordable.
- Ensuring new concepts do not result in additional system weight, which increases fuel burn substantially.
- Very high premium for safe operation, which constrains the use of unproven new technologies and strategies relative to other transportation modes.

RD&D Activities

- NASA is pursuing research activities on efficient engine technologies, advanced aerodynamic shapes and

structures, autonomous robust avionics, and low-emissions alternative power, which could lead to significant emissions reductions.

- FAA has a roadmap for continuing to mitigate the environmental impacts of aviation. This includes research to improve its understanding of the role of aviation emissions on the environment and optimize overall environmental impact mitigation strategies.
- Department of Energy research on alternative-fuel ground vehicles can lead to reduced emissions from airport ground-support equipment and access vehicles.

Recent Progress

- FAA's Inherently Low-Emission Airport Vehicle (ILEAV) Pilot Program seeks to evaluate airport use of alternative-fuel vehicles and infrastructure to determine their reliability, performance, and cost-effectiveness in the airport environment. Under this pilot program, there are 125 project vehicles in operation and at least 150 more vehicles planned for service.
- NASA's primary engine research program, the Ultra-Efficient Engine Technology Program (UEET), has made significant progress toward demonstrating its goals of 15% fuel burn (equivalent to CO_2) reduction and 70% NO_x reduction relative to 1996 standards.
- FAA has developed a unique capability to estimate aircraft emissions ranging from a single flight to regional and worldwide scales. The System for assessing Aviation's Global Emissions (SAGE) will be able to develop aviation emission inventories, both for baseline conditions and forecasted technology, operational, and market-based measures and improvements.
- Airlines have launched new initiatives to reduce fuel burn by limiting the use of auxiliary power units by using ground power whenever possible.
- FAA has established a new Center of Excellence for Noise and Emissions Mitigation, which will identify solutions for existing and anticipated aircraft emissions-related challenges.

Commercialization and Deployment Activities

- Aircraft are dependent on liquid fossil fuels, and potential modifications to fuel type and composition for environmental benefits are limited.
- FAA's Low-Emission Airport Vehicle (ILEAV) Pilot Program is assisting in deploying low-emissions technology to airport operations.
- Fuel costs are a significant portion of operating costs for an airline; hence airlines have great incentives to reduce fuel burn.
- Better meteorological information, yield-management tools, and the hub and spoke system – combined with the growth of low-cost, point-to-point carriers, and a significant increase in the number and reach of regional airlines – is improving the efficiency of the entire aviation network.