

GREENING U.S. AVIATION

Energy Challenges of Commercial Aviation

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GREENING U.S. AVIATION

Aviation's Contribution to Society

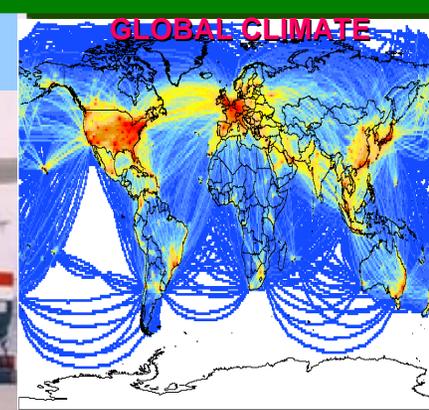
- > \$1.2 trillion each year to the U.S. economy
- Supplies more than 1 million jobs
- Global transport of people and products — quickly and safely
- Better quality of life — allowing us to visit friends and relatives, to travel, to experience new places, to connect the regions of the world



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But There associated environmental challenges

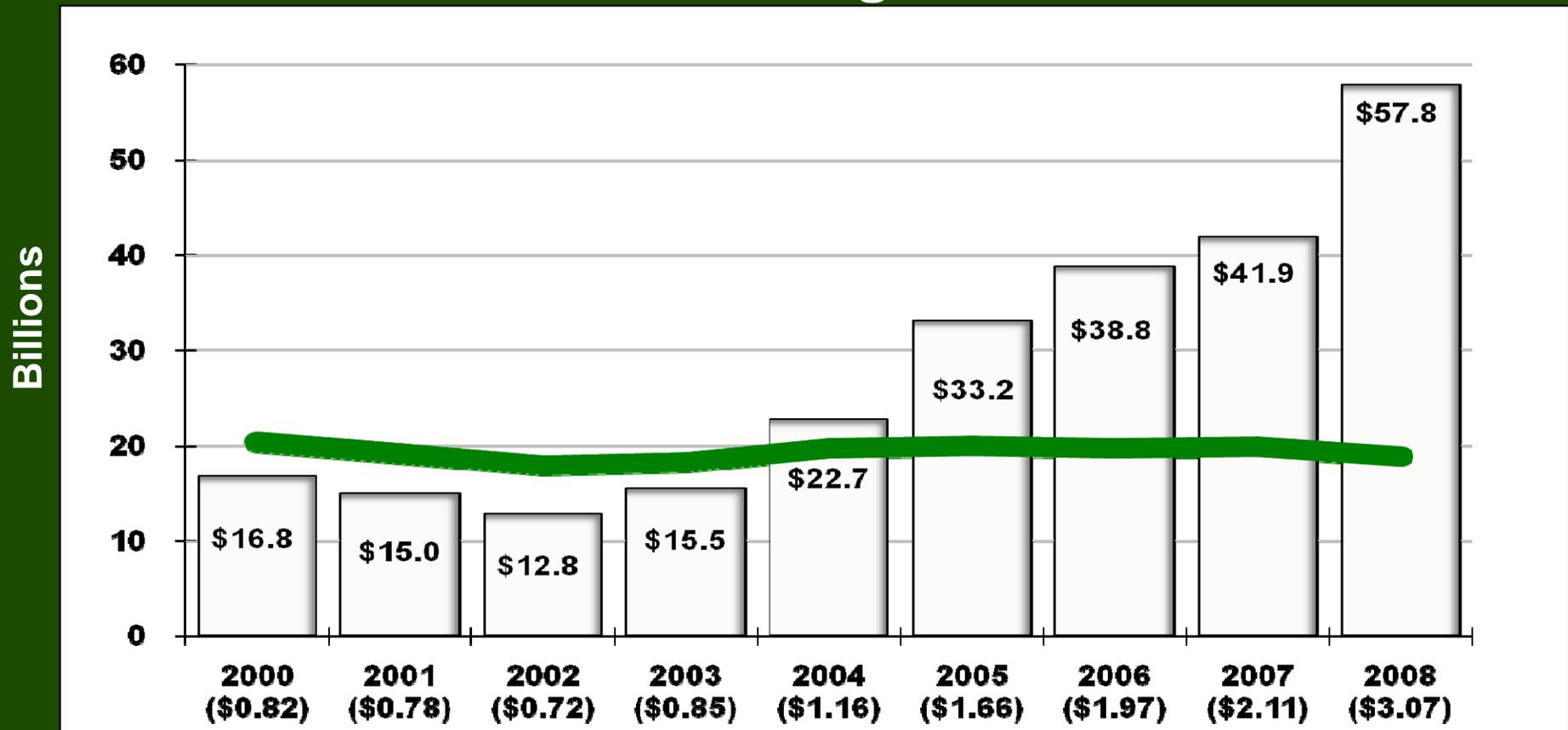
- Aviation impacts community noise footprints, air quality, water quality, energy usage and availability, and the global climate.
- Trends show environmental impacts from aircraft noise and emissions will be a critical constraint on mobility.
- Fundamental changes ongoing from economic downturn, fuel costs, and financial turmoil.



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ENERGY ISSUES

Demand and fuel cost continues to increase as the need for aviation grows

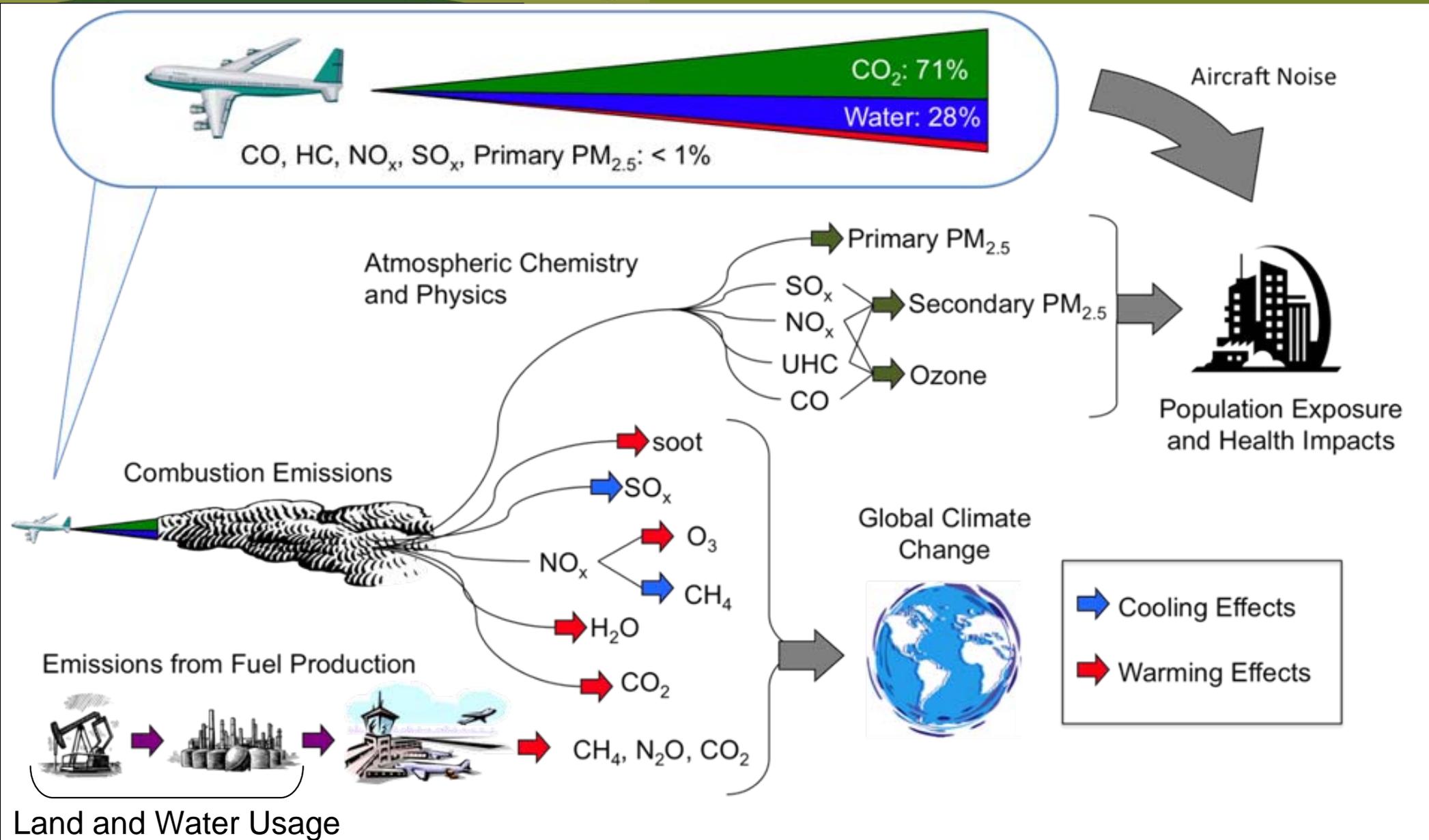


Note: Value in parentheses below year is average price paid per gallon excluding taxes, into-plane fees, pipeline tariffs and hedging costs

Sources: ATA, Energy Information Administration, Department of Transportation

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SIMPLIFIED VIEW OF AVIATION IMPACTS



The Solution - U.S. five-pillar approach

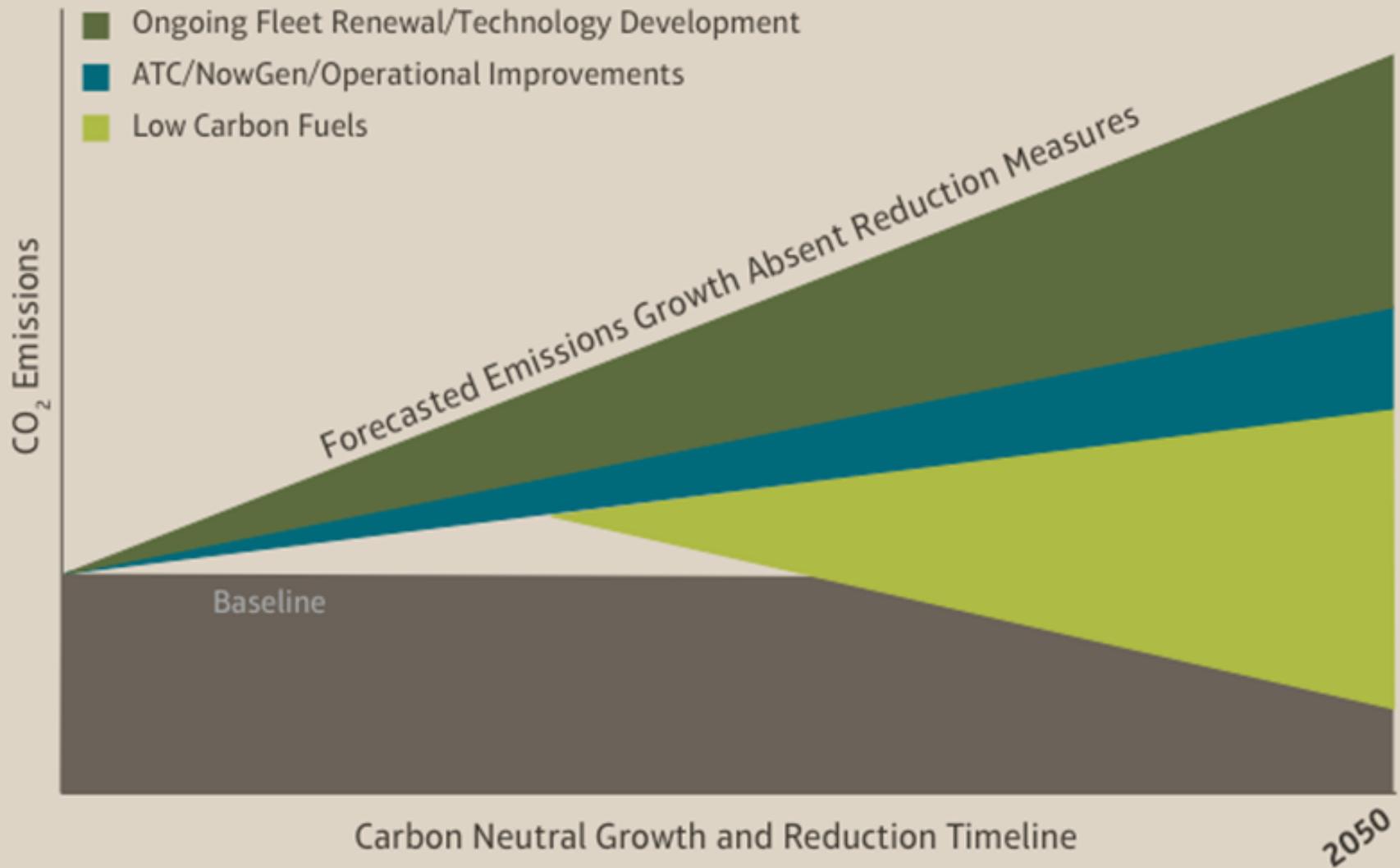
- Advance Scientific Understanding & Improve Analysis Capability
- Accelerate Transition of New Aircraft Technology
- Develop Alternative Fuels
- Accelerate Operational Changes
- Examine Policies, Standards and Market Based Measures

Our Plans

- Absolute reductions in significant noise and air quality impacts
- Aggressive efficiency improvements of at least 2% per year
- Carbon neutral growth by 2020, absolute reductions by 2050
- Aircraft and engine CO₂ and other emissions standards

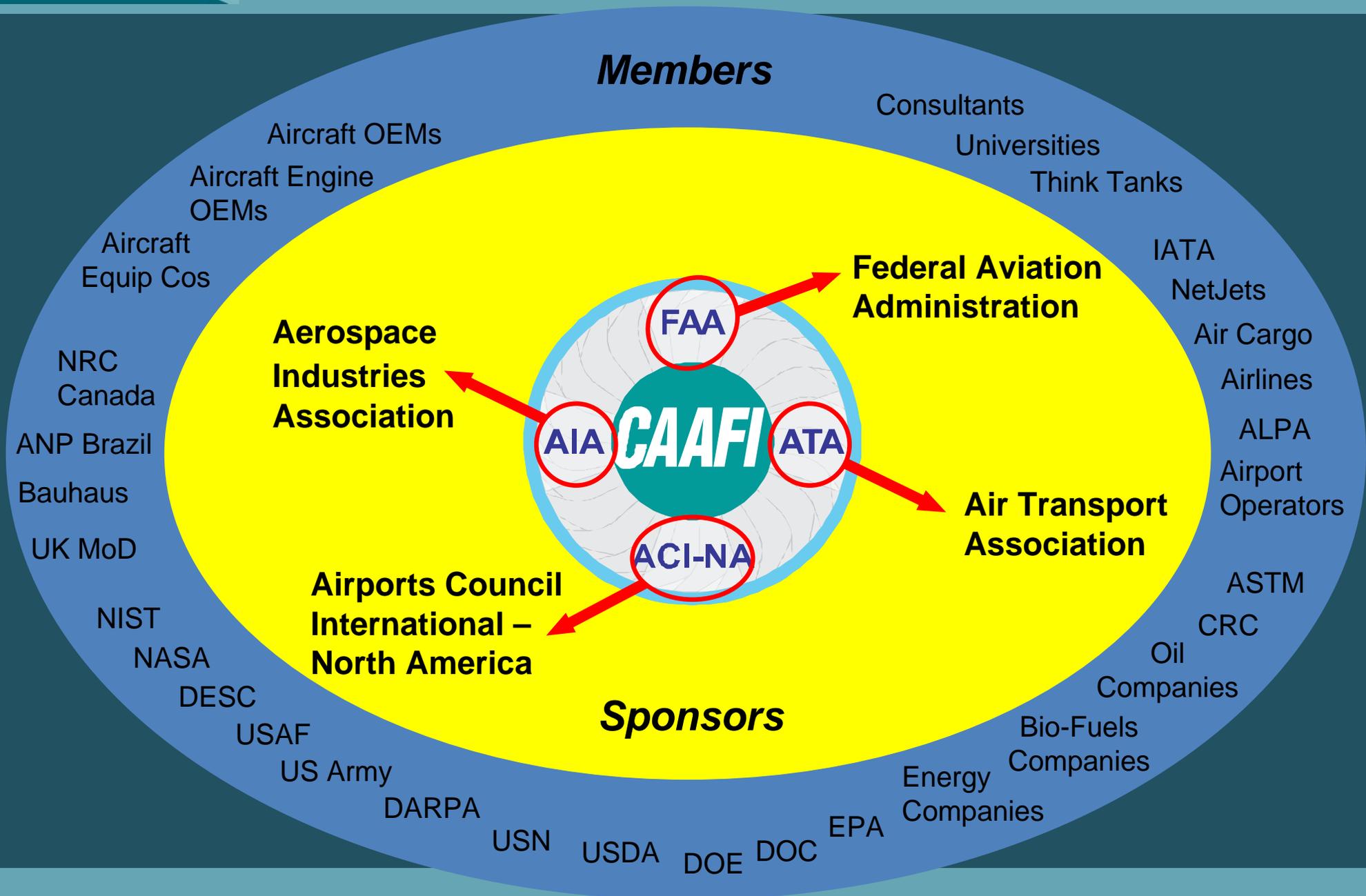
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CARBON NEUTRAL GROWTH GOAL



FAA Alternative Aviation Fuel Activities

- Commercial Aviation Alternative Fuels Initiative (CAAFI)
- Continuous Lower Energy, Emissions and Noise (CLEEN) program
 - Assess impact of alt fuels on aircraft fuel system
 - Alt fuel engine tests and flight demos
- Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) Center of Excellence www.partner.aero
 - Life cycle analysis of green house gas emissions
 - Modeling and assessment
- Airport Cooperative Research Program www.trb.org/ACRP/Public/ACRP.aspx
 - Resources for integrating alt fuels at airports
 - Cost/benefit analyses of alt fuels at airports



WHAT HAVE WE ACHIEVED RECENTLY?

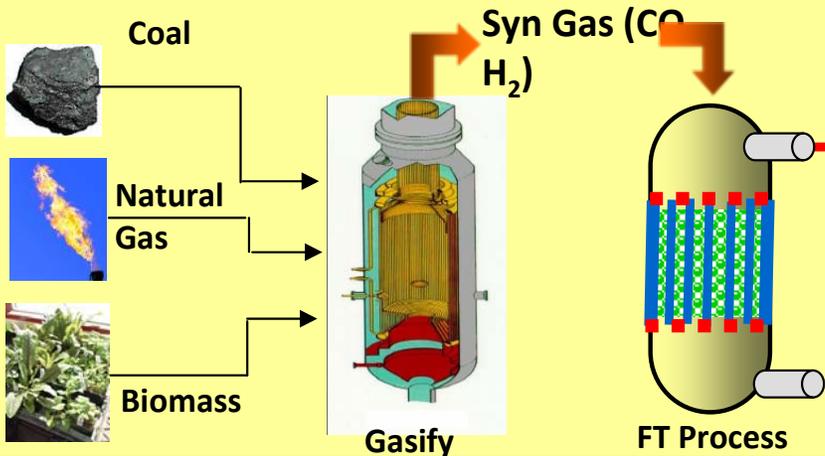
- Approval of a new synthetic jet fuel specification (ASTM D7566) —
 - Fisher-Tropsch alternative blends now approved
 - Hydroprocessed renewable jet (HRJ) expected soon
- Multiple flights on these fuels
- Research & Development roadmaps
- Development of a Fuel Readiness Level (FRL) scale
- Formed coalition of airlines, aircraft and engine manufacturers, energy producers, researchers and U.S. government agencies
- Facilitated links between energy companies, airline fuel buyers and investors in support of early commercial deployment;
- Established CLEEN program

CURRENT ALTERNATIVE JET FUEL PROCESSING

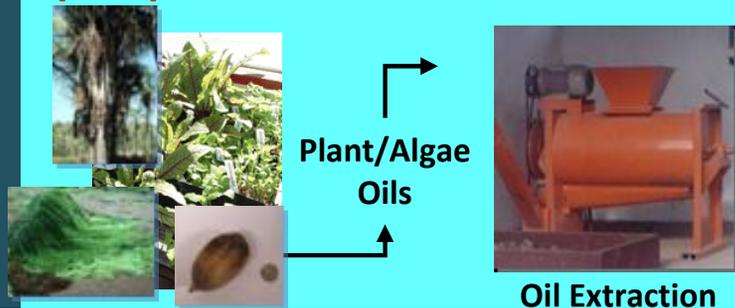
Petroleum



Fischer-Tropsch (FT)



Hydroprocessed Renewable Jet (HRJ) from Bio-Oils



Conventional Refinery Processes



Crude Oil



Syn-Crude



Bio-Crude



Hydroprocessing



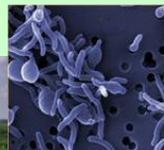
Jet Fuel

Synthetic Jet Fuels in R&D Phase

Advanced Fermentation (FRJ)



Fermentation



Genetically Engineered Microbes



Jet Fuel

Alcohol Oligomerization (CRJ)



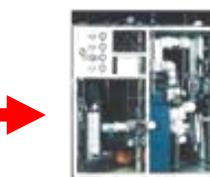
Fermentation



Dehydration



Olefins



Polymerization



Hydroprocessing



Jet Fuel

Pyrolysis (PRJ)



Pyrolysis



Bio-Crude



Hydroprocessing



Jet Fuel



sugarcane

Sugar



switchgrass



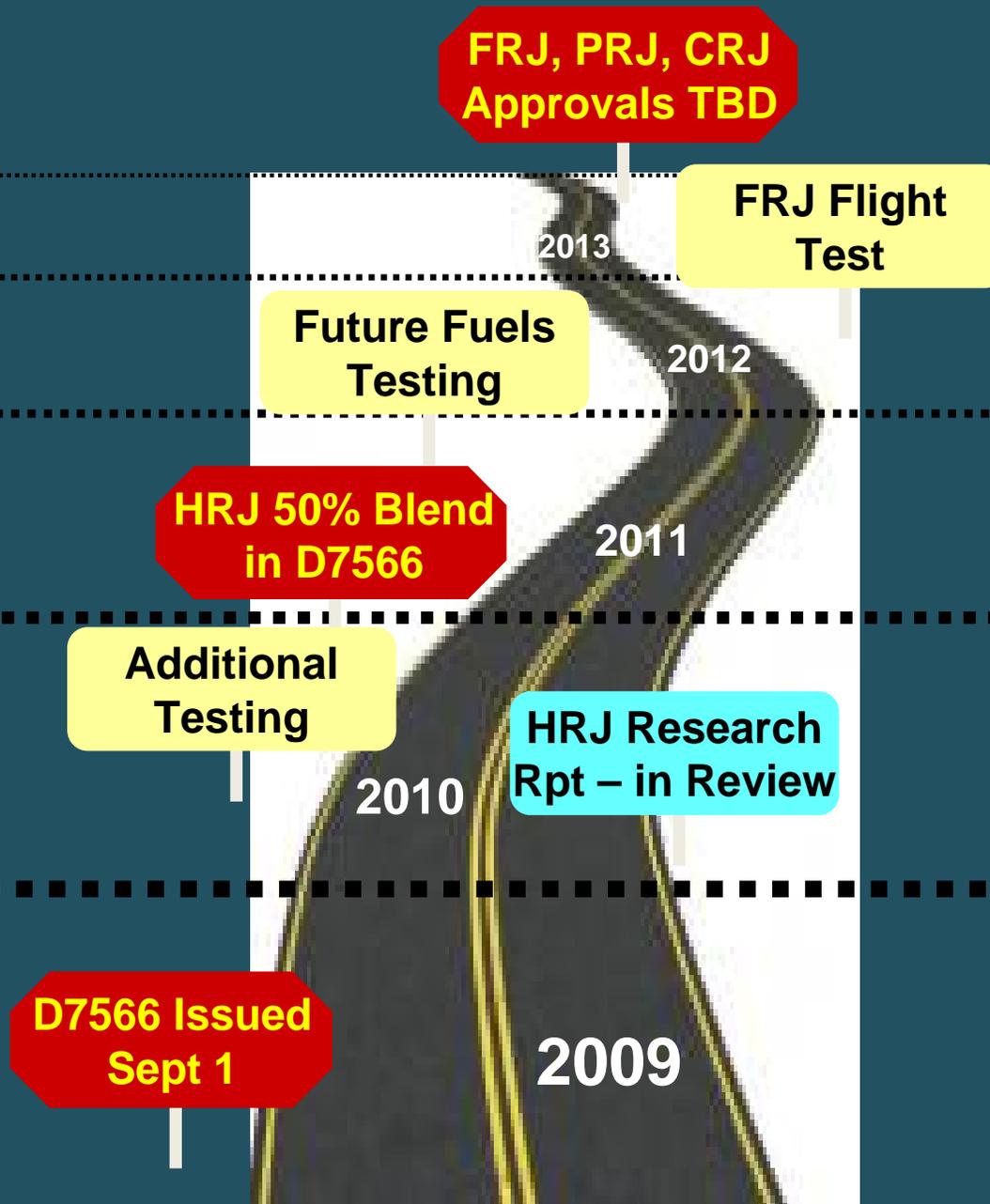
corn stover



forest waste

Lignocellulose

CERTIFICATION / QUALIFICATION PLANS & TARGETS



- **Commercial aviation growth & capacity constrained by environmental impacts**
- **We are actively addressing energy challenges of commercial aviation**
 - **Improving scientific understanding**
 - **Accelerating technology transition**
 - **Developing aviation alternative fuels**
- **Aviation alternative fuels show great promise for reducing environmental impacts and enhancing energy security**

- **Commercial Aviation Alternative Fuels Initiative (www.caafi.org)**
- **CLEEN**
(http://www.faa.gov/about/office_org/headquarters_offices/aep/research/cleen/)
- **Partnership for AiR Transportation Noise and Emissions Reduction**
(www.partner.aero)
- **Airport Cooperative Research Program**
(www.trb.org/ACRP/Public/ACRP.aspx)