

# Gas Turbine R&D

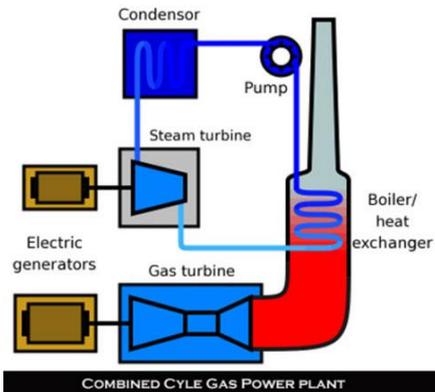
## Industry, Universities, and Government Collaborations Lead to Success

Karen A. Thole

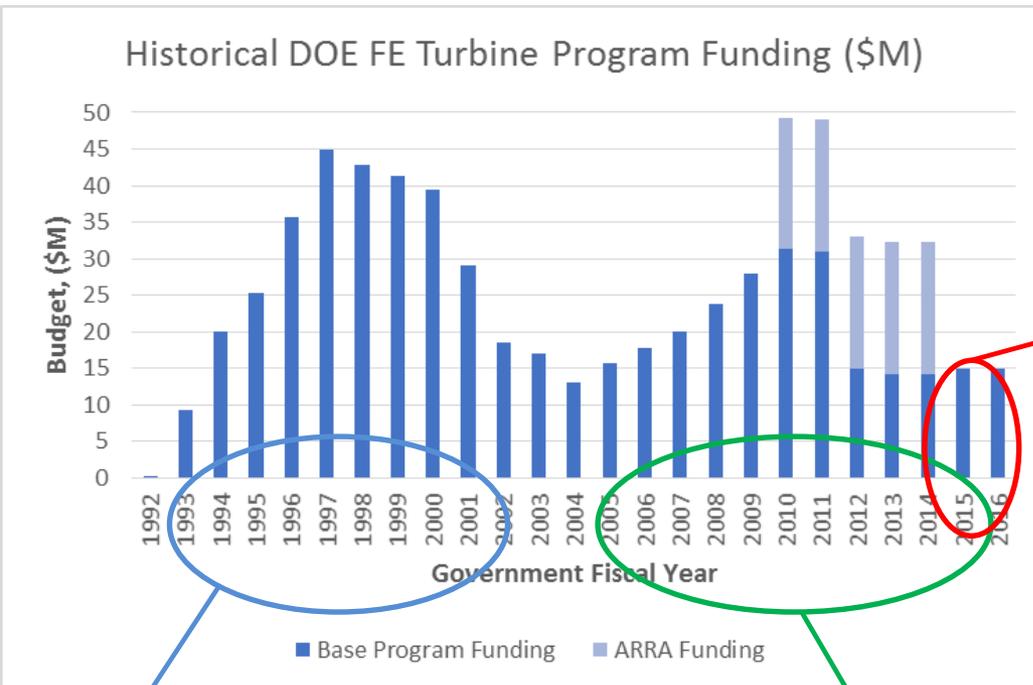
Mechanical and Nuclear Engineering



PennState



# DOE funding for turbine research is directly applicable to improving efficiencies (reducing impact to the environment)



## ATS Program (1992-2002)

- GE delivers most adv. 60% eff. NGCC
- Siemens produces adv. G-class components
- Focus on NG

## H<sub>2</sub> Turbine Program (2005-2015)

- Solved H<sub>2</sub> combustion problem
  - Revolutionized combustion
- Advanced cooling architecture through advanced manufacturing

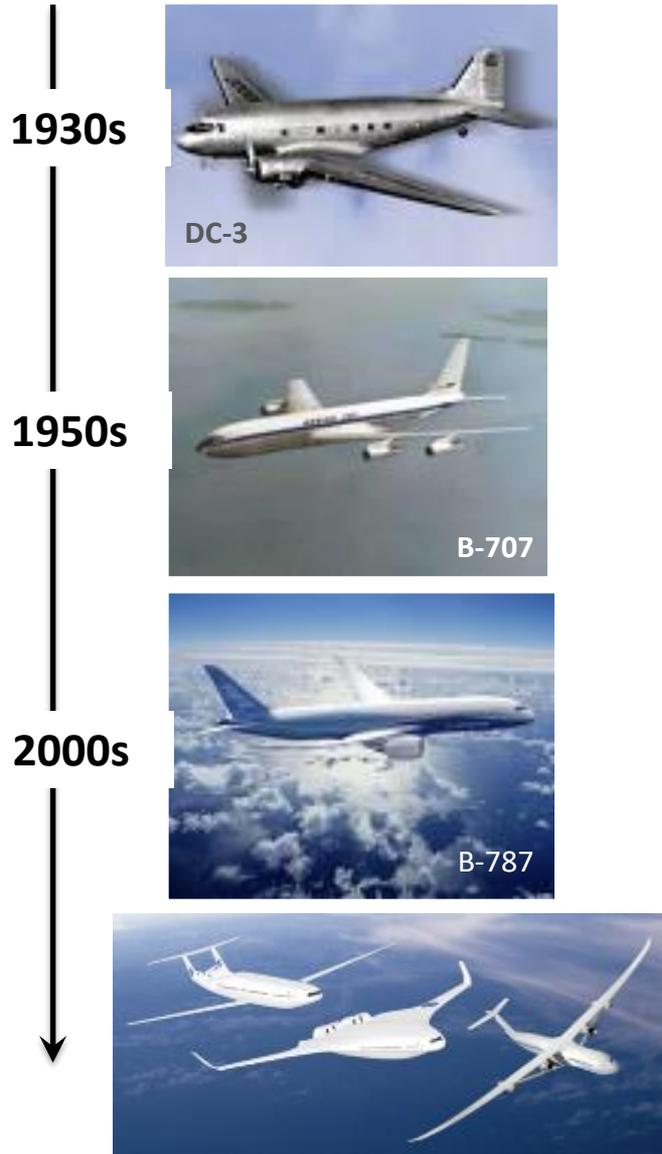
## AT Program (2014 – 2025)

- Moving to 65% efficiencies
- Full scale, full can combustion test at 3100F w/ < 25ppm NO<sub>x</sub>
- CMC nozzle design selected
- CMC combustor components down-selected from 50 concepts to 2
- Dry gas seal initial design completed for end seal in utility scale SCO<sub>2</sub> expander

# To achieve DOE's clean energy goals, they catalyze strong partnerships with industry and academia



# For aero applications, research in gas turbines is needed to reduce impacts to the environment



## 6 Strategic Research & Technology Thrusts



### Safe, Efficient Growth in Global Operations

- Enable full NextGen and develop technologies to substantially reduce aircraft safety risks



### Innovation in Commercial Supersonic Aircraft

- Achieve a low-boom standard



### Ultra-Efficient Commercial Vehicles

- Pioneer technologies for big leaps in efficiency and environmental performance



### Transition to Low-Carbon Propulsion

- Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology



### Real-Time System-Wide Safety Assurance

- Develop an integrated prototype of a real-time safety monitoring and assurance system



### Assured Autonomy for Aviation Transformation

- Develop high impact aviation autonomy applications

# To achieve NASA's goals, they catalyze collaborations between universities and industry

Courtesy of NASA

## Three Main Components:

- NASA in-house research
- Collaborations with partners (OGA, Industry, Academia)
- Sponsored research by NASA Research Announcement (NRA)



**Universities contribute to DOE's and NASA's goals by doing collaborative research with industry**

**Through teaching and research, universities educate the future workforce where advanced degrees with practical turbine experience are needed**



**PennState**

