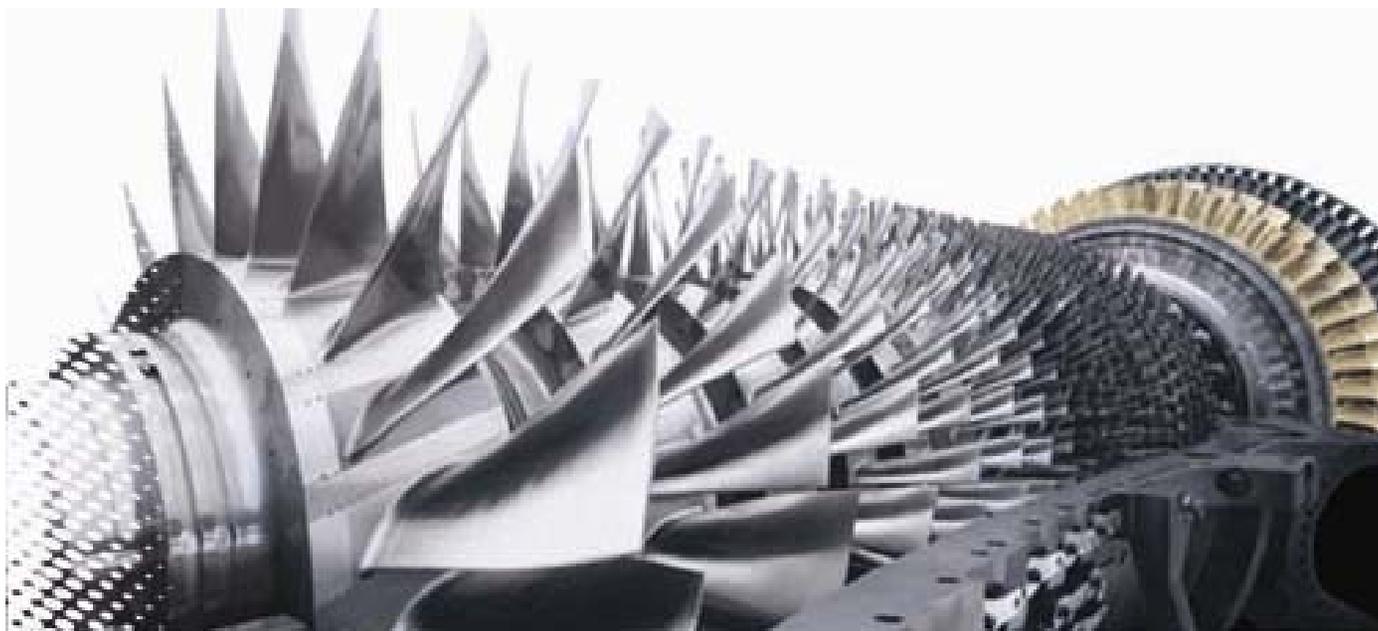


NATIONAL ENERGY TECHNOLOGY LABORATORY



Advanced Turbines for IGCC with CCS

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2010 University Turbine Systems Research Workshop
Penn State University
October 19-21, 2010



Presentation Overview

Advanced Turbines for IGCC with CCS

- Program Goals
- Budget
- UTSR Solicitation
- Discussion

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FE Coal Program Goals

- **RD&D to enable CCS in post-2020 timeframe**
- **Support first generation CCS technologies**
- **Coal plant performance targets include:**
 - <10% increase in IGCC COE with CCS
 - <35% increase in PC COE with CCS
 - 90% CO₂ capture
 - 99% CO₂ storage permanence
 - +/- 30% storage capacity resolution

Advanced Turbine Program Approach/Goals

Pre Commercial Hydrogen Turbine by 2020

- **Approach:** Exercise Phase II through 2012; compete phase III
- **Goals**
 - By 2020 validate a commercially ready hydrogen turbine with a 2,650 F inlet temperature
 - Improve turbine performance to recover cost (\$/kW) and performance (efficiency) penalties due to CCS in coal-based IGCC

Nominal Characteristics of the 2020 H₂ Turbine

- **Turbine**

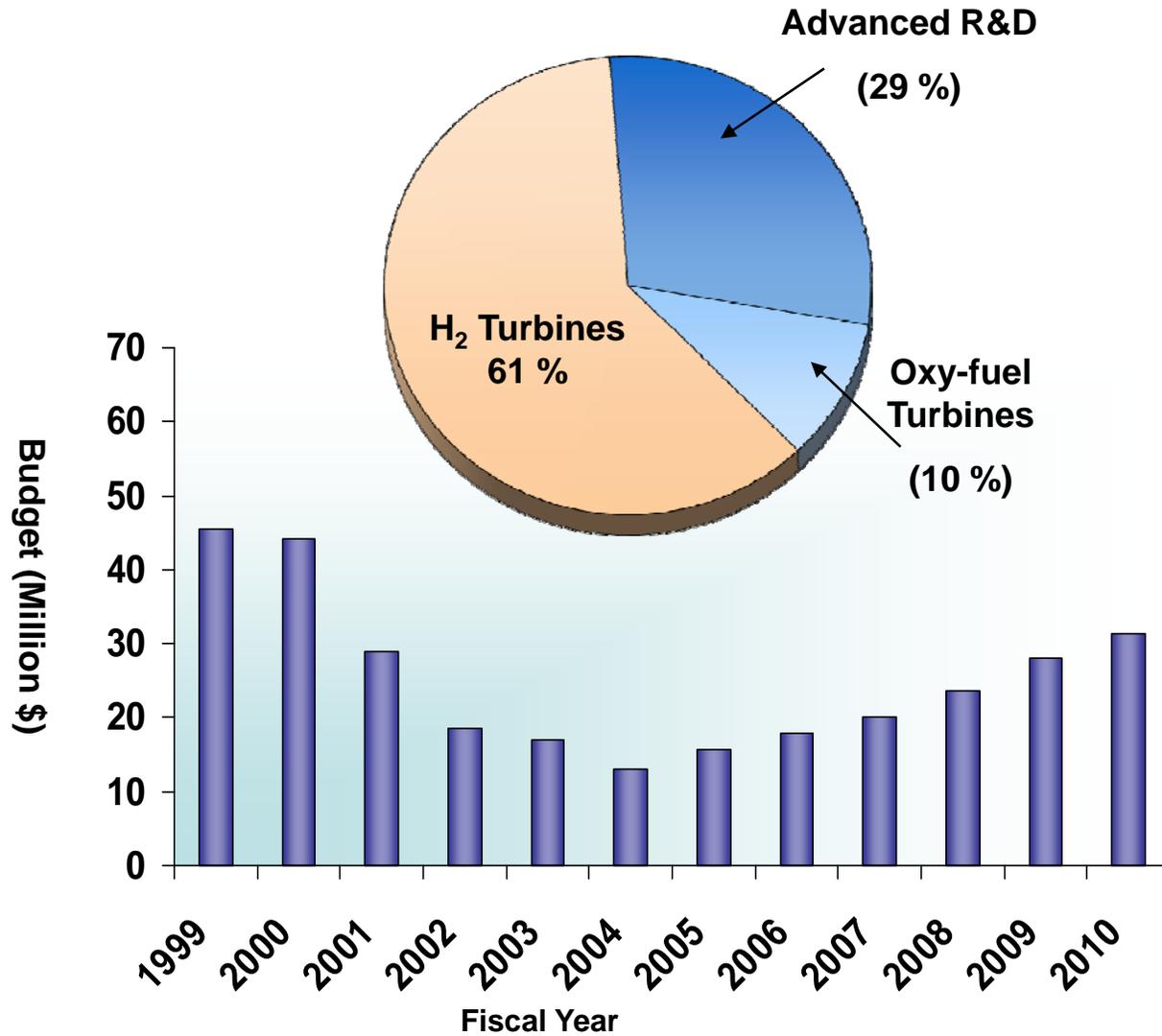
- Pressure Ratio = ~24
- Turbine inlet temperature = 2,600 – 2,700 F
- Inlet airflow = > 4,600,000 lb / hr
- ASU Integration: GT extraction ~10 %, ASU air ~40%
- CC Net power = ~1,100 MW (2 GT on 1 ST)

- **IGCC Plant**

- IGCC net output ~ 850 MW
- IGCC net efficiency ~ 36 % (HHV) w/ 90% CCS
- 2 Advanced gasifier trains
- NO_x control to 2 ppm with SCR

FE Advanced Turbine Budget/Projects

FY 2010 Budget \$31M



ARRA Investment in Turbine Technology

- **2009 ARRA funds to stimulate job growth through clean and efficient energy technology development**
- **Addresses Presidential initiatives for CO2 reduction**
- **Develop technology to improve GT performance for industrial applications with CCS.**
- **Three Turbine area awards made:**
 - GE H2 Turbine development
 - SE H2 turbine development
 - CES Oxy-fuel turbine development
- **ARRA Industrial H2 Turbine projects will benefit H2 Turbines for IGCC**

Overview of 2010 UTSR Solciation

2010 Procurment Schedule

| <u>Milestone</u> | <u>Completion Date</u> |
|--------------------------------|------------------------|
| PR Receipt | 01/16/10 |
| Procurement Strategy Meeting | 01/28/10 |
| Draft Solicitation Topic Areas | 02/23/10 |
| Public Comments recived | 03/08/10 |
| Solicitation Issuance | 03/15/10 |
| Applications Received | 04/28/10 |
| Initial Reviews Complete | 05/26/10 |
| Consensus Meeting | 06/10/10 |
| Senior Technical Briefing: | 06/18/10 |
| Source Selection | 06/26/10 |
| Congressional Notification | 07/14/10 |
| Award(s): | 09/30/10 |

Overview of Results

- **Three topic areas**
 - combustion (16)
 - *aero & HX* (12)
 - materials (12)
- **7 proposals selected**
- **2–3 review teams per area**
- **OEM, university, NL reviewers**
- **Rigorous tech evaluation**
- **\$3.3 MM DOE Award**
 - 20 % cost share

2010 UTSR Awards

Top Proposals Selected in All Areas

- **Combustion**
 - GA Tech - Flame propagation characteristics of H₂ fuels
 - Texas A&M - Turbulent burning vel., NOx validation
- **Aero & Heat Transfer**
 - U TX Austin - Cooling and TBC configurations
 - U of ND Grand Forks - Predictive HX with deposition
- **Materials**
 - LA University - Molecular methods to improve TBCs
 - U CA, Irvine - Degradation of oxides and TBCs
 - Stony Brook University, NY - Advanced TBCs

Summary

- **GE and Siemens have established the turbine design parameters to meet DOE goals**
 - Should recover cost and performance penalties accrued by CCS
 - Need to complete R&D
- **Budget sufficient to complete phase II**
- **ARRA funding will help advanced H2 turbines for IGCC**
- **UTSR is in excellent shape**