FACT SHEET

I. PROJECT PARTICIPANTS

Prime Participant

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(Richard Wenglarz, Research Manager, (864) 656-2267, rwnglrz@clemson.edu,
Bill Day, Outreach Manager, (860) 404-0759, billday@cttel.net)

Sub-Award Participants

Brigham Young University, Professor Jeffrey Bons
Clemson University, Professor John Wagner
Cleveland State University, Professor Kang Lee
Georgia Tech, Professor Jerry Seitzman
Georgia Tech, Professor Benjamin Zinn
Georgia Tech, Professor Tim Lieuwen
Louisiana State University, Professor Sumanta Acharya
Penn State University, Professor Domenic Santavicca
Texas A&M University, Professor J. C. Han
University of California, Irvine, Professor Scott Samuelsen
University of Central Florida, Professor Y. H. Sohn
University of Central Florida, Professor Eric Peterson
University of Connecticut, Professor Eric Jordan
University of Connecticut, Professor Nitin Padture
University of Minnesota, Professor Terrence Simon
University of Pittsburgh, Professor Minking Chyu
University of Pittsburgh, Professor Fred Pettit (2 projects)
Virginia Tech, Professor D. Tafti
Virginia Tech, Professor Karen Thole
Virginia Tech, Professor Uri Vandsburger
University of Wisconsin, Professor Scott Sanders

II. PROJECT DESCRIPTION

A. Objective(s) – This program supports and facilitates development of advanced energy systems incorporating turbines in the United States through a university research environment. The program uses university research capabilities to introduce students to high level turbine related issues and engage them in research that is consistent with the primary mission of universities, that is, to be institutions of learning at the highest level.

Industry involvement and leadership will be used to help set the highest possible standard for execution of university research consistent with two important goals: relevance to advanced energy systems development and the cultivation of student learning. The process of industry involvement includes:

- Recommending most appropriate topics for university research
- Evaluating proposals submitted by universities
- Recommending the best proposals for award
- Supporting and improving university-industry interfaces and interactions
- Improving technology transfer processes by supporting the highest education and training standards

With the support of an existing Industrial Review Board (IRB), an outreach plan has also been developed that aids excellent technology transfer and helps entice growth in the number of industry and university participants in the program.

B. Background/Relevancy – The UTSR Program follows a previous and similar AGTSR university research program that successfully supported the goals of the DOE ATS Program and research needs of the US gas turbine industry. The UTSR program has now been focused to addressing issues for turbines fueled by syngas and hydrogen (SGH).

C. Project Summary – Under this UTSR program, SCIES is coordinating a consortium of members from 108 performing member universities from 40 states, gas turbine manufacturers, and other energy related organizations. Gas turbine research and other activities that support DOE advanced energy program goals and meet the needs of the US energy industry are defined with input from an Industrial Review Board (IRB), representing the non-university member organizations of the consortium. The performing member universities conduct the research.

D. Period of Performance – January 1, 2002 through December 31, 2007

III. PROJECT COSTS $ 3,150 K/yr

A. DOE Costs	$ 3,000 K/yr
B. Prime Cost Sharing	$ 150 K/yr
C. Partner Cost Sharing	Not required

IV. MAJOR ACCOMPLISHMENTS SINCE THE BEGINNING OF THE PROJECT

IMPORTANT RECENT TECHNICAL ACCOMPLISHMENTS

- *PREVENTION OF TURBINE FAILURES. A patent disclosure has been filed for a method to monitor pressure or heat release data to determine the stability margin of gas turbine combustors. This enables plant operators to avoid excessive noise, structural failures, and forced removal of turbines from service from instabilities such as have occurred in the past for low emissions combustors. (Georgia Tech University, initiated in 2002).*
- *IMPROVED TURBINE BLADE COOLING. An improved computational model has been shown to provide much better flow and heat transfer predictions than the standard turbulence model for rotating cooling channels with angled ribs to enhance turbulence. Compared to W-shaped ribs, discrete W-shaped ribs and angled ribs, discrete V-shaped*

ribs provide the best overall thermal performance in both rotating and stationary cooling channels. (Texas A&M University, initiated in 2003).

- *DEPOSITION FACILITY FOR SYNGAS TURBINE EVALUATIONS. Validation tests representing turbine ingestion of foreign particulate in the urban environment showed deposits formed on test specimens were very similar to deposits formed on components of turbines that had operated in urban environments. This new facility may be the only one currently operating in the US designed to simulate turbine deposition environments, such as in syngas turbines. (Brigham Young University, initiated in 2002).*

EARLIER BEST TECHNICAL ACCOMPLISHMENTS SINCE PROGRAM INCEPTION

- *NON-DESTRUCTIVE EVALUATION (NDE) INSTRUMENT DEVELOPED (University of Connecticut): Laser Fluorescent research resulted in a superior portable low cost instrument used by turbine manufacturers to assess residual life in thermal barrier coatings, TBCs. (University of Connecticut, project initiated in 1995).*
- *TBC MANUFACTURING PROCESS DRAMATICALLY IMPROVED. Polishing technique to remove bond coat surface defects (e.g., roughness and embedded oxides) was implemented by a turbine manufacture and use triples TBC life (University of Connecticut, project initiated in 1995).*
- *NEW COATING APPLICATION TECHNIQUES DEVELOPED FOR TBCs. Process was developed to halve internal oxidation rate of the bond coat (Northwestern University, project initiated in 1998.*
- *CORROSION RESISTENT TBCs DEVELOPED. Ceramic barriers for TBCs developed for turbines that allow operation on syngas fuel (Cleveland State University, project initiated in 1996).*
- *TBCs DEVELOPED FOR IMPROVED PERFORMANCE AND DURABILITY. New ceramics identified show a pathway to a $200,000,000/year fuel cost savings as well as significantly reducing CO2 emissions (University of Connecticut, initiated in 2000).*
- *ABILITY TO CONTROL COMBUSTION INSTABILITIES DEMONSTRATED. An Active control approach was demonstrated for overcoming instabilities in order to allow operation of low emission combustors. Several turbine manufacturers are actively studying practical application (Georgia Tech, initiated 1995).*
- *DESIGN TOOLS FOR TURBINE COMBUSTORS DEVELOPED. Finally, a practical computer code (low cost and low run times) was developed to predict specific combustor design emissions and to a very high degree of accuracy (Cornell University, initiated in 1996).*
- *INFRARED TEMPERATURE SENSOR. Research on infrared temperature sensing led to two commercial products, a rapid scanning linear-array spectrometer (En'Urga, Inc.) and a turbine inlet temperature measurement sensor (Ametec, Inc.). Purdue University initiated 1996.*
- *ADVANCED COOLING OF TURBINE COMPONENTS. Research resulted in improved design of turbine blade cooling systems with the potential for significant improvements in fuel efficient and extended parts life on sygngas fuels. (Clemson University, initiated 1995).*

- *SURFACE ROUGHNESS CHARACTERIZATION for IMPROVED AIRFOIL DESIGN. A data base is now in place that characterizes three dimensional roughness of turbine vane and bade airfoil surfaces and this now provides a valuable tool to aid aerodynamic and heat transfer design for advanced turbines. Mississippi State University (MSU) and the Air Force Institute of Technology (AFIT) 2002*
- *PROBE FOR MEASURING FUEL/AIR MIXING. A new probe enables direct measurement of fuel/air mixing thus allowing designers to improve combustor designs and thereby reduce CO, UHC, NOx and flame instability. The probe has been validated by a number of the UTSR's Industrial Review Board member companies. University of California at Berkeley. 2001*

V. MAJOR ACTIVITIES PLANNED DURING THE NEXT 18 MONTHS

- By March 2005, announce awards based on RFP selections made in September 2004.
- By July 2005, receive proposals for selection-award in 2006.
- By October 2005, conduct major workshop on accomplishments from university projects.

VI. ISSUES

- Identification of appropriate basic and fundamental research projects to benefit syngas and hydrogen fuel turbine systems continues to be a high priority and major challenge.