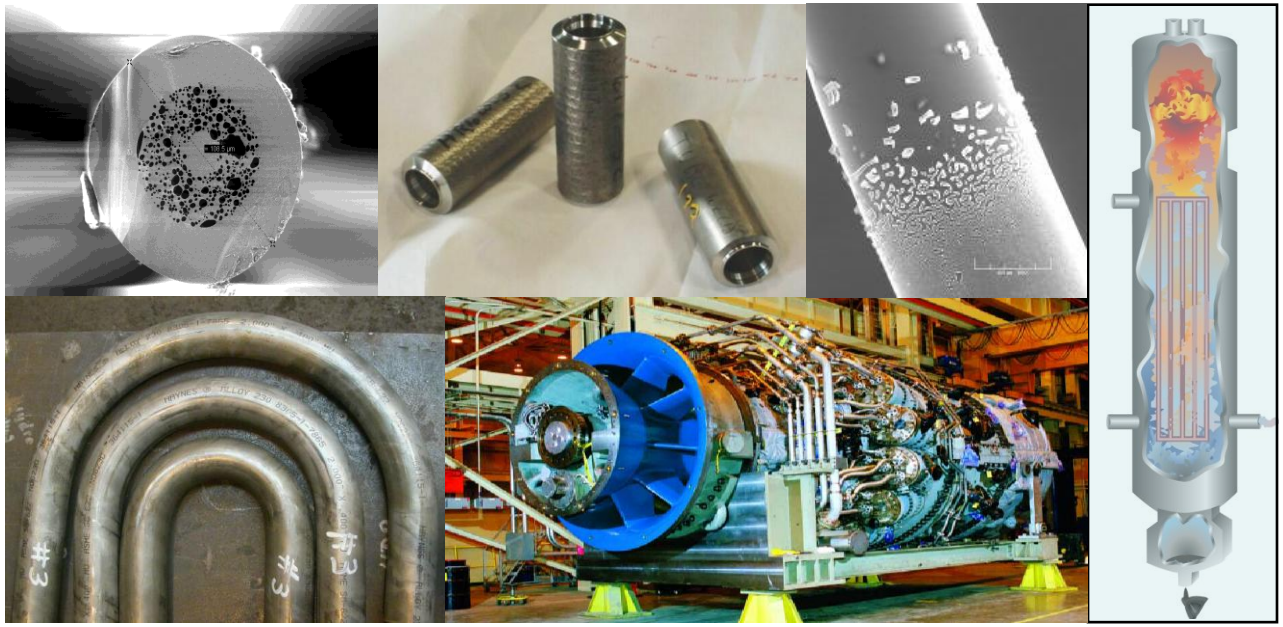
NATIONAL ENERGY TECHNOLOGY LABORATORY



26th Annual Fossil Energy Materials Conference

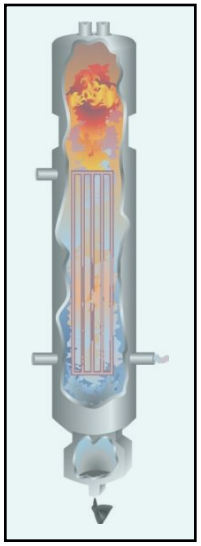
Robert R. Romanosky, Advanced Research Technology Manager

The Doubletree Hotel – Pittsburgh, PA
April 17-19, 2012

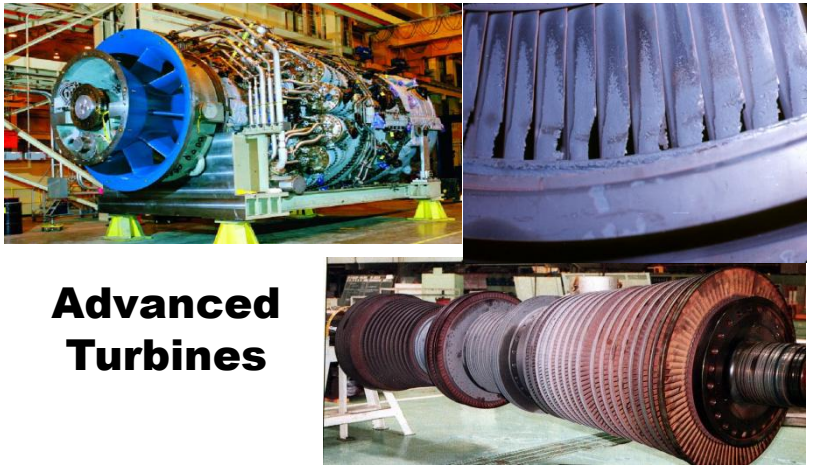
Fossil Energy Key Material Research Areas

USC Boilers/Turbines

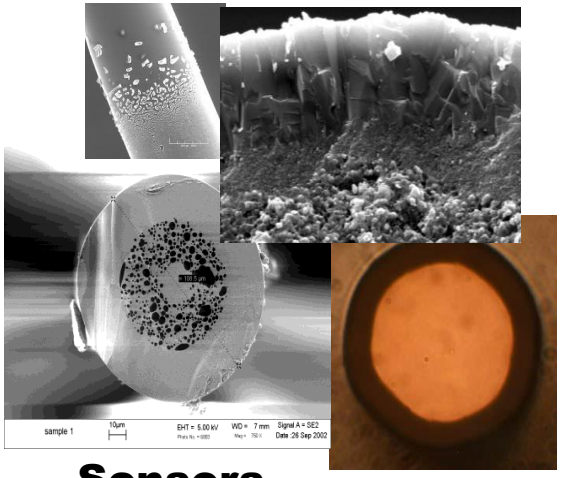
Gasifier



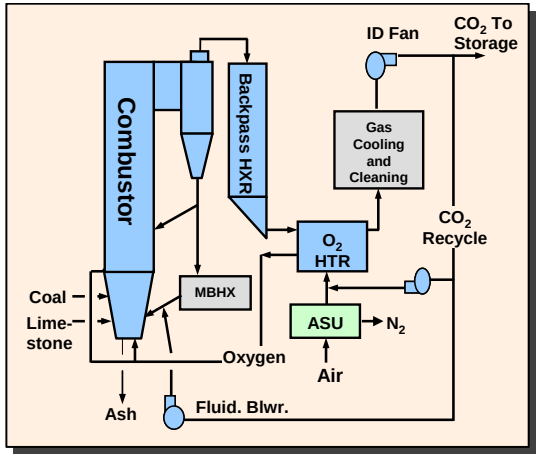
Advanced Turbines



Sensors



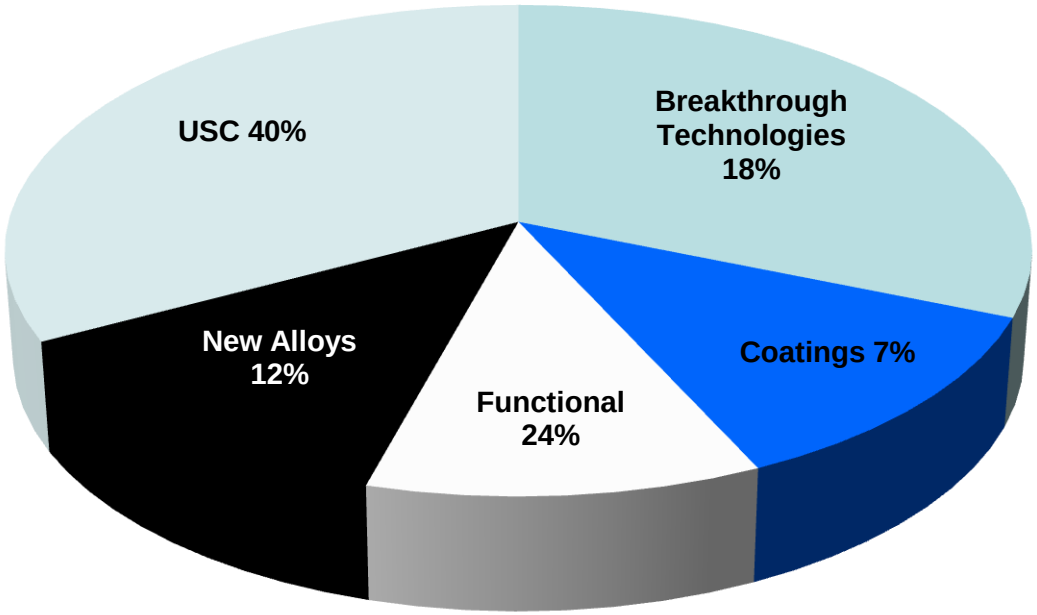
Oxy-Firing



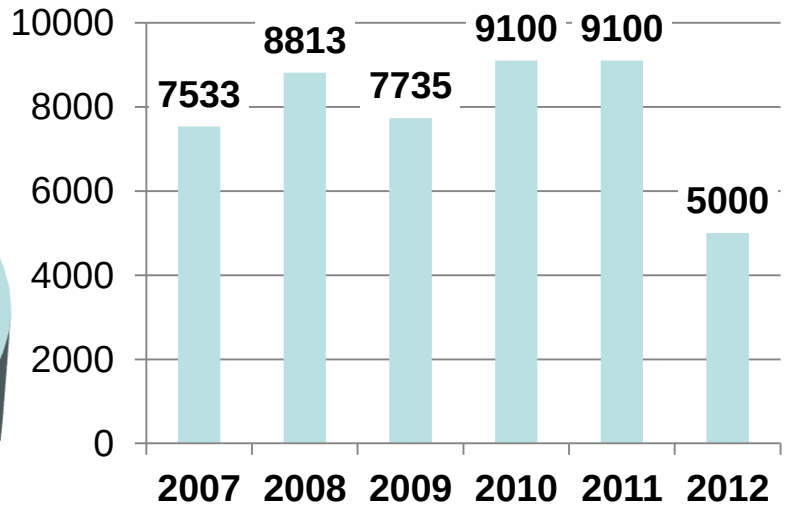
Fuel Cells

Advanced Research Materials Program Funding Profile

FY12 Material Program



Annual Budget



Projects by Organization

- *Industry* 7
- *National Laboratories* 13

Total Projects ***20***

Advanced Research Materials Program
HIGH TEMPERATURE APPLICATIONS

New Alloys

To increase the temperature capability of alloys for use in specific components required for advanced power plants by understanding the relationships among composition, microstructure, and properties.

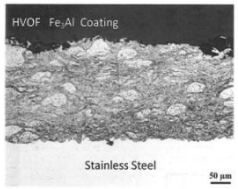
Breakthrough Materials

To explore routes for the development of materials with temperature/strength capabilities beyond those currently available.

UltraSupercritical Materials

To evaluate and develop materials technologies that allow the use of advanced steam cycles in coal-based power plants to operate at steam conditions of up to 760 C (1400 F) and 5,000 psi

Coatings and Protection of Materials

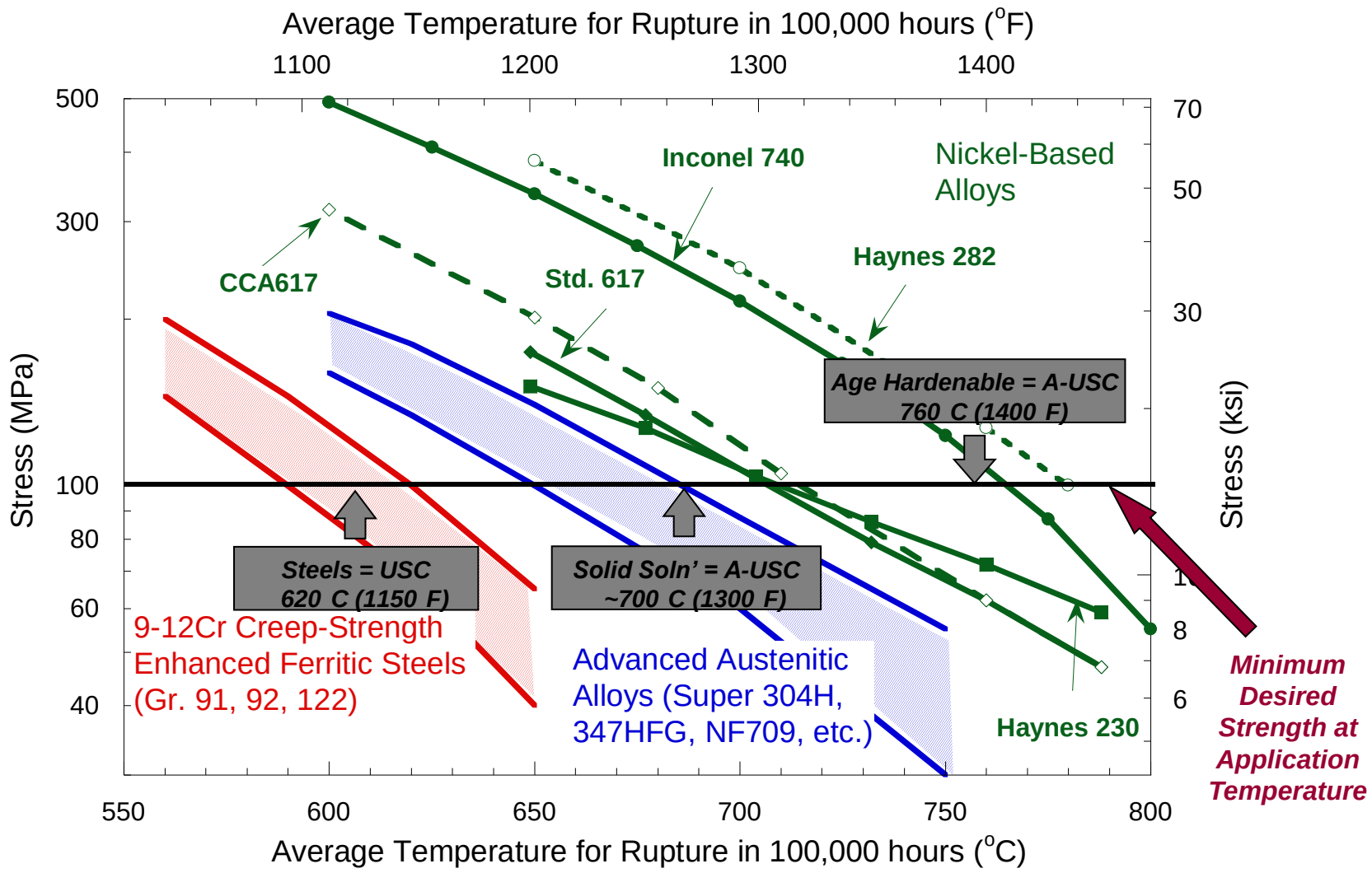


To develop the design, application, and performance criteria for coatings intended to protect materials from the high-temperature corrosive environments encountered in advanced fossil energy plants.

Functional Materials

To understand the special requirements of materials intended to perform specific functions, such as energy storage systems.

Materials Limit the Current Technology

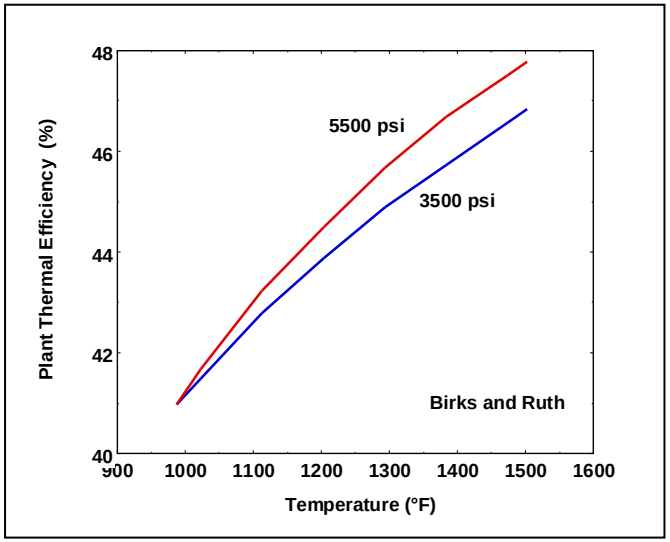


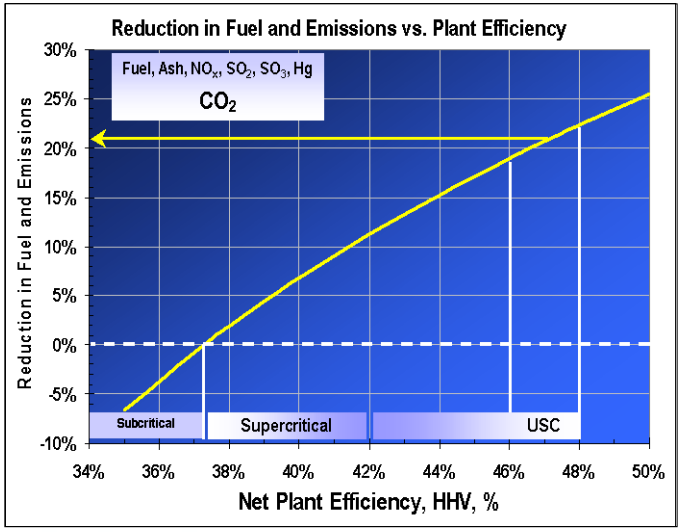
US A-USC Materials Programs

- Identify and evaluate **advanced materials** that help achieve highly efficient, cost competitive, and environmentally acceptable pulverized coal combustion based electric power generation (A-USC)
  - Steam conditions of 760 °C (1400 °F) and 5000 psi
  - Plant efficiency increases to 45 -47%
- Primarily a Materials Technology Evaluation Program
  - Focus on **nickel-based alloys** including gamma prime (age-hardenable) strengthened alloys for highest temperature regions of the boiler and steam turbine
  - Develop fabrication and joining technology for new alloys
  - Continue research on stainless and ferritic steels for economy of new plant
- Unique Conditions for US Program
  - Higher-temperatures than European Program (760 C versus 700 C) means **different alloys** are being evaluated
  - High Cr Alloys and extensive testing of coatings and surface modification for **US coals**
  - Data for **ASME code** acceptance of new materials
  - Phase II Boiler work includes focus on **Oxycombustion**

"Advanced" Ultra Supercritical Power Plant

Operating up to 5,000 psi and 1,400 °F





- *Ultrasupercritical (USC) DOE goal for higher efficiency and much lower emissions, materials capable of:*
  - *760 C (1400 F)*
  - *5,000 psi*
  - *Oxygen firing*
- *Plant efficiency can be improved to 45-47 % Ultrasupercritical (USC)*
- *CO_2 Emissions are reduced by 15 to 22%*
- *Lower balance of plant cost means smaller coal handling and pollution controls for the same net plant output*
- *Meeting these targets requires:*
  - *The use of new materials*
  - *Novel uses of existing materials*

Materials Modeling Program

- *Develop modeling methodology tools that can provide a scientific understanding of high-performance materials*
- *Must be compatible with the hostile environments associated with advanced Fossil Energy (FE) power generation technologies*
- *Thereby enabling faster development and/or improved processing of these materials.*

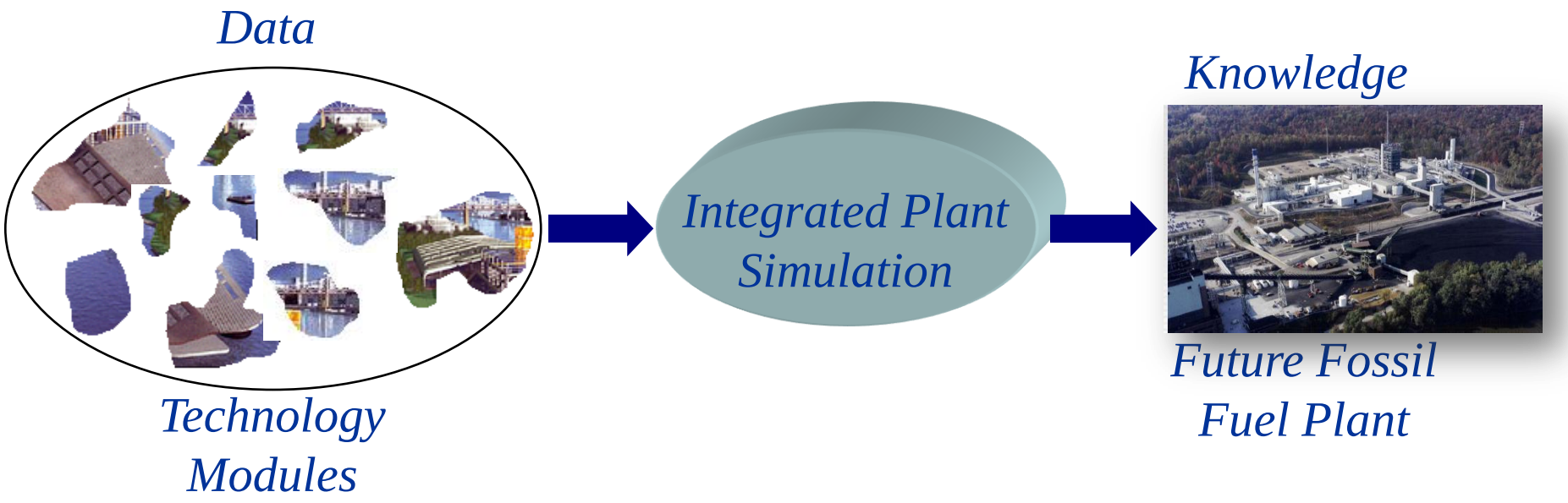
- Included are structural materials, including processing and fabrication methods, and functional materials necessary for all FE systems
- Including materials for coal fuels technologies and for advanced power generation technologies such as coal gasification, gas turbines, coal combustion systems (i.e. advanced ultra supercritical and oxygen fired), and fuel cells.

Desired Program Outcomes

- **Development of extended temperature (>100 F) iron based alloys – large cost savings versus nickel based alloys**
- **Development of improved modeling tools may allow for faster code approval**
- **More organized, reliable, and accessible data bases of materials properties and data to support advanced modeling tools**
- **Advanced alloy design at the atomistic level**

"If you cannot model the process, you don't understand it. If don't understand it, you cannot improve it. If you cannot improve it, you cannot be competitive"

Jim Trainham, ex-VP, Global Technology, DuPont



What Does the Future Look Like?

- **The USA and the world will face great energy challenges with ever increasing environmental constraints**
- **Advanced fossil energy power systems will be needed**
- **The Advanced Research Materials Program is poised to have even greater impacts on future energy systems**
  - Novel materials for high temperature applications
  - Next generation ferritic steels with higher strength and better oxidation resistance
  - Advanced coatings
  - Computational materials design and lifetime prediction for extreme environments

Contact Information

Robert R. Romanosky
304-285-4721
robert.romanosky@netl.doe.gov

NETL
www.netl.doe.gov

Office of Fossil Energy
www.fe.doe.gov

Patricia Rawls
412-386-5882
patricia.rawls@netl.doe.gov