the ENERGY lab

PROGRAM FACTS

Strategic Center for Coal

Crosscutting Technology Research Program Sensors & Controls Summary

Sensors & Controls research and development makes available new classes of sensor and measurement tools that manage complexity, lower costs and enable robust monitoring and real-time optimization of fully integrated, highly efficient power-generation systems. Controls research centers around self-organizing information networks and distributed intelligence for process control and decision making. The reliability of these systems is promoted by the networking of sensors and the use of wireless communication technologies.

- The **Sensor** effort addresses new classes of sensors and measurement tools that manage complexity, permit low cost, robust monitoring, and enable real-time optimization of fully integrated, highly efficient power generation systems. Ongoing research is focused on development of sensors capable of monitoring key parameters in harsh environments. Sensor technology is proceeding along a multipronged path of technologies including optical sensing, microsensors, and imaging.

Harsh Environment Wireless Surface Acoustic Wave Temperature Sensor. (University of Maine)

- The development of **Controls** includes investigating fundamental combustion and gasification chemistry to discern rates and mechanisms affecting emissions behavior under combustion and gasification conditions. The controls development work centers around artificial and distributed intelligence for process control and decision making in networks. New algorithms will be developed to more closely control these processes to the optimum conditions even under transient conditions to reduce emissions, improve efficiency, and provide for more stable operation allowing fossil plants to operate more cost-effectively under a wider range of conditions. These control strategies will work in concert with the superior intelligence provided by the array of process data gathered with the new control sensors developed by this program.

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Impacts and Benefits

The following impacts are possible through this proposed research:

- Benefit both existing and advanced power systems such that meaningful improvements can be made with respect to their efficiency and availability.
- Serve as an essential and enabling technology to operate advanced power systems under conditions where optimal performance is balanced with reliability.
- Provide the ability to make and implement decisions and derived optimizations in real time by means of new computational tools capable of matching sensor data and analytical inputs to decision-making assistance and controls actuation resulting in desired outcomes.
- Meet tomorrow's energy system needs through stable control and monitoring by extending component life and providing plant flexibility through load following and higher efficiencies of complex energy systems that are unstable using traditional control and monitoring techniques.

Real-Time Raman Gas Composition Monitor. (University of Pittsburgh)

Systems Benefits Analysis

- Increased unit efficiency from use of advanced sensors and controls can reduce CO_2 emissions
  - Refurbishing the U.S coal fired fleet with advanced sensors and controls could reduce CO_2 emissions by over 14 million metric tons per year for every 1% heat rate improvement
  - Results in low cost per ton of CO_2 avoided—\$2-\$10/mt CO_2
- Availability a key driver for unit refurbishment that includes advanced sensors and controls[1]
  - Advanced sensors and controls could reduce forced outages by 10%, making it economical for the coal fleet to refurbish sensors and controls at capital cost under \$1 million
  - 500 MW coal fired units could produce an additional 44 million kWh/yr in added generation for each 1% improvement in availability, resulting in ≈\$2.6 million/yr in sales (@ 6 cents/kWh)

Heat Rate and Availability Improvements of 1% are easily achievable.

Coal
35,700 MMBTU/yr
\$70 Million/yr
@ \$2/MMBTU

Entire coal-fired fleet

\$300 M/yr coal cost savings
A reduction of 14.5 Mt CO_2 / yr
More than 2 GW of additional power

Power
3.5 Billion kWh/yr
@ 80% capacity factor

Sensors & Controls can enable improvements to be maintained for long term.

[1] Source: Outage Data - NERC GADS Database 9/19/12 Accessed 1/9/13; \$55.07 Avg. Wholesale Price Data – EIA http://www.eia.doe.gov/cneaf/electricity/wholesale/wholesale.html Wholesale Market Data, PJM West, NEPOOL, ERCOT Wtg. Avg.