Technology Options for Existing Coal Units

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EPRI Coal Research Programs

- Existing coal plant technology
  - Major Component Reliability
  - Boiler Life and Availability Improvement
  - Steam Turbines-Generators and Auxiliary Systems
  - Generation Maintenance Applications Center
  - Boiler and Turbine Steam and Cycle Chemistry
  - Fossil Materials and Repair
  - Instrumentation, Controls, and Automation
  - Maintenance Management & Technology
  - Operations Management & Technology
  - Water Management in Power Plants

- Environmental controls
  - CO₂ Capture and Storage Technology
  - Combustion Performance and Emissions Control
  - Post-Combustion NOₓ Control
  - Integrated Environmental Controls
  - Particulate and Opacity Control
  - Continuous Emissions Monitoring

- Advanced Coal Generation Technology
Heat Rate Improvements are a Key Enabling Technology

- Reducing thermal energy necessary to produce electricity (i.e. heat rate) increases economic viability of unit:
  - Lower emissions
  - Lower fuel consumption
  - Lower operating costs

- Creates margin to enable compliance with existing or future requirements:
  - Enables use of less-water intensive cooling technology
  - Offsets adverse impacts on plant efficiency potentially caused by addition of environmental controls (e.g. CO2 capture.)
  - Enables compliance to more stringent limits on CO\textsubscript{2} or other pollutants
  - Enables unit flexible operations
Common Issues

- **Performance issues**
  - Feedwater heater performance problems
  - Low final feedwater temperature
  - Low hot reheat temperature
  - Low main steam temperature
  - Low HP turbine efficiency
  - High condenser backpressure
  - High air heater exit gas temperature

- **Leakages**
  - High reheat spray flow
  - High main steam spray flow

- **Reduce auxiliary power consumption**
Common Recommendations

- **Testing/monitoring**
  - Increase routine feedwater heater monitoring
  - Perform cycle alignment checks on a regular, routine basis

- **Operator awareness/information**
  - Provide Heat Rate awareness training to operations staff
  - Improve utilization of controllable losses information by operations
  - Make Heat Rate information readily available to all

- **Optimize sootblower operation / restore & repair**
EPRI Field Research on Heat Rate Improvements
Evaluation of Capital and Maintenance Projects

- Wide range of potential actions and modifications to improve efficiency were evaluated in detail

- Potential gains are unit specific

- Projected heat rate improvements range: 0.1% to >2%

- Steam turbine path modifications were worth 2 - 4% heat rate improvements

- Implementing a cycle alignment (isolation of high energy fluid leaks) program was documented to be worth >0.5% improvement in heat rate
Capital and Maintenance Projects for Plant Efficiency Improvements

- **HP, IP, LP Turbines**
  - Replace Seals
  - Steam Path Upgrade
  - Replacement

- **LP Turbines**
  - Replace last stage buckets
  - Exhaust Hood / Flow Guide Modifications

- **Generator**
  - Rewind
  - Hydrogen purity
Capital and Maintenance Projects for Plant Efficiency Improvements

- Intelligent Soot Blowing
- Economizer retrofit
- Vacuum / clean economizer
- Automate boiler drains
- Repair boiler air in-leakage sources
- Cleaning air heater
- Electrostatic Precipitator Variable Power
Capital and Maintenance Projects for Plant Efficiency Improvements

- Steam Condensers / Cooling System
  - Clean condenser tubes
  - Replace condenser tubes
  - Spongy ball cleaning system
  - Waterbox vacuum priming, automated fill system
  - Circulating water strainers
  - Restore / upgrade circulating water pumps
EPRI Field Research on Heat Rate Improvements
Evaluation of Production Cost Optimization Projects

- Identified potential 3-5% heat rate improvements through various means.

- Sliding pressure operations can yield a 2% heat rate improvement at partial load.

- The use of remote monitoring centers was documented to improve heat rate 2.5 - 4%.
EPRI Field Research on Heat Rate Improvements
Summary

- Overall, Heat Rate improvements documented between 0.5% – 5%

- Actual improvements are unit-specific.

- Specific improvements may not always be possible or justifiable.

- Gains from individual measures may not be additive.
Heat Rate Improvements to Enable Cycling

- Sliding pressure operation
- Variable-speed drives for main cycle and auxiliary equipment.
- Automated pulverizer supervisory controls and variations with mill design.
- Optimum partial load operation of air quality control systems.
- Feedwater heater drain system modifications for cycling.
- Cooling system optimization.
- Performance monitoring.
- Reducing warm-up flow for idle boiler feed pumps.
- Minimizing flow, pressure, and temperature oscillations during cycling operation
EPRI Heat Rate Research 
Long Term Priorities

- **Improve heat rate**
  - Identify and evaluate new methods and hardware
  - Field tests and/or engineering studies with cost benefit analyses

- **Improve monitoring and diagnostics**
  - Applications of Advanced Analytics
  - Real-time Diagnostics
  - Update Test Methods

- **Address industry performance issues**
  - Identify common failures and degradation scenarios
  - Determine causes
  - Evaluate options for mitigation, recovery, and restoration
EPRI Research
Plant Efficiency Improvements

- Capital and Maintenance Projects for Efficiency Improvements (EPRI Report #1019002)

- 57 Detailed Evaluations of potential projects
  - 32 Capital projects
  - 25 Maintenance projects

- Not all had positive payback!
EPRI Research on Range and Applicability of Heat Rate Improvements

- Summarizes methodologies and tools for assessing and implementing measures for improving heat rate in coal-fired power plants

- Brackets the range of achievable improvements possible for an existing coal-fired power plant, based on EPRI research.

- Provides references to related EPRI research.

- Publically available to all.

- EPRI report #3002003457.
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