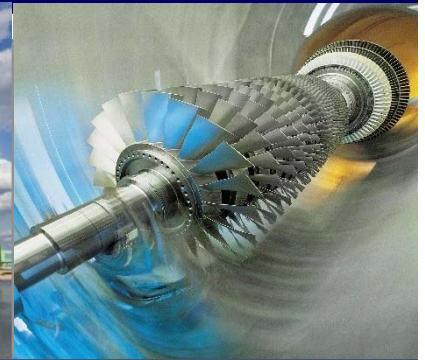
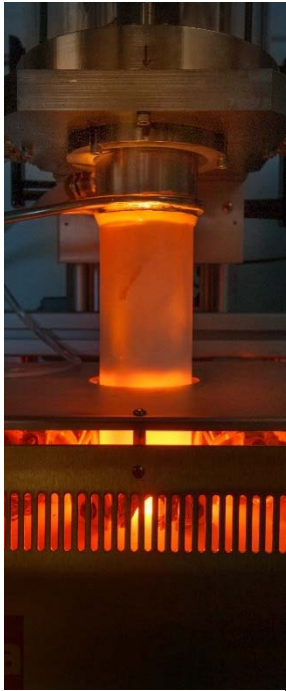




U.S. DEPARTMENT OF
ENERGY

Office of
Fossil Energy



Importance of Crosscutting Research on Power Plant Efficiency & Reliability

March 21, 2017

Angelos Kokkinos

Director, Office of Advanced Fossil
Technology Systems

Advanced Fossil Technology Systems

Fossil
Energy

National Energy
Technology Laboratory

2016



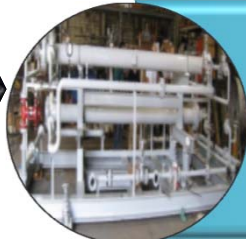
Major Demonstrations

First Generation carbon capture systems built to validate first of a kind fully integrated CCUS projects full scale demonstration projects for power and industrial sectors



Advanced Energy Systems

Technologies that greatly improve plant efficiencies, reduce CO₂ capture costs, increase plant availability, and maintain the highest environmental standards



Carbon Capture

R&D and scale-up technologies for capturing CO₂ from new and existing industrial and power-producing plants



Carbon Storage

Safe, cost-effective, and permanent geologic storage of CO₂ in depleted oil and gas fields and other formations



Cross Cutting Research

Materials, sensors, and advanced computer systems for future power plants and energy systems integrated with CCS



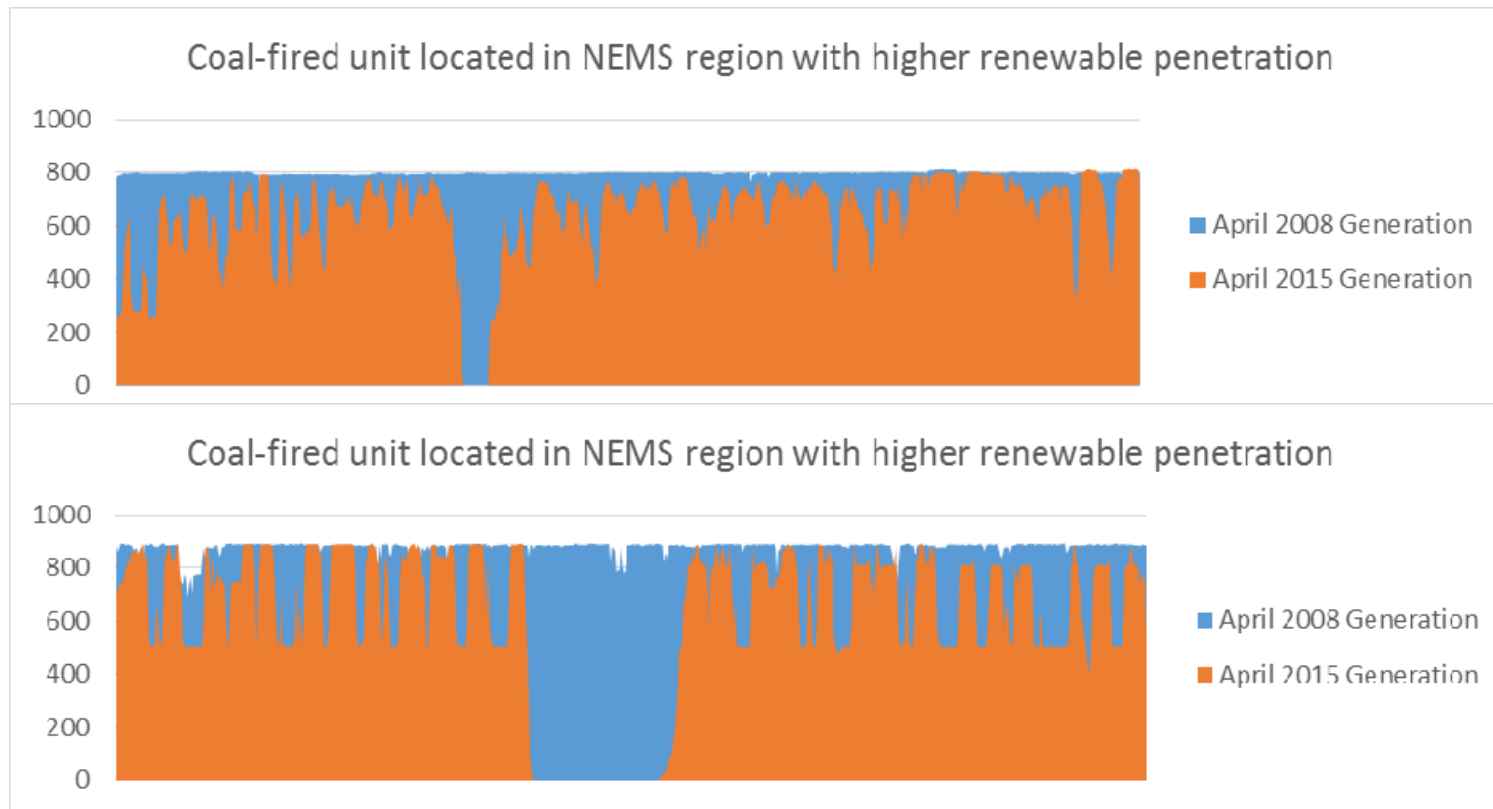
U.S. DEPARTMENT OF
ENERGY

Current Power Generation Landscape

Fossil
Energy

National Energy
Technology Laboratory

- Increased use of incentivized renewable energy
- Fossil units are being asked to provide grid reliability
- Fossil units:
 - Not designed for duty required
 - R&D funding has been lacking
 - Inefficient operation

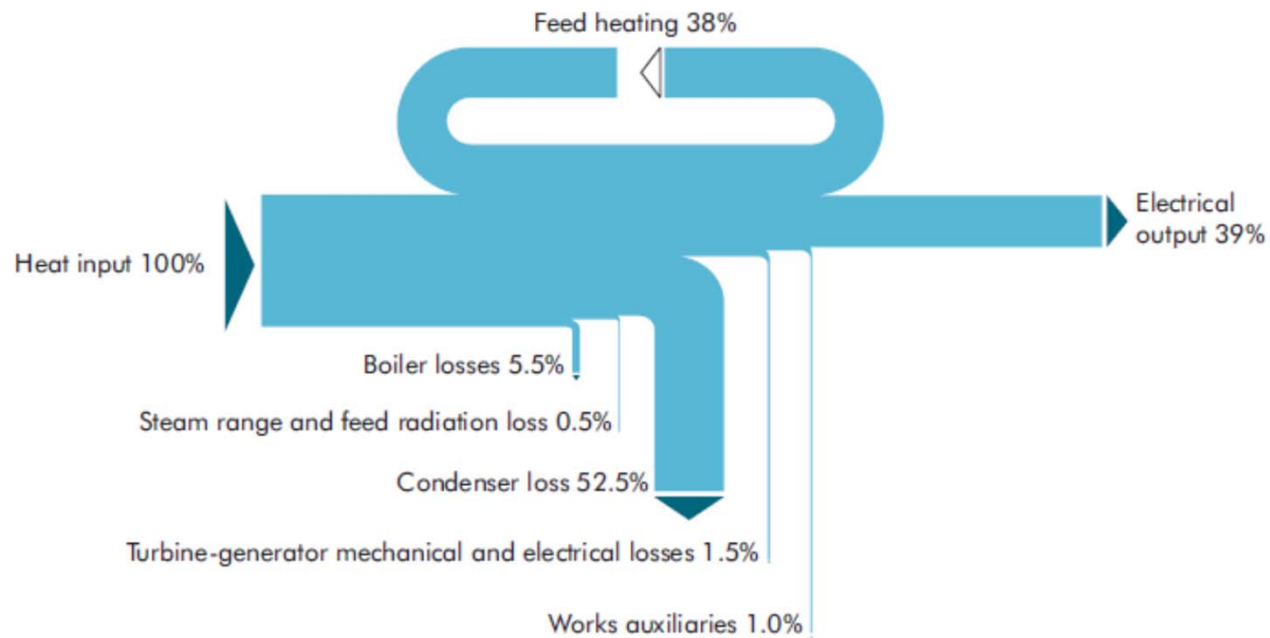


Source: R.K
Smith Report
on Impact of
Renewables
of Fossil

Power Plant Efficiency Losses

Fossil
Energy

National Energy
Technology Laboratory



Source: EIA Power Generation from Coal Report

Impact of Operating Conditions on Efficiency

Fossil
Energy

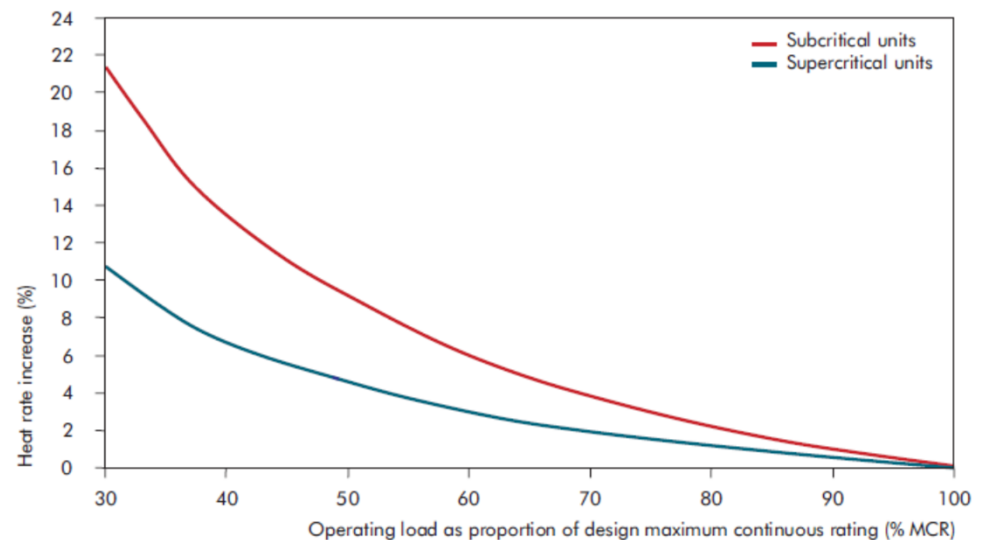
National Energy
Technology Laboratory

Impacts of Cycling Operation

Fossil
Energy

National Energy
Technology Laboratory

- Partial load operation lower efficiency
- Fast ramping (up or down) reduces efficiency
- Ramping impacts reliability of equipment



Source: EIA Power Generation from Coal Report

Impact of Operation on Efficiency

Fossil
Energy

National Energy
Technology Laboratory

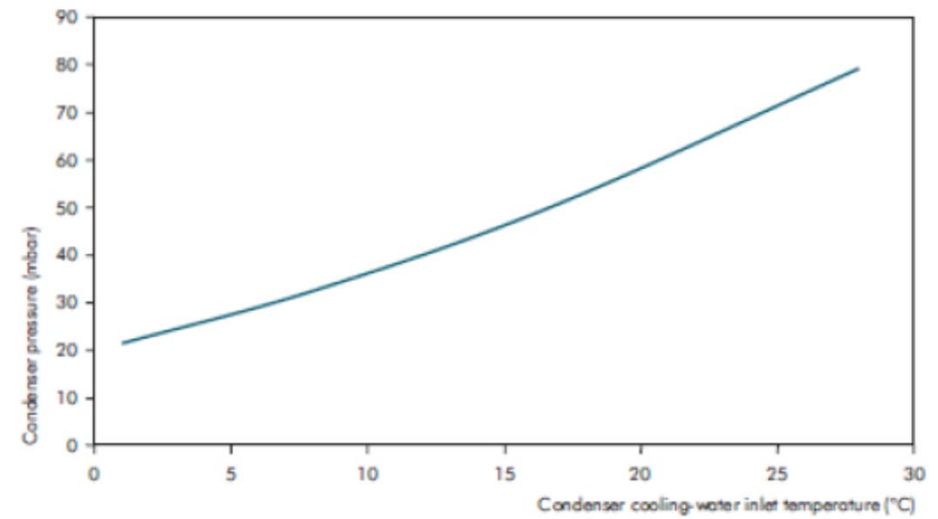
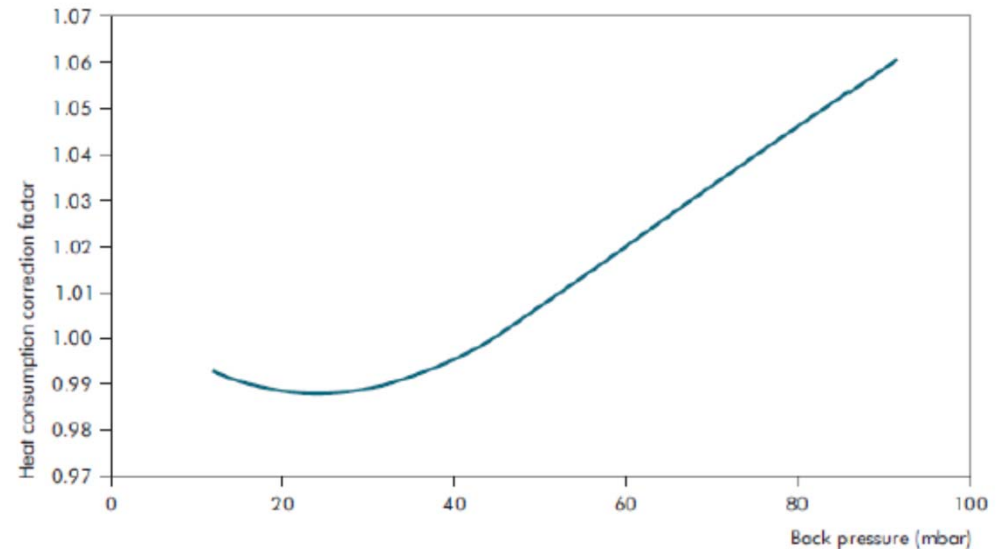
Basis: 10,000 Btu/kWh (net)

Parameter	Change	Heat Rate Change, %
Main Steam Temperature	-10 °F	0.17
Hot Reheat Temperature	-10 °F	0.16
Main Steam Pressure	-1%	0.06
Condenser Pressure	+0.5 in Hg	0.6
Feedwater Temperature	-10 °F	0.27
Superheater Spray Flow	+1% of steam flow	0.025
Reheat Spray Flow	+2% of steam flow	0.4
Auxiliary Steam Flow	+ 0.5% of Cold Reheat	0.35
Excess O ₂	+ 1%	0.2
Auxiliary Power	1 MW	0.2
APH Exit Temperature	+ 10 °F	0.25

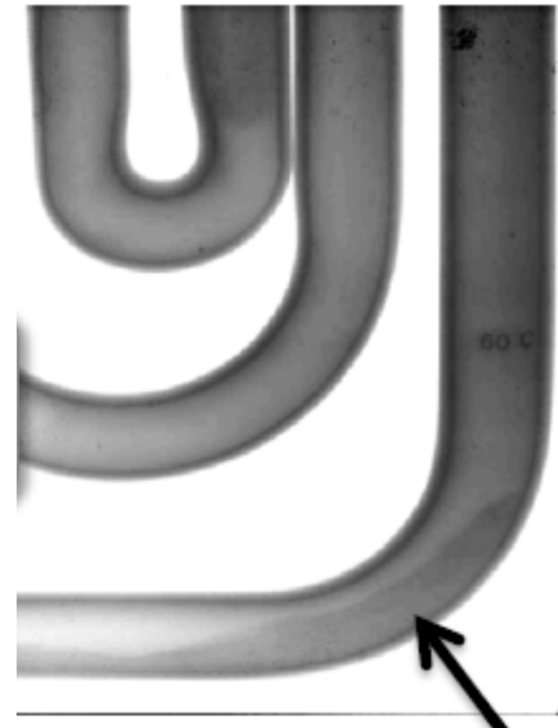
Source: Kokkinos, et. al., AREGC Meeting, 2015 Biloxi MS

Condenser

- Largest heat loss in power plant
- Cooling water temperature has most significant impact
- Condenser pressure matches turbine performance
- Improve heat transfer:
 - Materials?
 - Design?



Impact on Reliability



Source: EPRI/ORNL/NPL Weld & Repair Conference, 2014



Controls

↻ **Advanced monitors and instrumentation**

- Wireless transmission
- Embedded in equipment and material
- Capable of operating reliably in harsh environment

↻ **Predictive tools/software**

- Convert from “scheduled” to “predictive” maintenance
- Dynamic data analysis

↻ **Online measurements**

- Water chemistry
- Tube thickness loss
- Weld integrity

Water

↻ Condenser

- Improve heat transfer
- Eliminate water use

Materials

↻ Develop “designer” materials

↻ Address material reliability

↻ Predictive tools for:

- Weld failure
- Material failure
- Fireside/waterside corrosion

THANK YOU

Impact of Coal & Desing on Efficiency

Fossil Energy

National Energy Technology Laboratory

