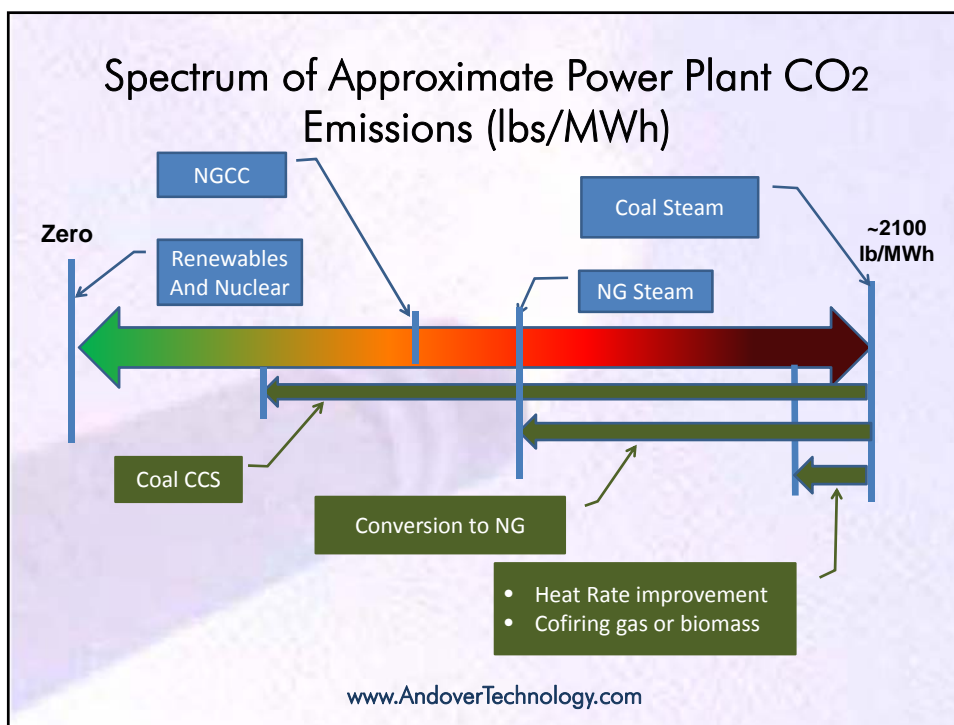


# Reducing CO2 Emissions from Fossil Fueled Power Plants

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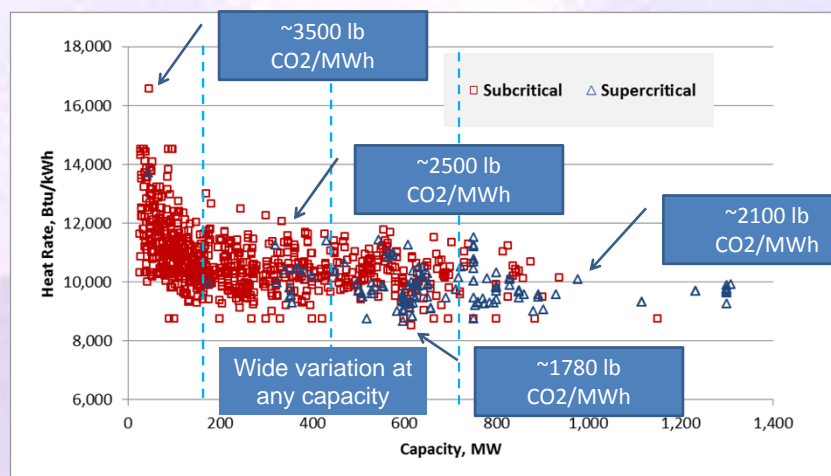


## Reducing CO<sub>2</sub> Emissions from Existing Coal

- **Heat Rate Improvement** (reduce the fuel required per kWh produced)
  - Improve boiler efficiency
  - Improve steam plant efficiency
  - Reduce auxiliary loads
- **Less Carbon-Intensive Fuels**
  - Gas co-firing or reburn
  - Gas conversion
  - Cofiring of biomass or biomass conversion/repower
- **CCS**
  - Unlikely to play a significant role

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## Digging into the data on Heat Rates for Existing Coal Units (NEEDS v4.10)



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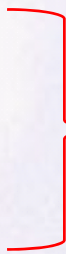

## Digging into the data on Heat Rates for Coal Units

- Important factors
  - Capacity, especially below 200 MW
  - Steam pressure for small, subcritical units
  - Steam cycle – but the lowest HR units are subcritical!
  - Fuel type, CFB versus PC, etc.
- Not so important factors
  - APC equipment (best units get scrubbers)
- Missing data from EIA submittals
  - Steam temp/pressure, cooling water temp

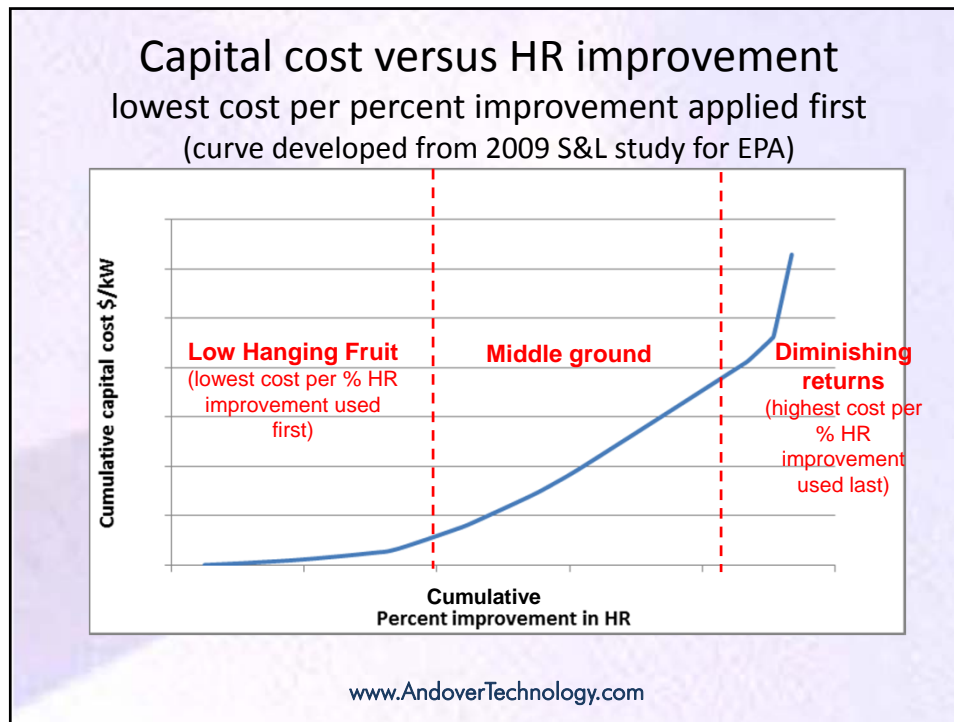
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## Examples of Methods for HR Improvement

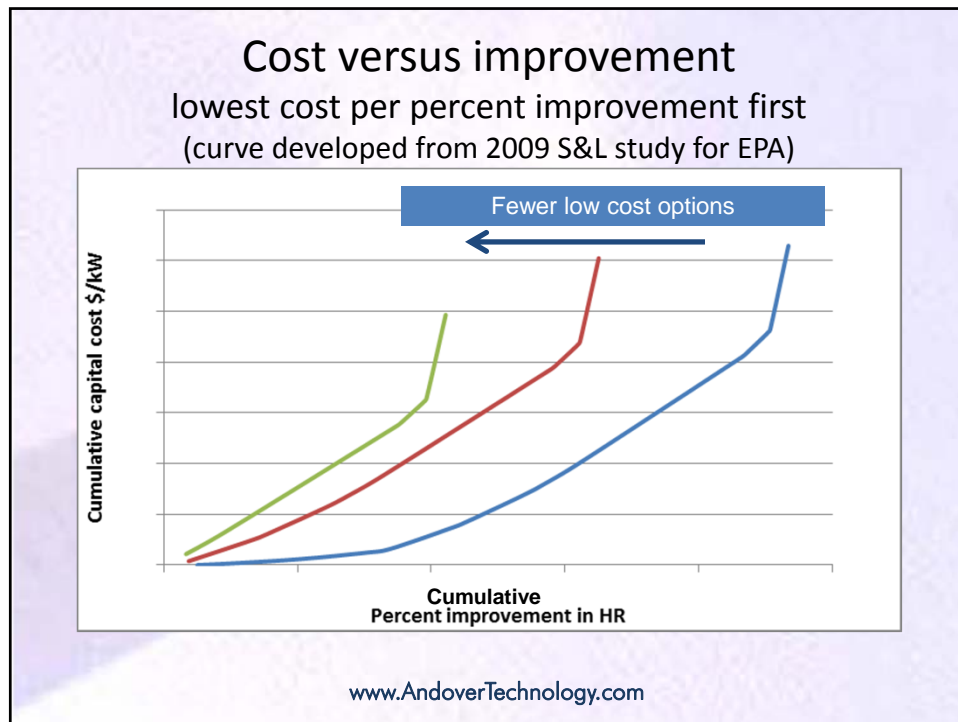
*(not an exhaustive list, to be sure)*

- Coal Drying (esp., lignite coals)
  - Variable Speed Drives
  - Centrifugal to Axial fan conversion
  - Steam turbine modifications
  - Intelligent soot-blowing system
  - New APH seals
  - Repair boiler casing and duct in-leakage
  - Condenser cleaning
- 
**Capital improvements**
- 
**Maintenance**

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- ### Staudt's three categories of units – HR improvement potential
- Flagships
    - Little or no low hanging fruit
    - A few middle ground opportunities
    - Mostly left with higher cost opportunities
  - Old Clunkers
    - Lots of low hanging fruit, but . . .
    - Might be a candidate for retirement on economic grounds
    - If worth keeping around, might be well suited for a gas conversion
  - Rest of the fleet
    - More variability in what may be feasible
    - Typically some, but probably not a lot of low hanging fruit
    - Varying degrees of middle cost improvements
    - Higher cost opportunities
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### Questions on Heat Rate Improvement

- Will a HR improvement provide a positive ROI?
- What is the current condition of the unit?
  - For some units may be little opportunity for further improvement, or may not be worth the investment
- What is the planning horizon?
- NSR trigger?
- What is the economic environment?
  - merchant versus utility
  - investor owned versus co-op versus government owned
  - local power market dynamics
  - company budget constraints

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## Gas Conversion/Cofiring/Reburn

- **Conversion** (convert to 100% gas)
  - Being pursued by several utilities
  - Capital cost ~\$80/kW (with gas on site)
  - Gives the owner options
- **Cofiring/Reburning** (10-15% gas)
  - Modest cost (somewhat higher for reburn), assuming gas is on site
  - Reburning may allow for additional NOx reduction

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## Biomass

- **Co-firing \***
  - Pulverized Coal ~\$500-600/kW
  - Cyclone ~\$300-400/kW
- **Repower**
  - PC to biomass fired CFB
    - (50 MW Schiller) \$1600-1700/kW\*\*

\* Renewable Energy Technical Assessment Guide—TAG-RE: 2006. EPRI, Palo Alto, CA: 2007. 1012722 and escalated to 2012 dollars  
 \*\* escalated to 2012 dollars.

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## Improving HR is also possible for Gas Turbines!

- Compressor inlet modifications (guide vanes, etc.)
- Inlet Air Cooling
- Combustor upgrades
- Hot section coatings
- New seals
- Most of these will increase turbine output!

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## Recap

- Most likely options for existing coal to reduce CO<sub>2</sub> emissions are heat rate improvement or lower carbon fuel
  - No “one size fits all” solution
  - Best choice determined by several factors
  - CCS not expected to play a significant role
- Options for HR improvement exist for gas turbines as well
  - May also increase power output
- Methods that are low in capital and offer optionality will be preferred.

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Thank you!

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