Comparative Assessment of CO_2 Capture Options for Existing Coal-Fired Power Plants

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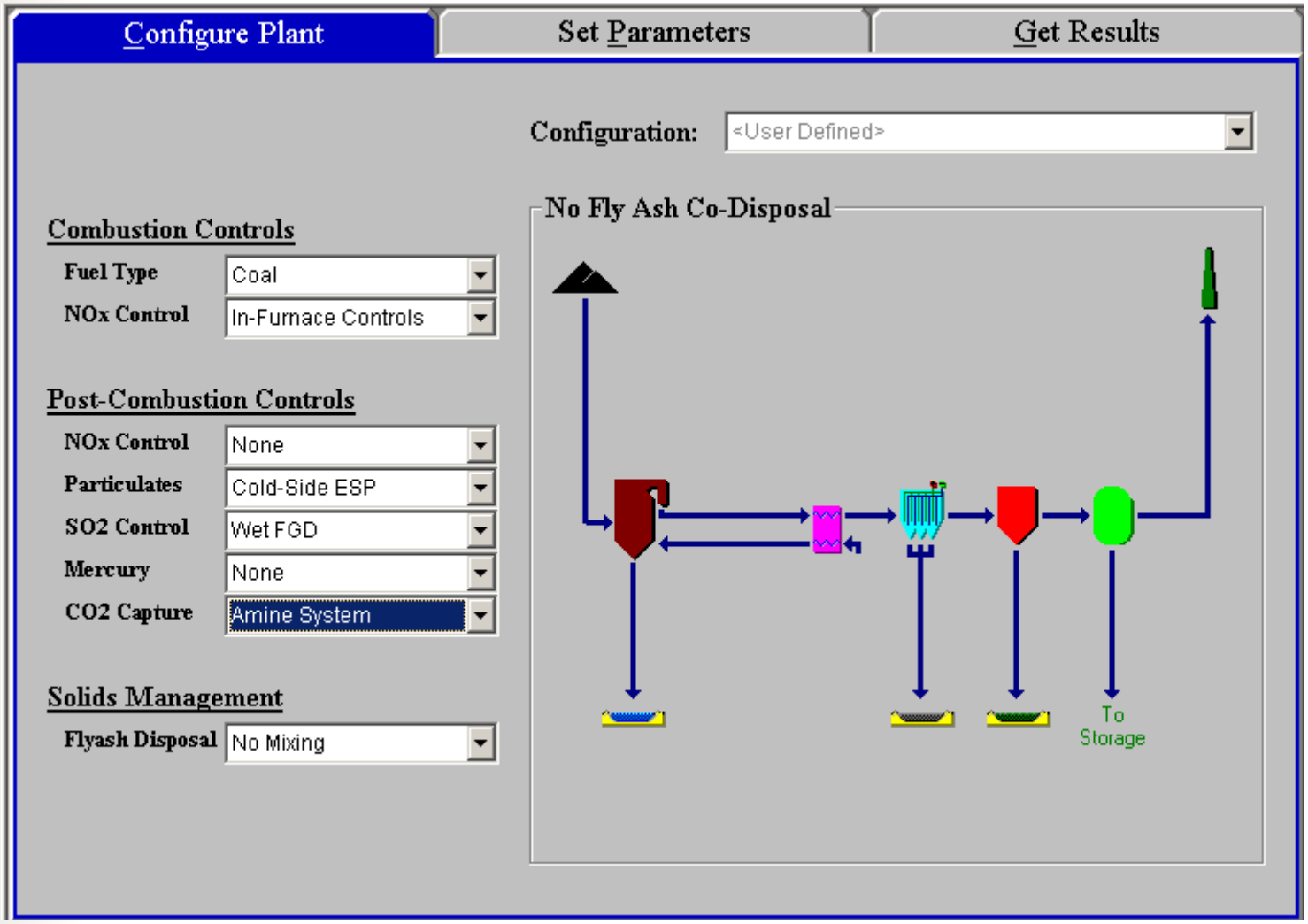
Objective

- Investigate available CO_2 capture and storage (CCS) strategies for existing coal-fired plants
- These plants currently account for:
  - 51% of all power generation
  - 79% carbon emission from electric utilities
- Any effort to significantly reduce CO_2 emissions in next few decades must deal with existing coal-fired plants

Technology for Existing Coal-fired Units

- Focus on currently available CCS technology:
  - Amine scrubbing retrofitting: Post-combustion
  - IGCC repowering with Selexol absorption: Pre-combustion

CO_2 Capture Using Amine-based System

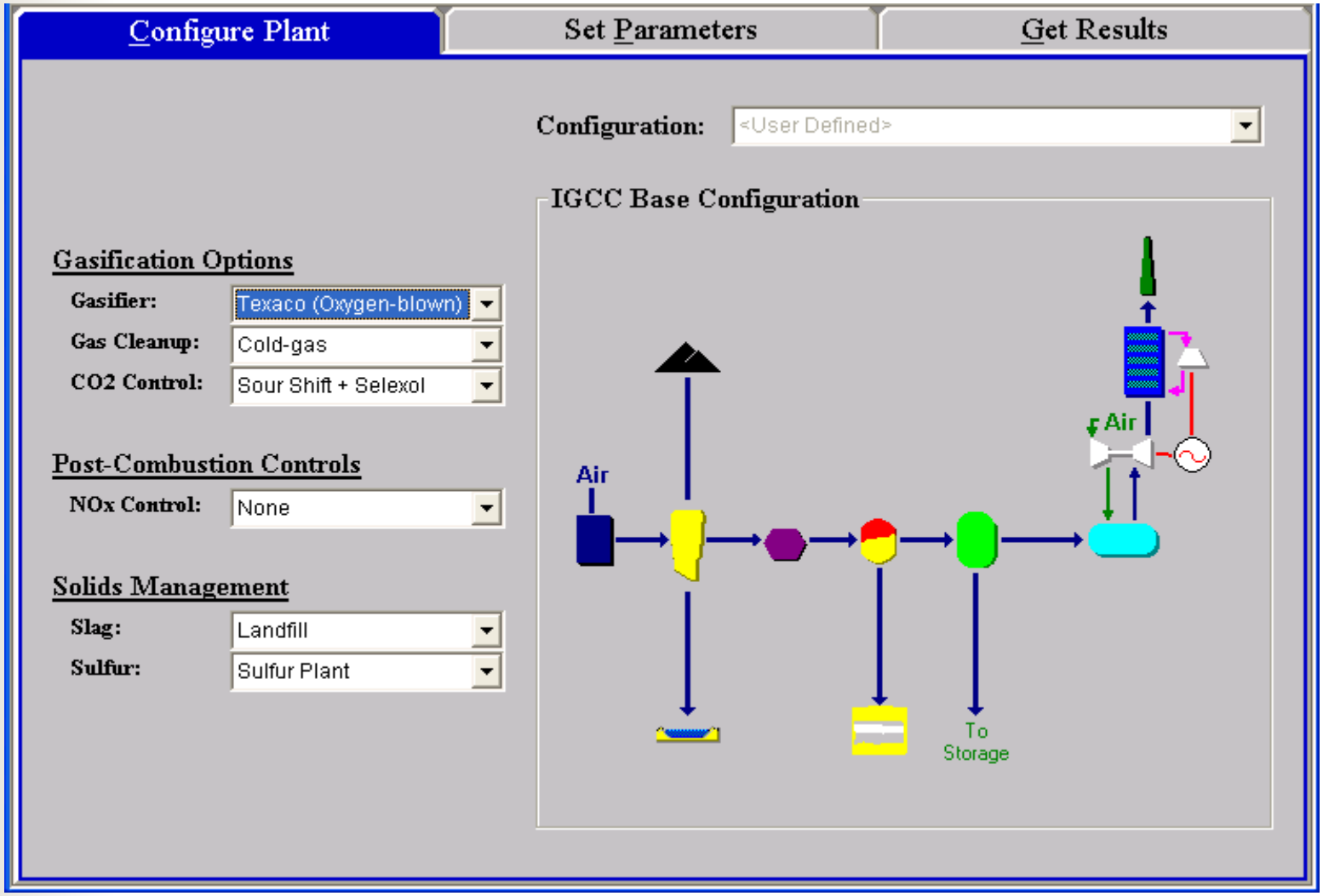


Two Options for Auxiliary Energy Requirements

- *Option A*: Derate existing plant

- *Option B*: New auxiliary NG boiler and turbine (without capture of CO_2 from NG combustion)

IGCC with Selexol-based CO_2 Capture



Two Repowering Options

- *Option A*: Heat Recovery Repowering (use existing steam turbine and land)

- *Option B*: Site Repowering (Completely new IGCC on existing land)

Study Assumptions

- Reference plants are fully amortized and equipped with FGD systems
- Plant performance parameters based on DOE/EIA database for units at 3 sizes:

Gross capacity	100 MW	270 MW	540 MW
Heat rate (Btu/kWh)	11,292	10,734	10,355
CO_2 (g/kWh)	1064	1004	996
Capacity factor	67%	76%	77%

Assumptions (cont'd)

- Retrofitting/Repowering

CO_2 capture (%)	90
Capacity factor (%)	80
Interest rate (%)	9
Lifetime (years)	20

Repowering: O_2-blown Texaco gasifier w/quench; GE MS7001F gas turbines

- CO_2 pipeline transport and geologic storage costs included in all results

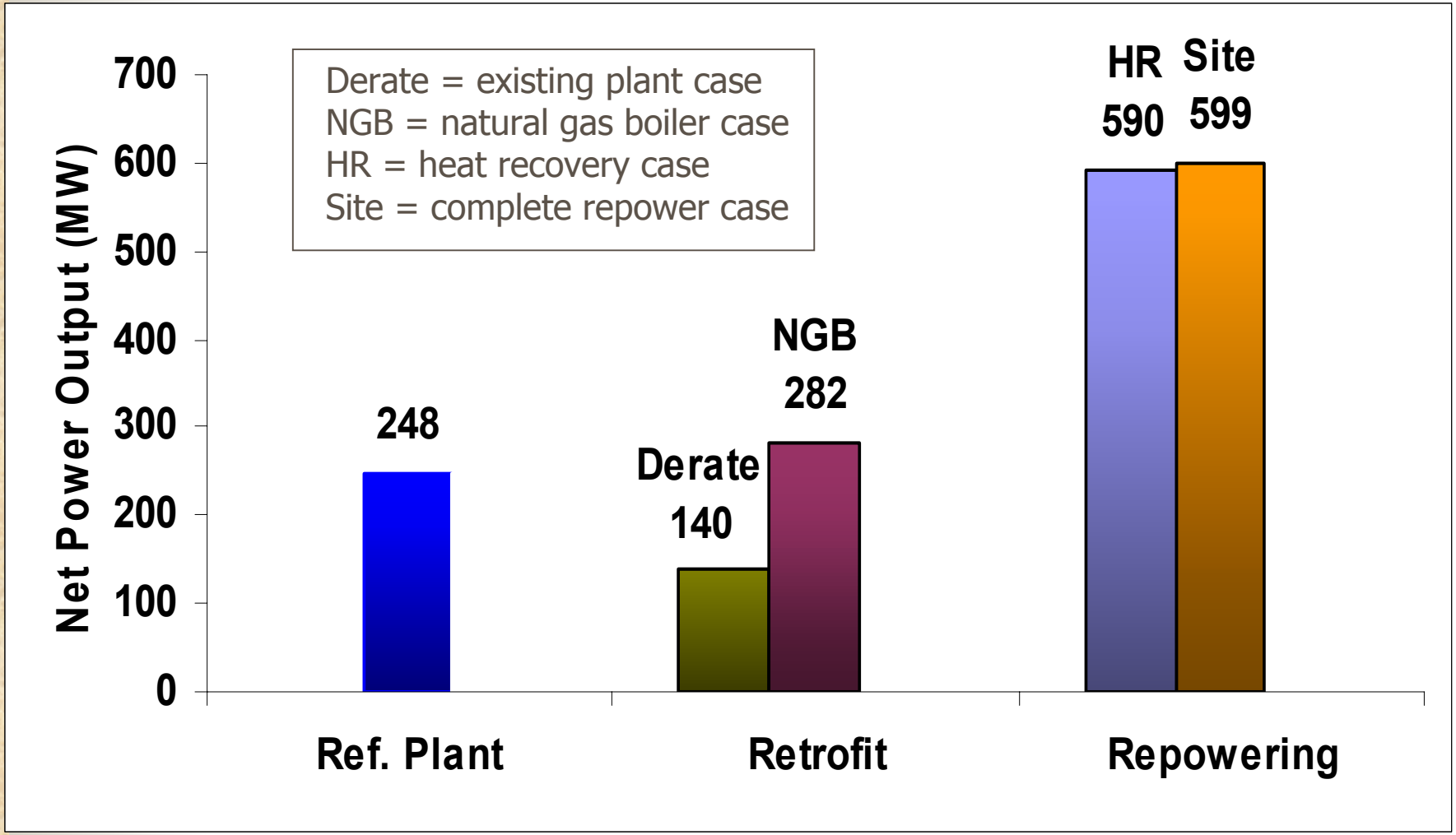
Study Methodology

- Evaluate performance and cost of each option using the Integrated Environmental Control Model (IECM) – CS Version
  - Developed by Carnegie Mellon University for the U.S. Department of Energy
  - For details, see www.iecm-online.com, and recent publications

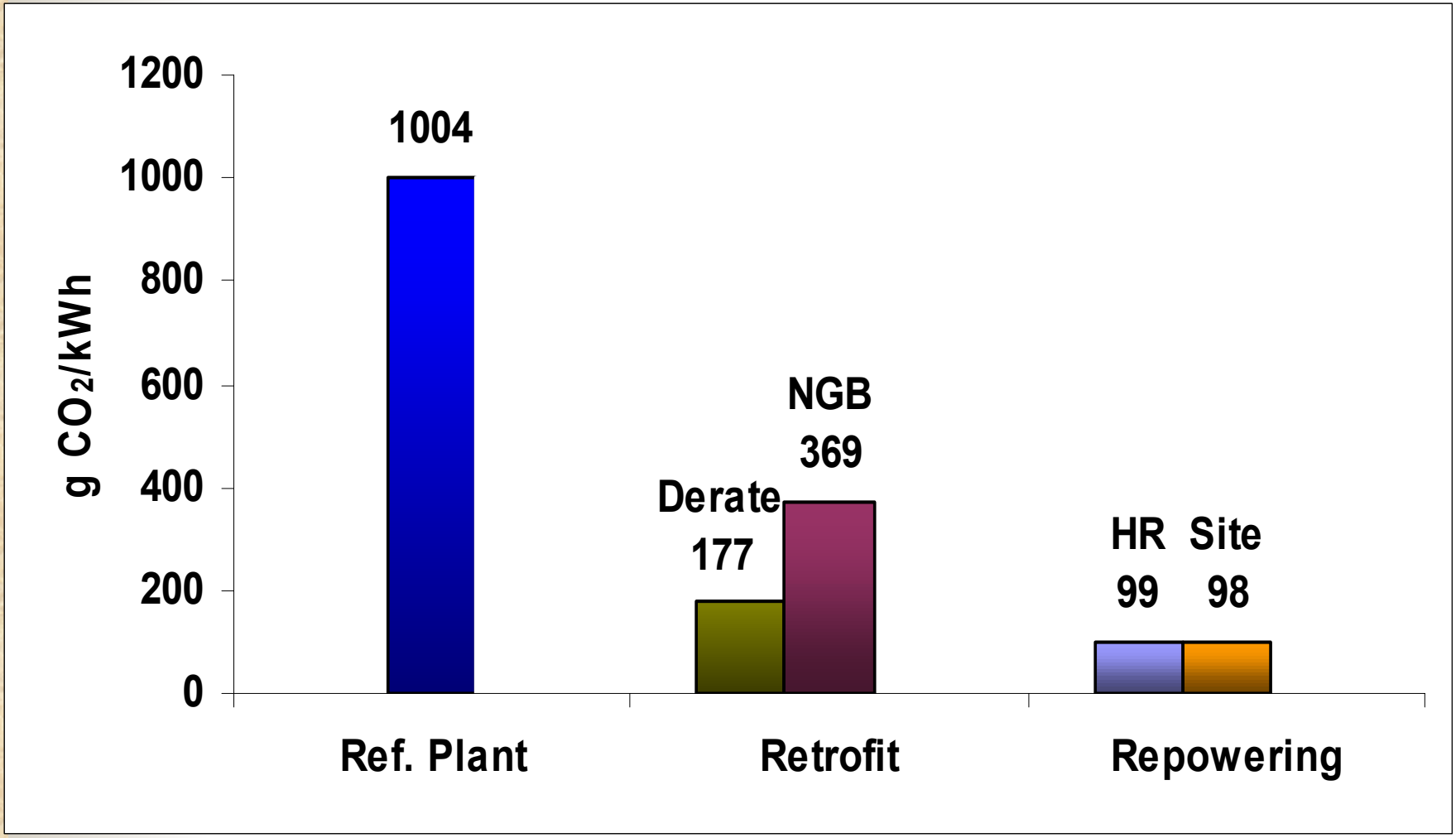
Study Results

(270 MW_g plant)

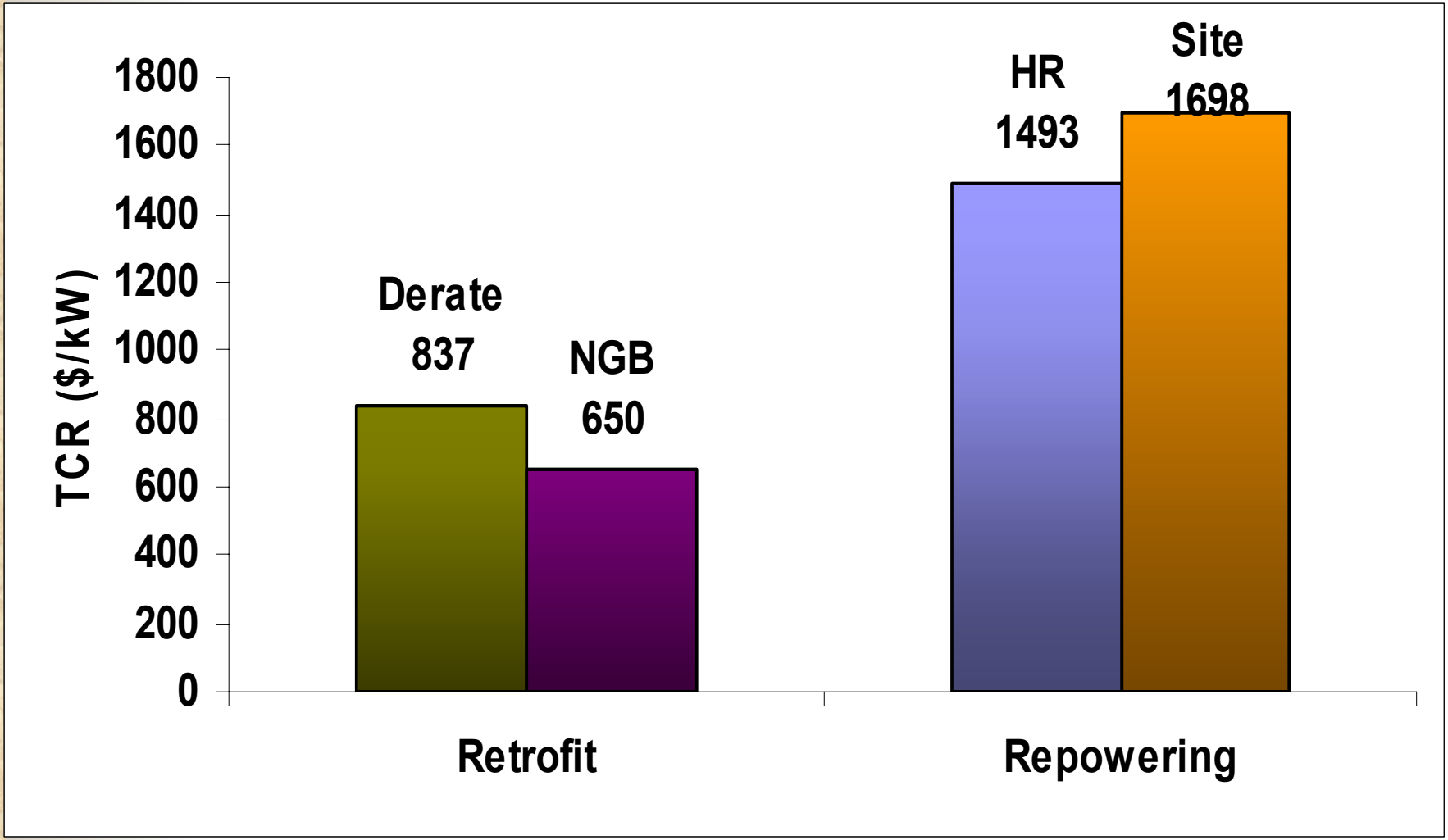
Net Power Output



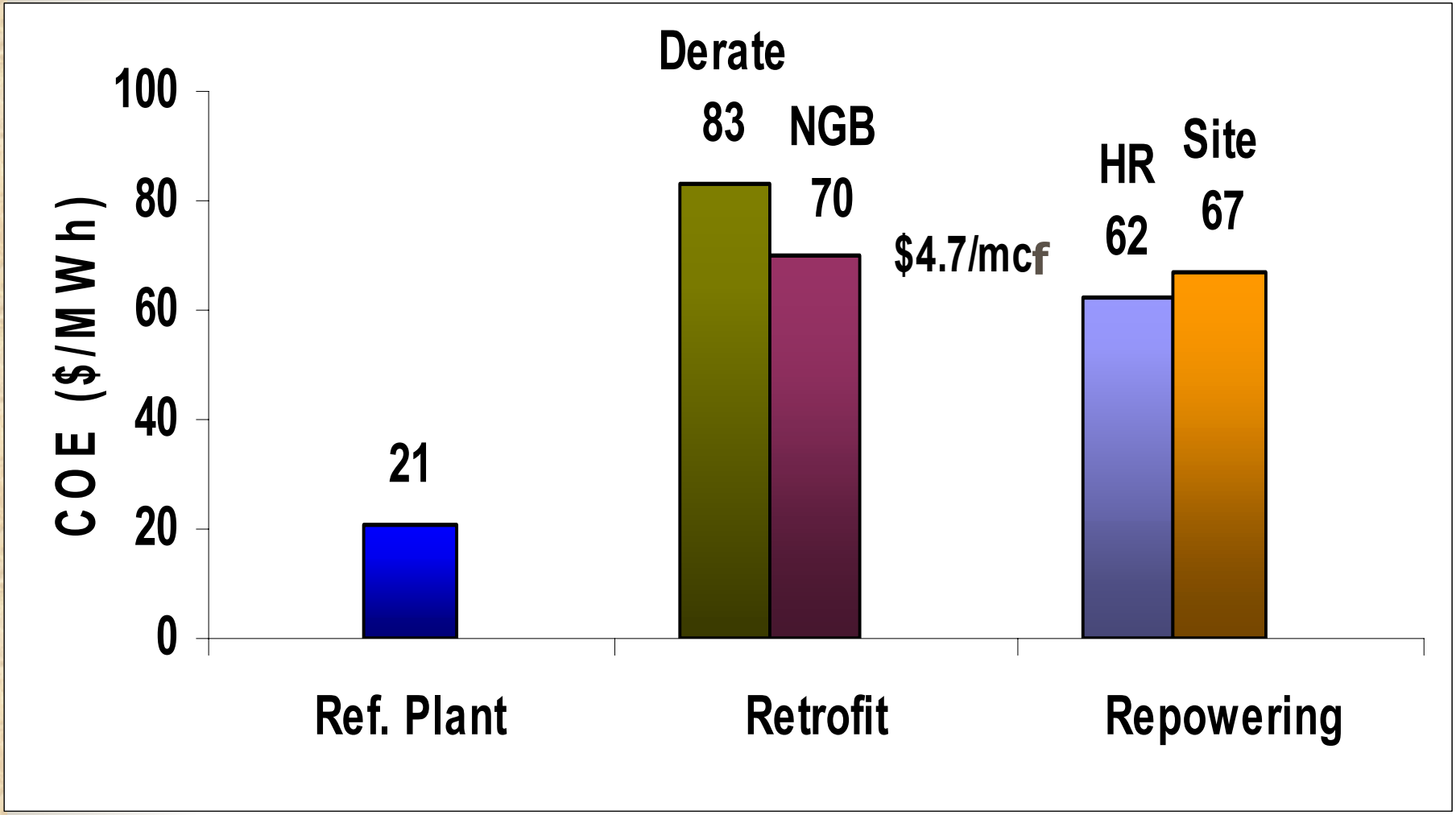
CO_2 Emission Rate



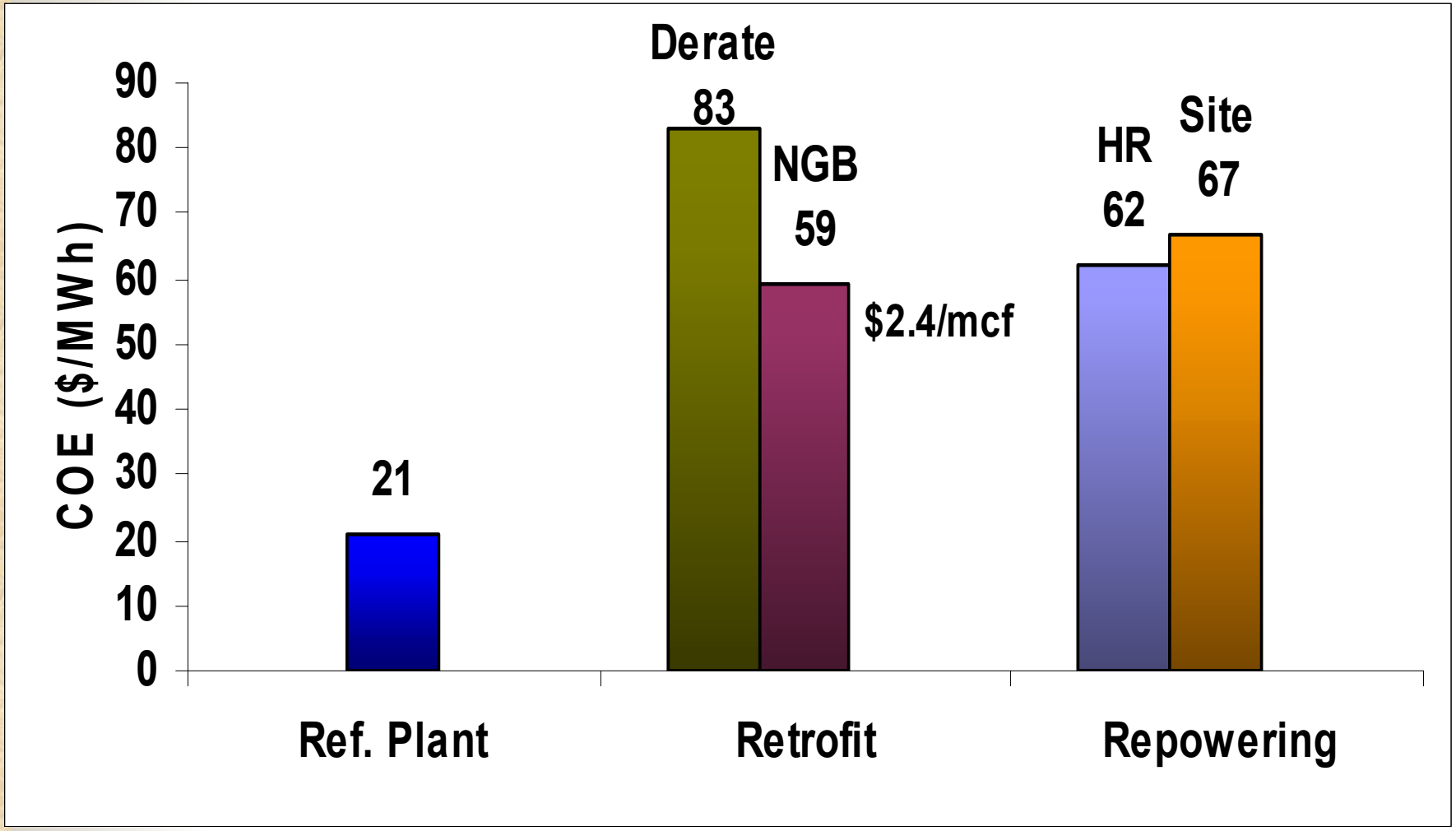
Total Capital Requirement



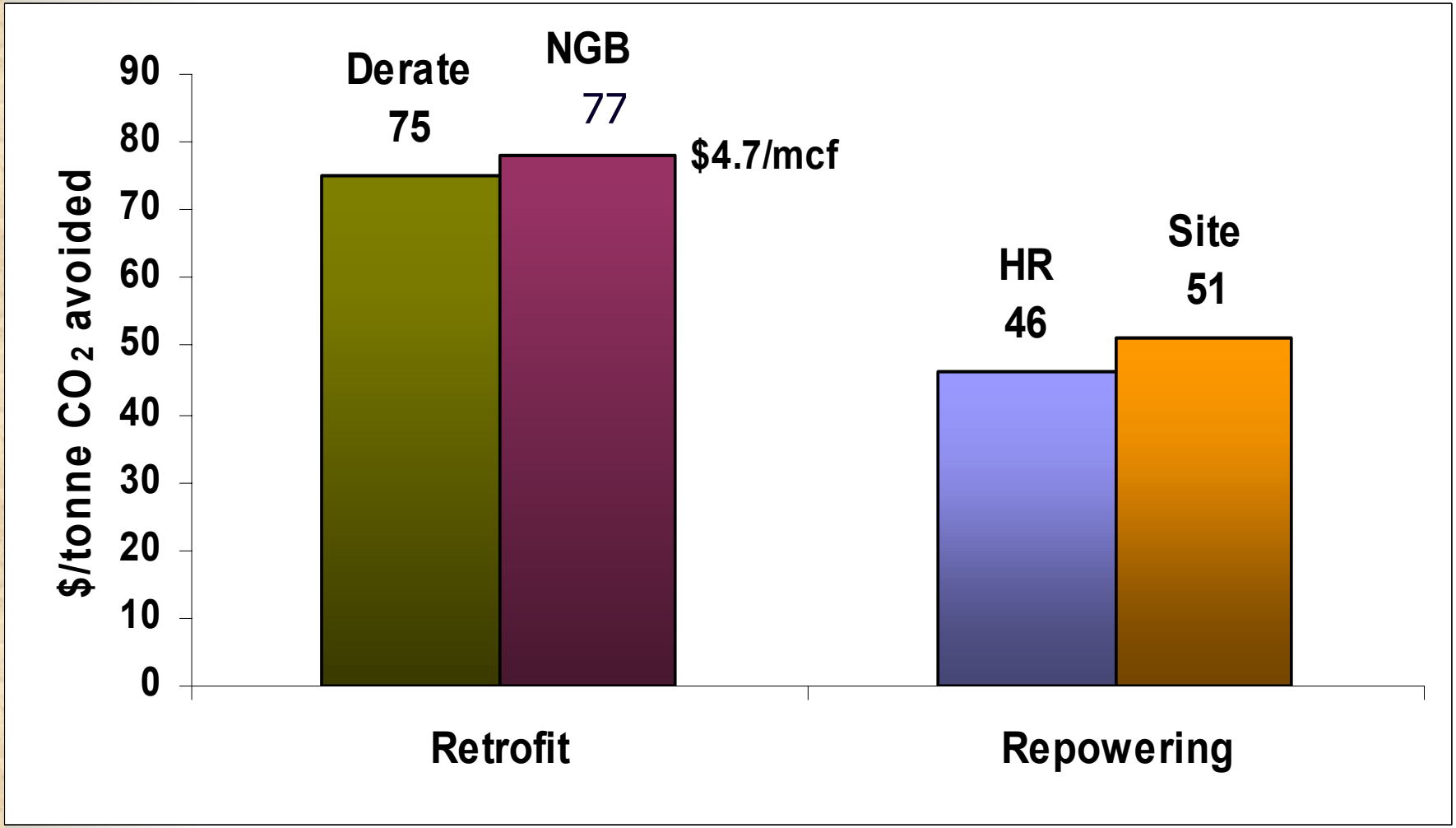
Cost of Electricity



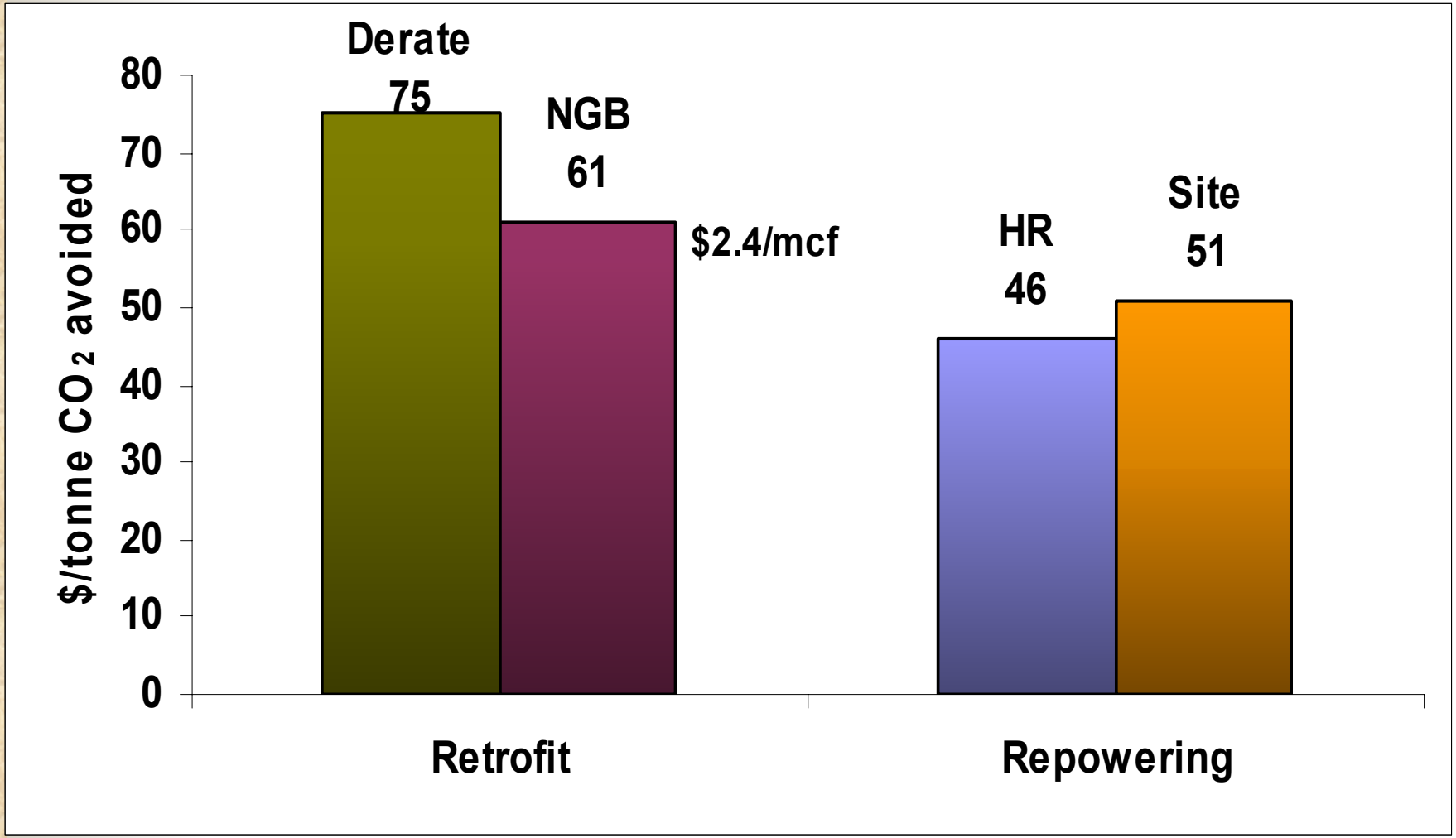
Cost of Electricity



Cost of CO_2 Avoided



Cost of CO_2 Avoided

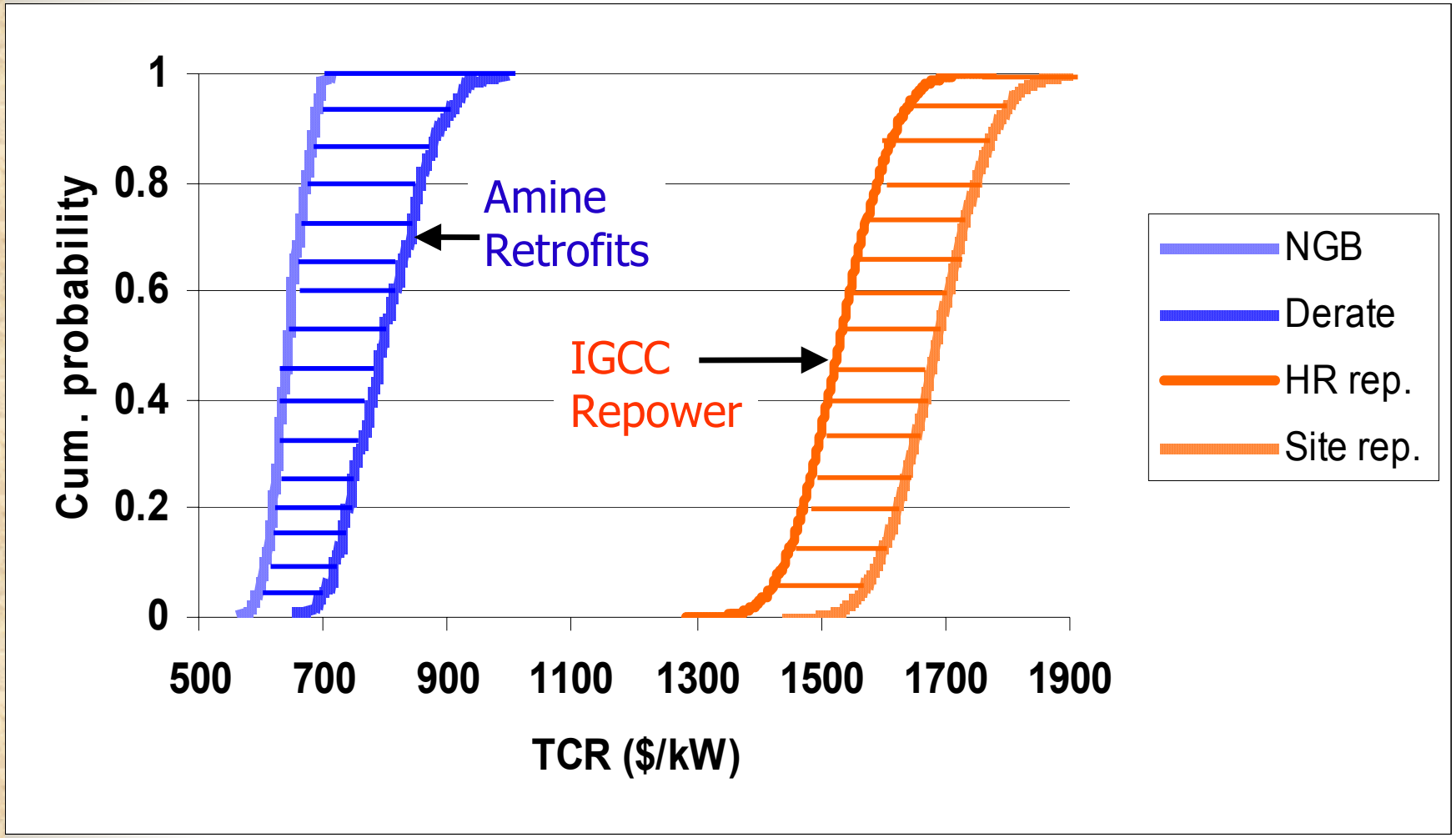


Uncertainty Analysis

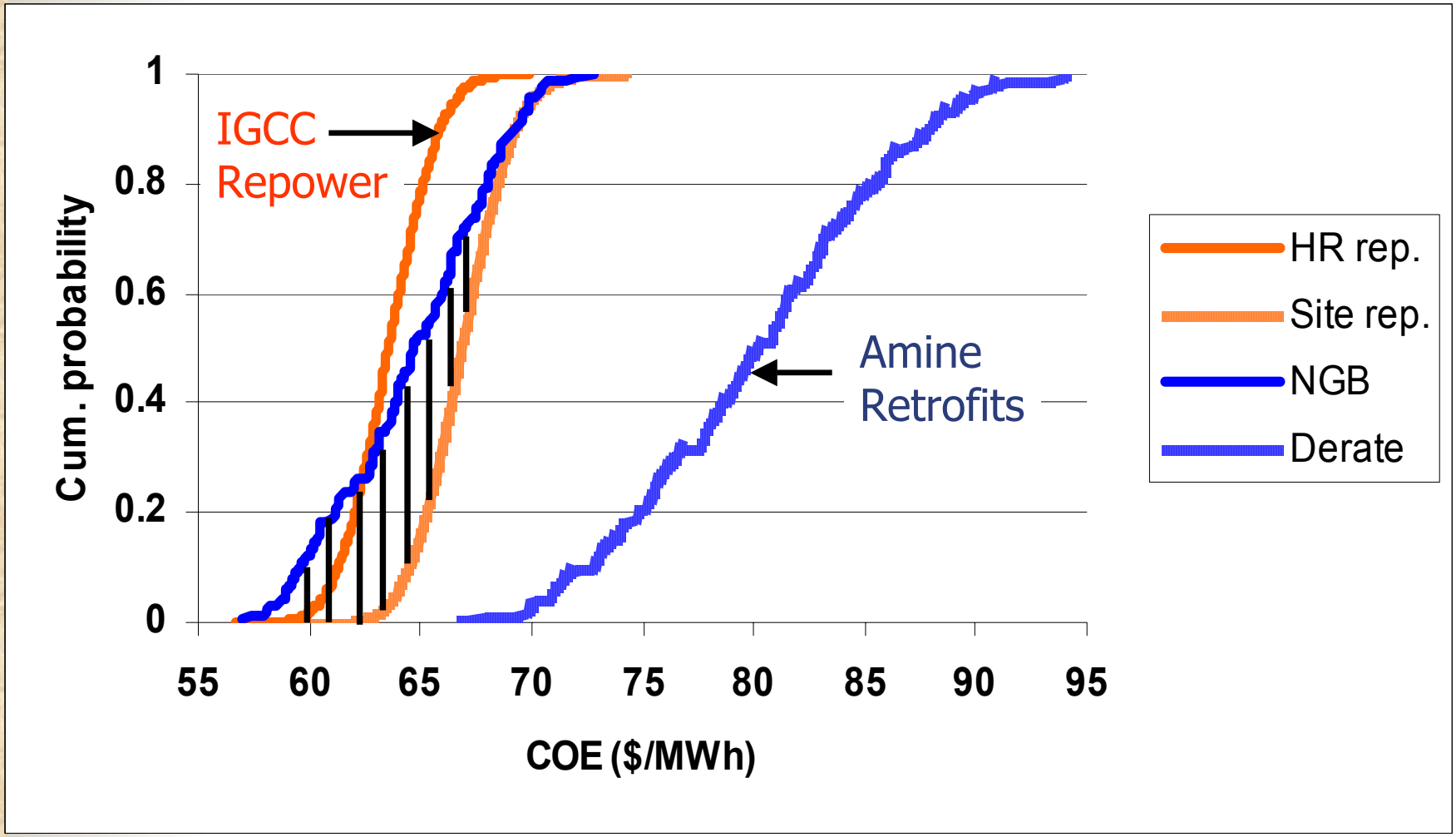
- Assign probability distributions to key performance and cost parameters for the amine scrubber and IGCC systems (~ 30-50 parameters in the IECM-CS)

- Perform Monte Carlo simulation and display results as a cumulative prob. dist.

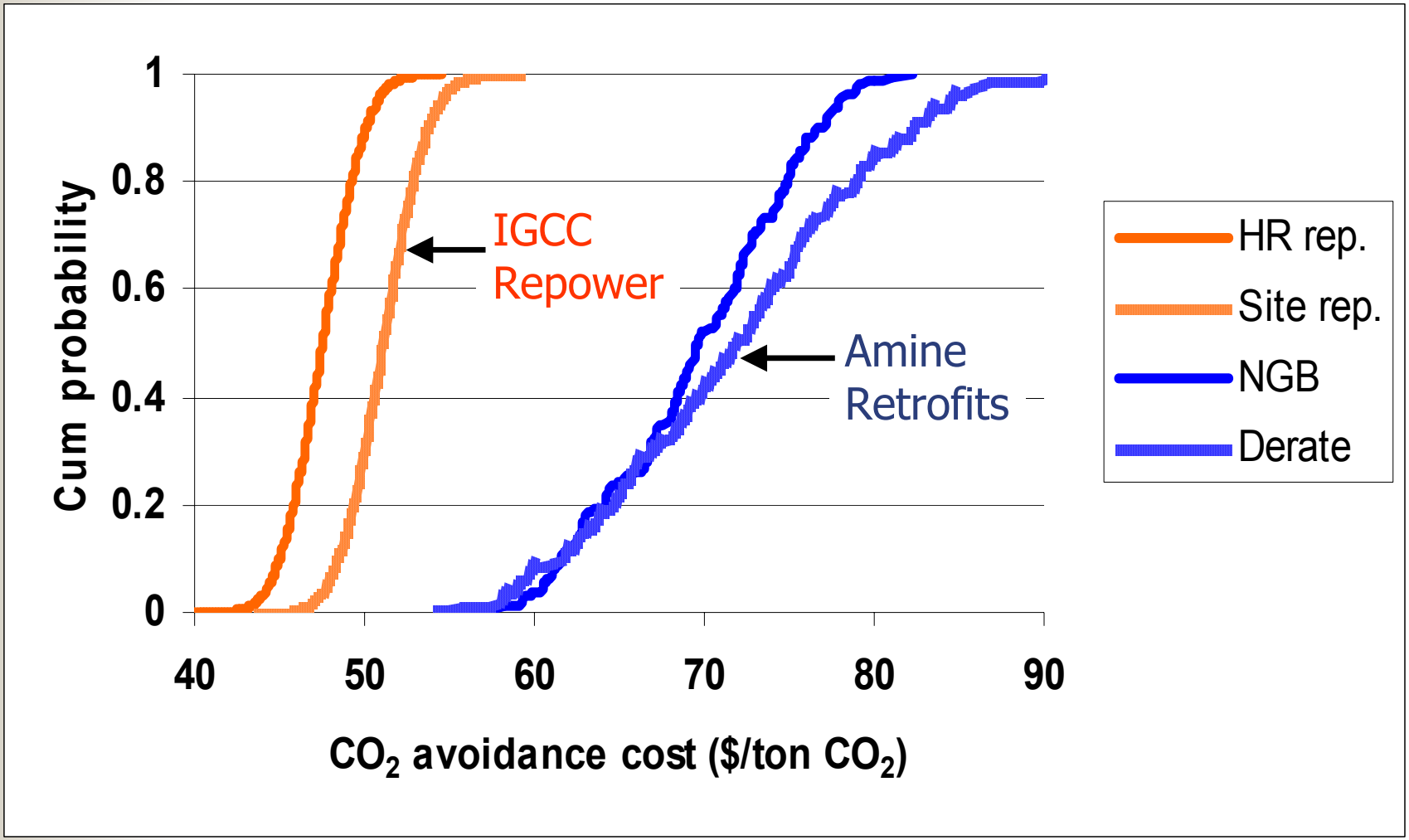
Total Capital Requirement



Cost of Electricity



Cost of CO_2 Avoided



Conclusions and Caveats

- Based on current technology, IGCC repowering is the most cost-effective method of CO_2 capture and storage for existing coal-fired plants
- Costs depend strongly on
  - economic/financial assumptions
  - site specific situations
- Future development of new or improved CCS system might provide alternative or lower-cost options for CO_2 capture