

**Synapse**  
Energy Economics, Inc.

# WECC Coal Plant Retirement Based On Forward-Going Economic Merit

Western Grid Group

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# Forward-Going Economic Merit

- Estimate all-in cost of operating coal fired generation in the west based on publicly available information (2008 EIA data)
  - Plants in 11 Western States: WA, OR, CA, MT, WY, ID, UT, CO, NV, AZ, NM
  - Fuel Cost
    - Heat Rate
    - Coal Source and Cost
  - O&M Estimates
    - Capacity and Capacity Factor
    - O&M Costs from NERC, 2010
  - Capacity Factor
    - Generation
- Add operating and capital cost of environmental upgrades to meet BART, Strict Utility MACT, and 316(b)
  - Capital expenditures
    - amortized over 15 yr period
    - WACC by utility type (NERC 2010)
    - Spread over MWh (2008)
  - Fixed O&M
  - Variable O&M

# Environmental Controls

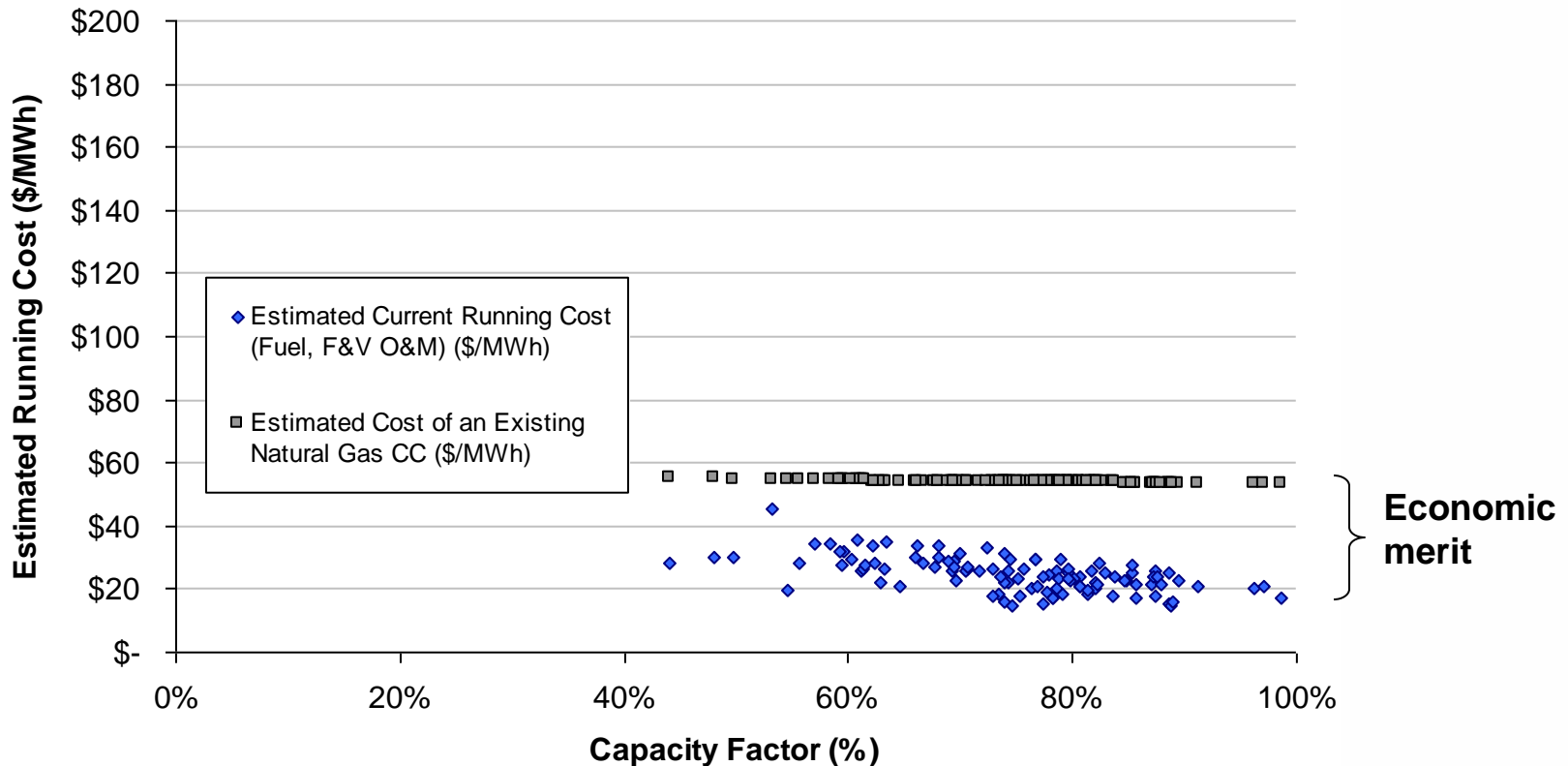
- **SO<sub>2</sub>:** Flue Gas Desulfurization (FGD)
  - EPA EPM v4.1, Sergant & Lundy
- **NO<sub>x</sub>:** Selective Catalytic Reduction (SCR)
  - EPA EPM v4.1, Sergant & Lundy
- **Hg:** Activated Carbon Injection (ACI)
  - EIPC MRN-NEEM (CRA)
- **PM:** Baghouse
  - EIPC MRN-NEEM (CRA)
- **Cooling Water Intake:** Cooling Towers
  - Powers, W. 2003.
- Assume all plants without appropriate FGD, SCR, ACI, PM, and cooling towers require upgrades
- Assume all plants with existing environmental controls must operate them at 100%
  - i.e. include O&M costs for env. controls

# Forward-Going Economic Merit

- Compare all-in forward-going cost to “replacement cost”
  - Replacement analog is natural gas CC unit
  - New or existing
    - If new, includes capital cost, amortized over 30 yrs
  - Natural gas price levelized AEO 2010 forecast (2015-2034)
- Goal of project is to choose economic merit order, fraction to retire is given

# Estimated 2008 Running Costs vs. Existing Natural Gas CC in WECC Region

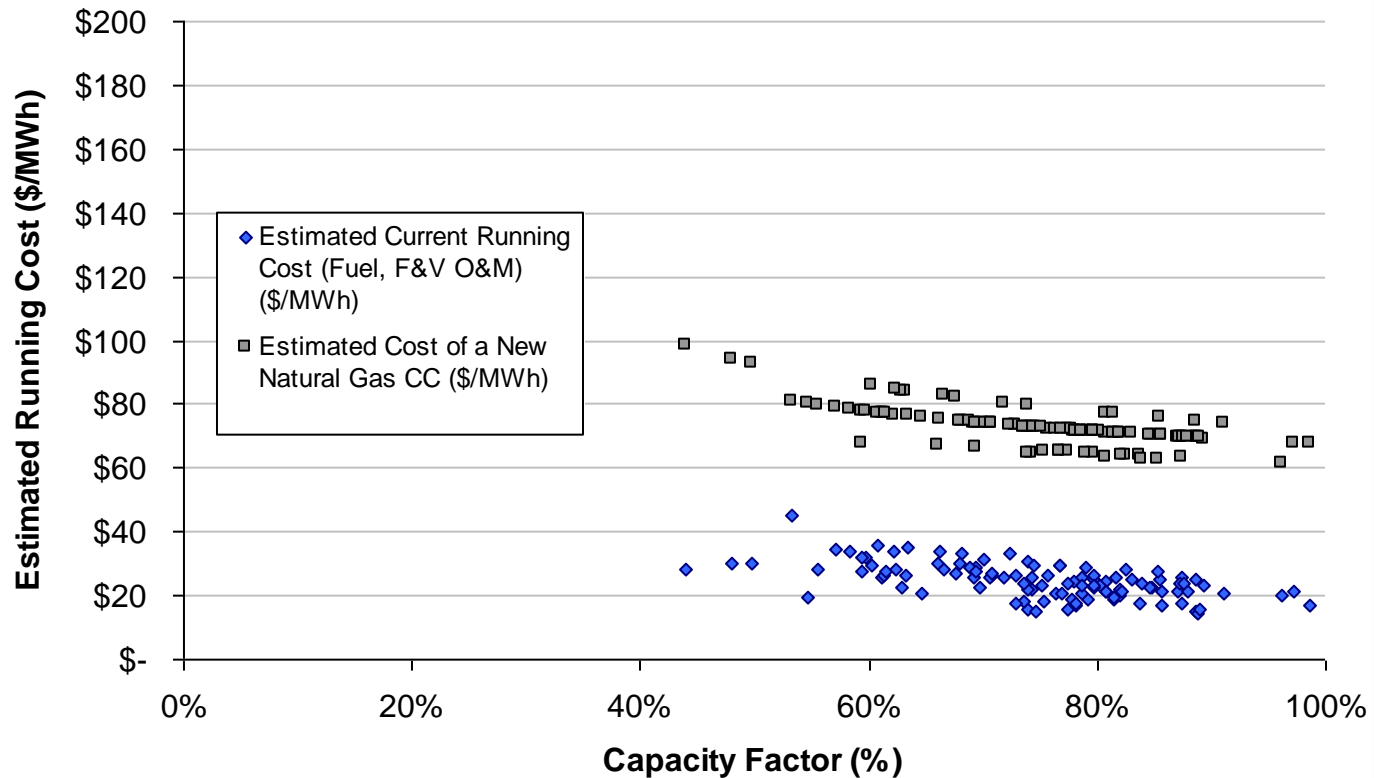
Estimated Current Running Cost (Fuel, F&V O&M) (\$/MWh)



Economic merit is positive for all existing coal-fired units (without environmental upgrades) relative to existing natural gas

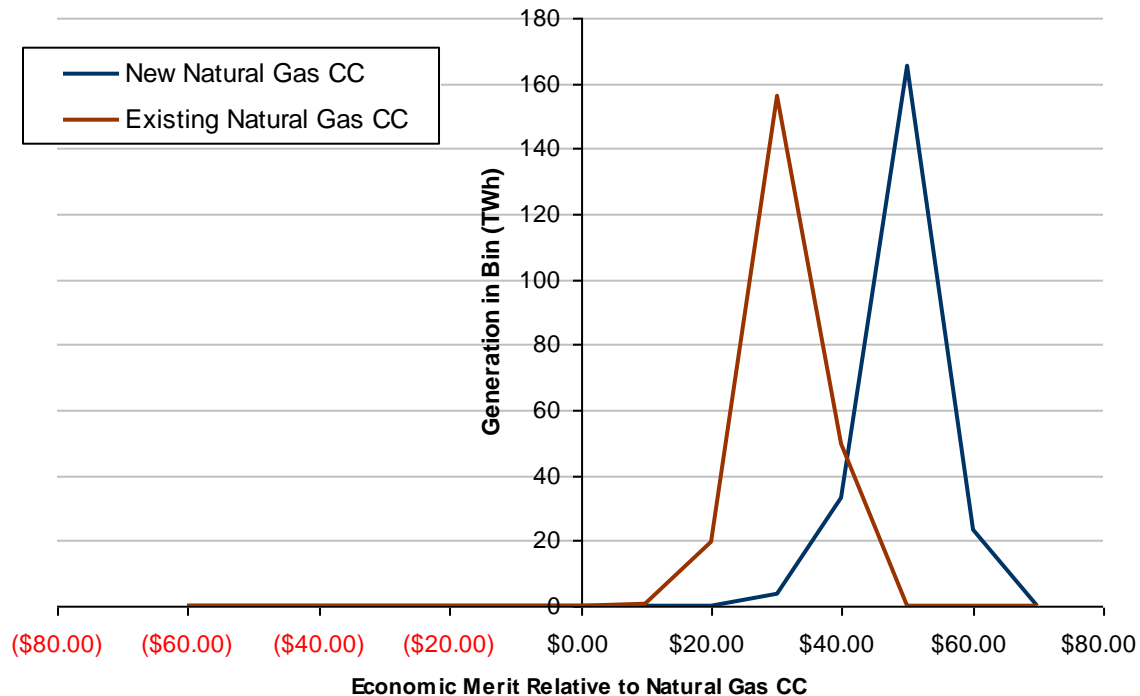
# Estimated 2008 Running Costs vs. New Natural Gas CC in WECC Region

Estimated Current Running Cost (Fuel, F&V O&M) (\$/MWh)



Economic merit is fairly large for all existing coal-fired units (without environmental upgrades) relative to new natural gas

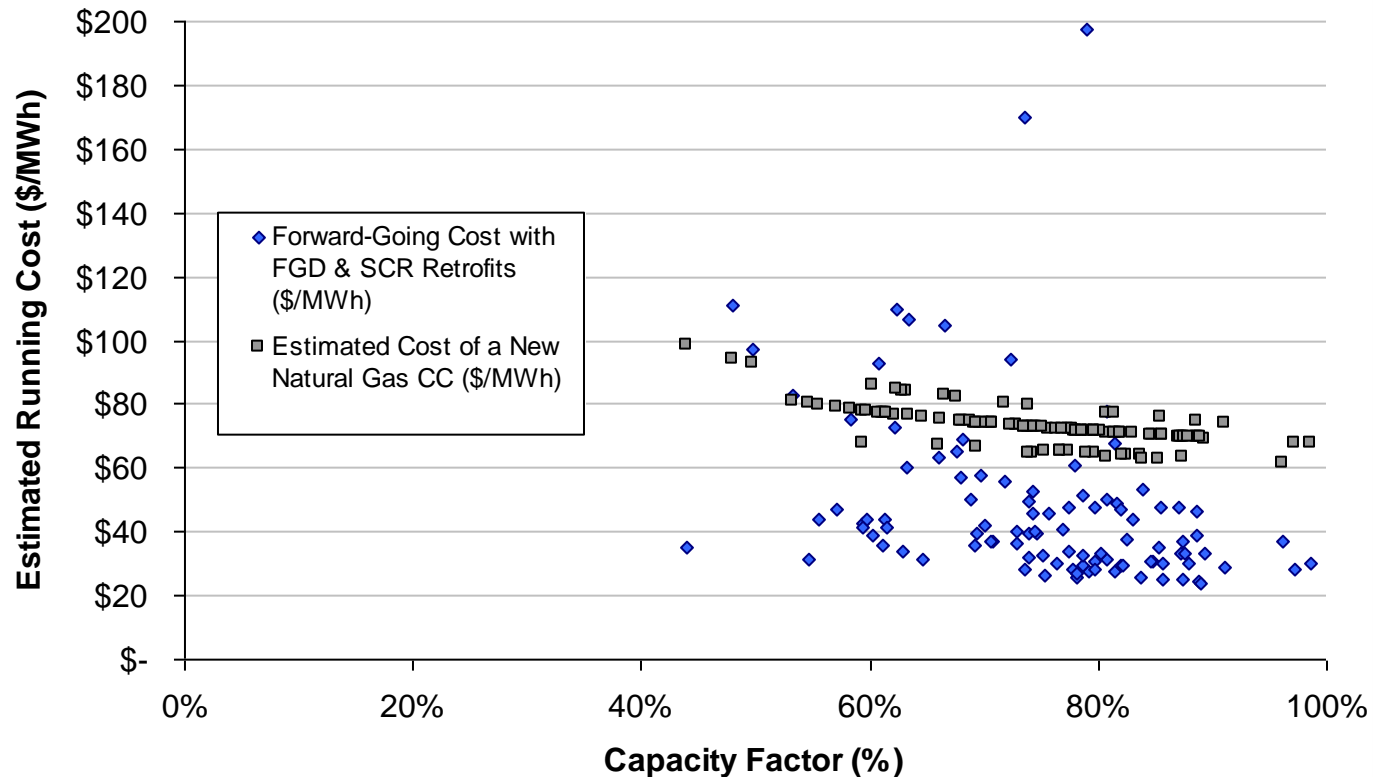
# Estimated 2008 Running Costs vs. New and Existing Natural Gas CCs



Economic merit is the distance between the all in cost of coal generation and the cost of running an alternative (natural gas CC)

# Forward-Going Costs with FGD & SCR vs. New Natural Gas CC in WECC Region

## Forward-Going Cost with FGD & SCR Retrofits (\$/MWh)

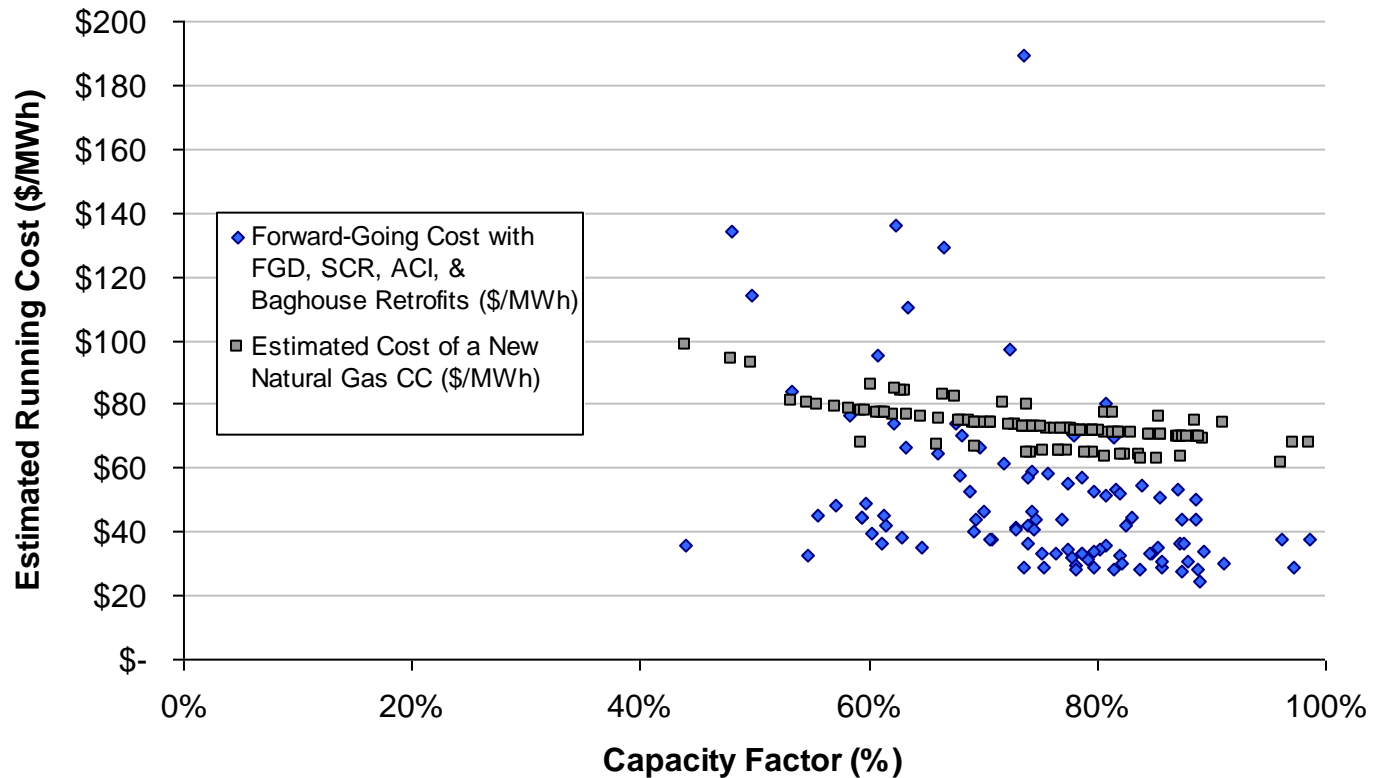


Smaller, less efficient & uncontrolled units migrate towards (and above) the cost of the alternative.



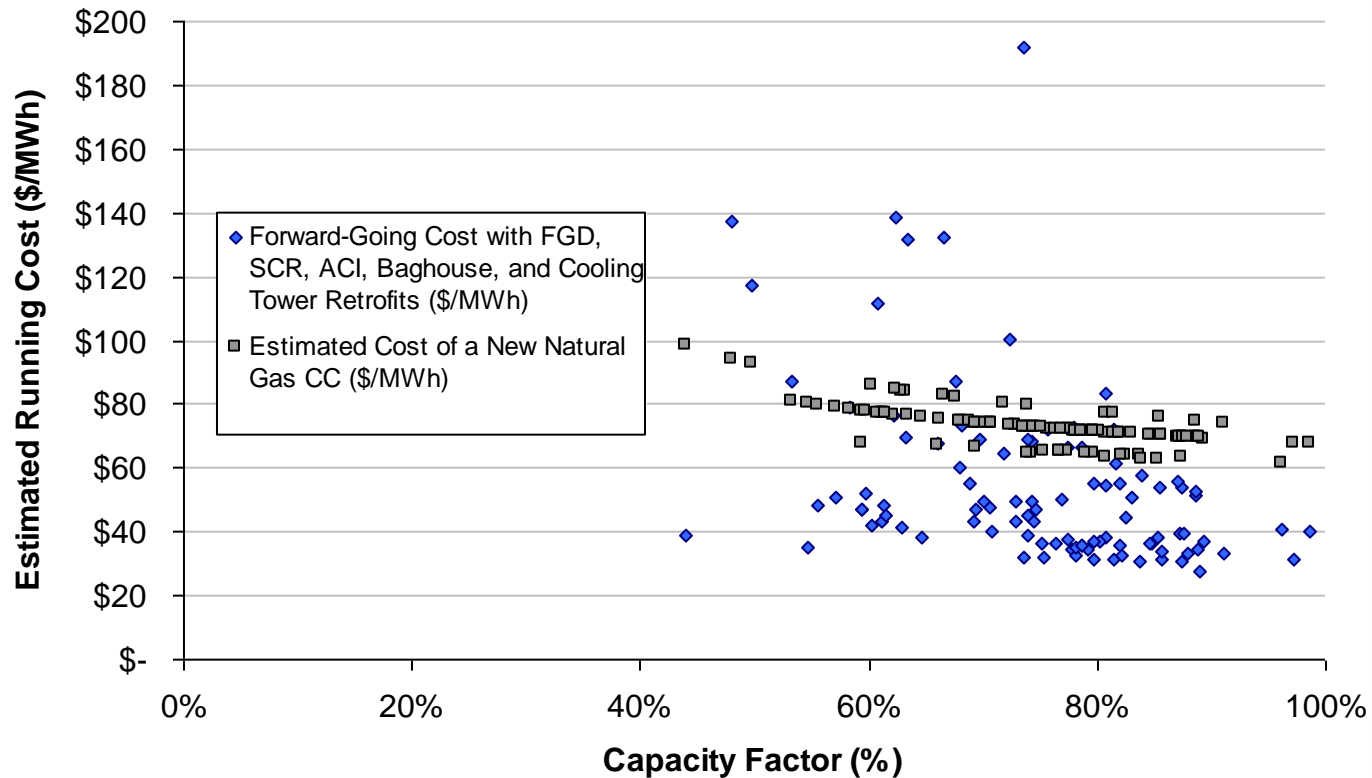
# Forward-Going Costs with FGD, SCR, ACI, and Baghouse vs. New Natural Gas CC

## Forward-Going Cost with FGD, SCR, ACI, & Baghouse Retrofits (\$/MWh)



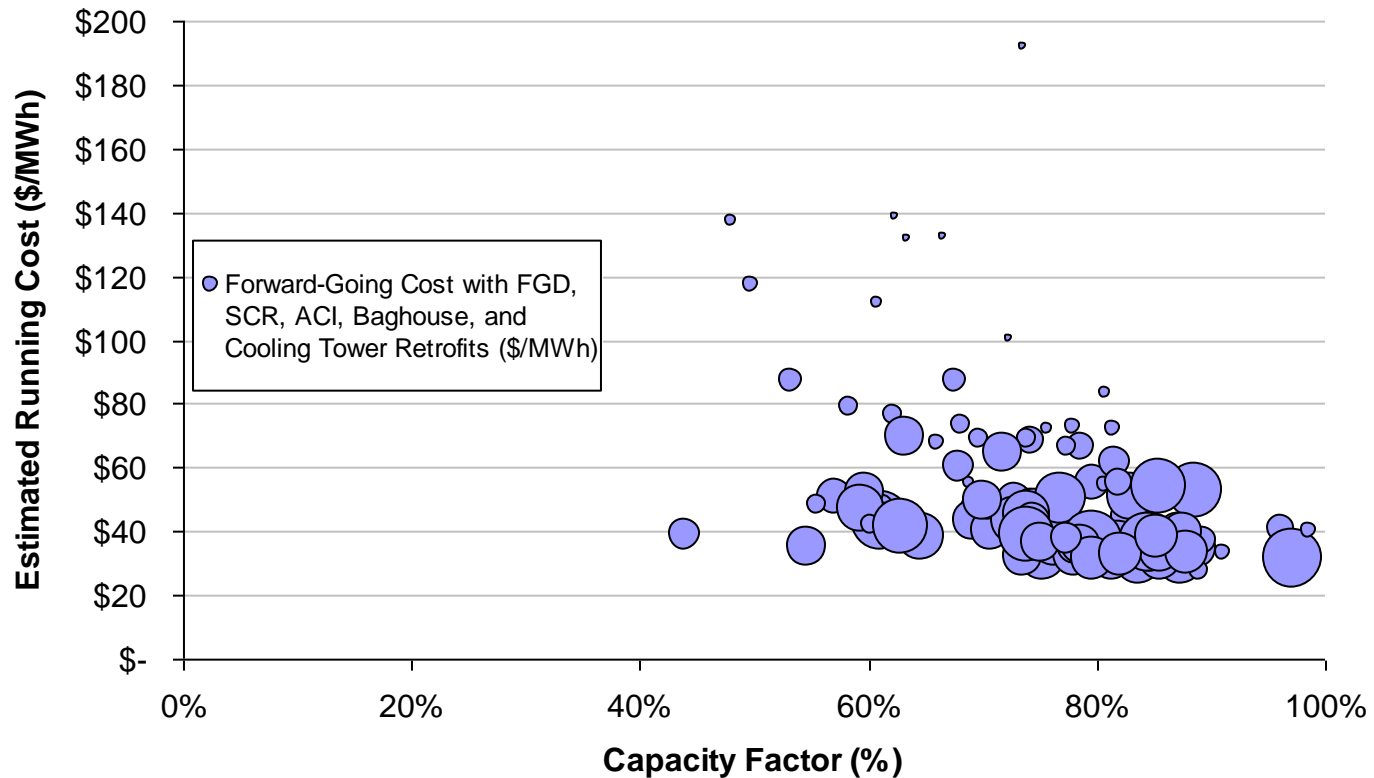
# Forward-Going Costs with FGD, SCR, ACI, Baghouse, and Cooling Tower vs. New Natural Gas CC

Forward-Going Cost with FGD, SCR, ACI, Baghouse, and Cooling Tower Retrofits (\$/MWh)

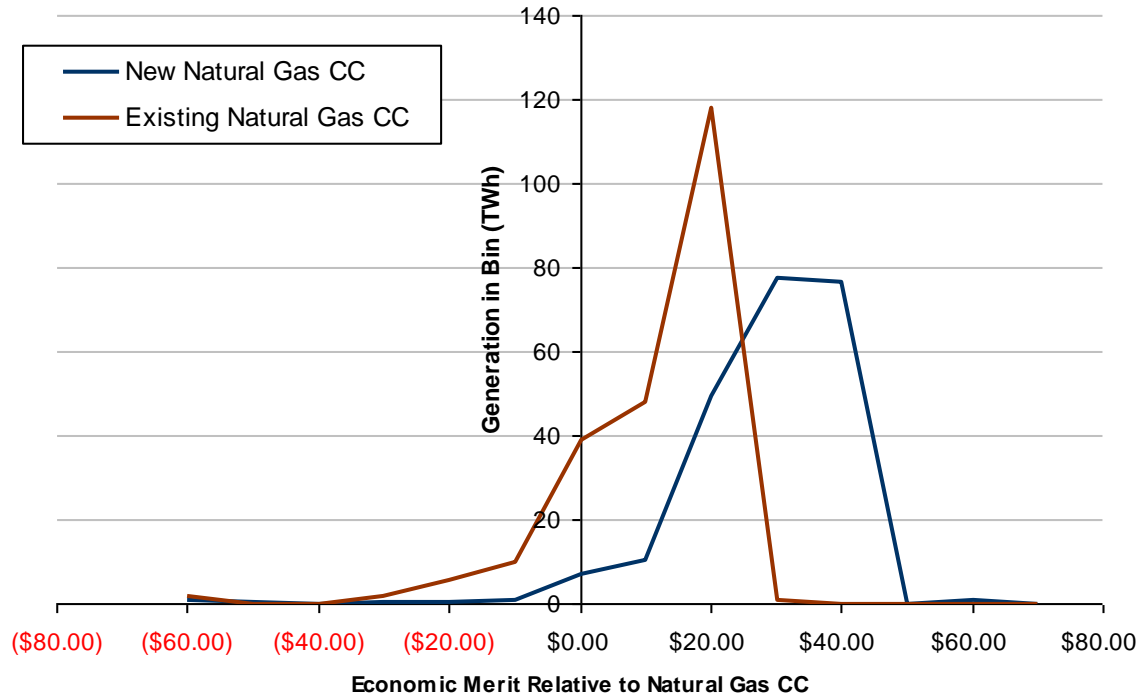


# Smaller units more impacted by regulations

**Forward-Going Cost with FGD, SCR, ACI, Baghouse, and Cooling Tower Retrofits (\$/MWh)**



# Smaller units more impacted by regulations



Approximately 5% of generation becomes economically non-meritorious relative to new NG if all environmental upgrades are required. Fraction is above 30% relative to existing NG.

# Coal Plant Retirement List

Lowest 25% (Generation) Economic Merit  
with all environmental retrofits

## Relative to New Natural Gas

Osage, 3 (WY)	Nucla, ST4 (CO)	Cholla, 3 (AZ)
Osage, 2 (WY)	Reid Gardner, 3 (NV)	Dave Johnston, 3 (WY)
Osage, 1 (WY)	Lewis & Clark, 1 (MT)	Arapahoe, 3 (CO)
Nucla, 2 (CO)	Reid Gardner, 2 (NV)	San Juan, 4 (NM)
Nucla, 3 (CO)	Dave Johnston, 1 (WY)	Apache Station, ST3 (AZ)
W N Clark, 1 (CO)	Four Corners, 1 (NM)	Apache Station, ST2 (AZ)
Nucla, 1 (CO)	Sunnyside Cogen Associates, C	Four Corners, 4 (NM)
Neil Simpson, 5 (WY)	Carbon, 2 (UT)	San Juan, 3 (NM)
Cameo, 1 (CO)	Four Corners, 2 (NM)	Ray D Nixon, 1 (CO)
KUCC, 3 (UT)	Dave Johnston, 2 (WY)	Boardman, 1 (OR)
KUCC, 2 (UT)	Martin Drake, 5 (CO)	
KUCC, 1 (UT)	Martin Drake, 6 (CO)	
Cameo, 2 (CO)	Four Corners, 3 (NM)	
W N Clark, 2 (CO)	Naughton, 1 (WY)	
KUCC, 4 (UT)	North Valmy, 1 (NV)	
Colstrip Energy LP, GEN1 (MT)	Colstrip, 2 (MT)	
H Wilson Sundt Generating Sta	Martin Drake, 7 (CO)	
J E Corette Plant, 1 (MT)	Cholla, 1 (AZ)	
Carbon, 1 (UT)	Colstrip, 1 (MT)	
Reid Gardner, 1 (NV)	Naughton, 2 (WY)	

## Relative to Existing Natural Gas

Osage, 3 (WY)	Reid Gardner, 2 (NV)	Cholla, 1 (AZ)
Osage, 2 (WY)	Carbon, 1 (UT)	Colstrip, 4 (MT)
Osage, 1 (WY)	Sunnyside Cogen Associates, C	Colstrip, 3 (MT)
W N Clark, 1 (CO)	Lewis & Clark, 1 (MT)	Dave Johnston, 3 (WY)
Nucla, 2 (CO)	Carbon, 2 (UT)	San Juan, 1 (NM)
Nucla, 3 (CO)	Colstrip, 2 (MT)	Four Corners, 4 (NM)
Nucla, 1 (CO)	Dave Johnston, 1 (WY)	Boardman, 1 (OR)
Neil Simpson, 5 (WY)	Four Corners, 1 (NM)	Reid Gardner, 4 (NV)
KUCC, 3 (UT)	Nucla, ST4 (CO)	Martin Drake, 7 (CO)
KUCC, 1 (UT)	Dave Johnston, 2 (WY)	
KUCC, 2 (UT)	Four Corners, 2 (NM)	
Cameo, 1 (CO)	Colstrip, 1 (MT)	
KUCC, 4 (UT)	Four Corners, 3 (NM)	
Cameo, 2 (CO)	North Valmy, 1 (NV)	
W N Clark, 2 (CO)	Martin Drake, 5 (CO)	
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