

AURORA^{xmp}, EPIS Inc.
2008 Electric Market Forecasting Conference

Modeling Reductions in the Northwest Power System's Annual Carbon Dioxide Production

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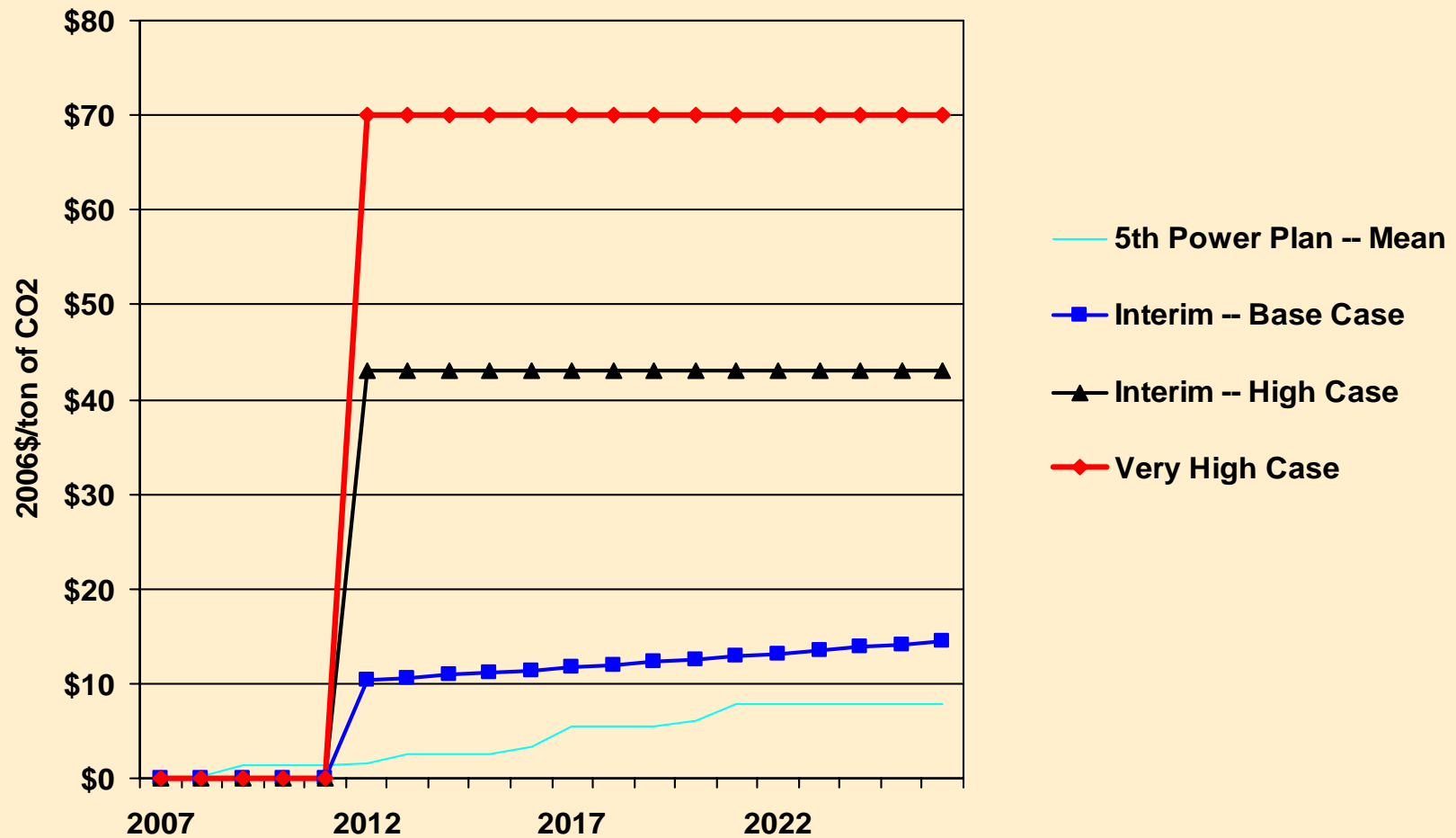
Stevenson, WA

September 12, 2008

Two Questions

- How high would CO₂ emission allowance prices need to climb in order to significantly reduce the Northwest power system's annual CO₂ production?
- How sensitive would CO₂ allowance prices (and reductions in power system CO₂ emissions) be to increased natural gas prices?

CO₂ Emission Prices



Medium Fuel Price Cases

Natural gas prices from ~ \$5 to \$6 per MMBtu (in 2006\$)

1. Interim Base Case:

- Full RPS achievement
- Capital costs circa Jan. 2006
- CO₂ allowance prices from ~ \$10 to \$15 per ton of CO₂ (in 2006\$)

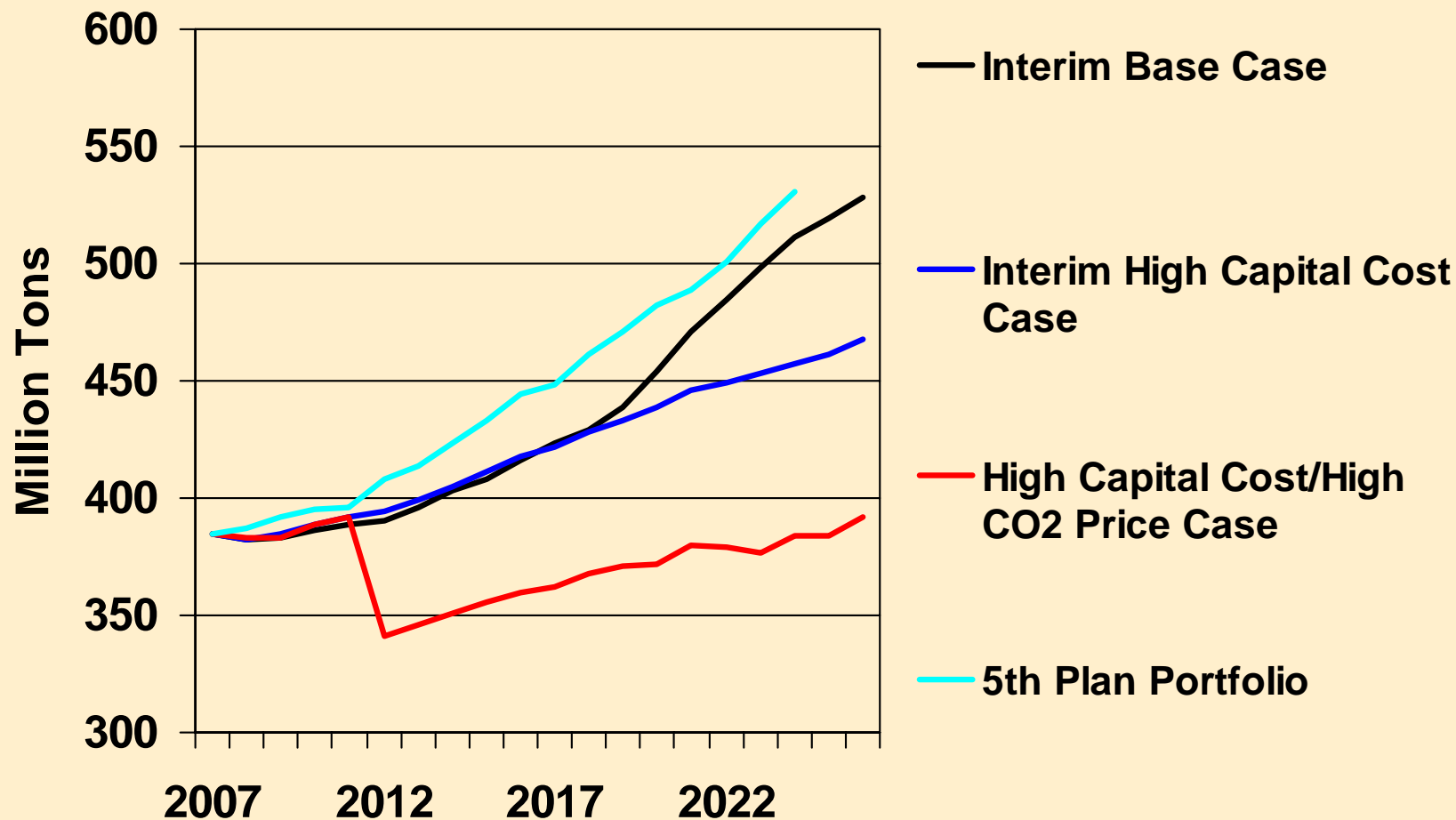
2. Interim High Capital Cost Case:

- Same as previous except:
 - Capital costs circa Jan. 2008

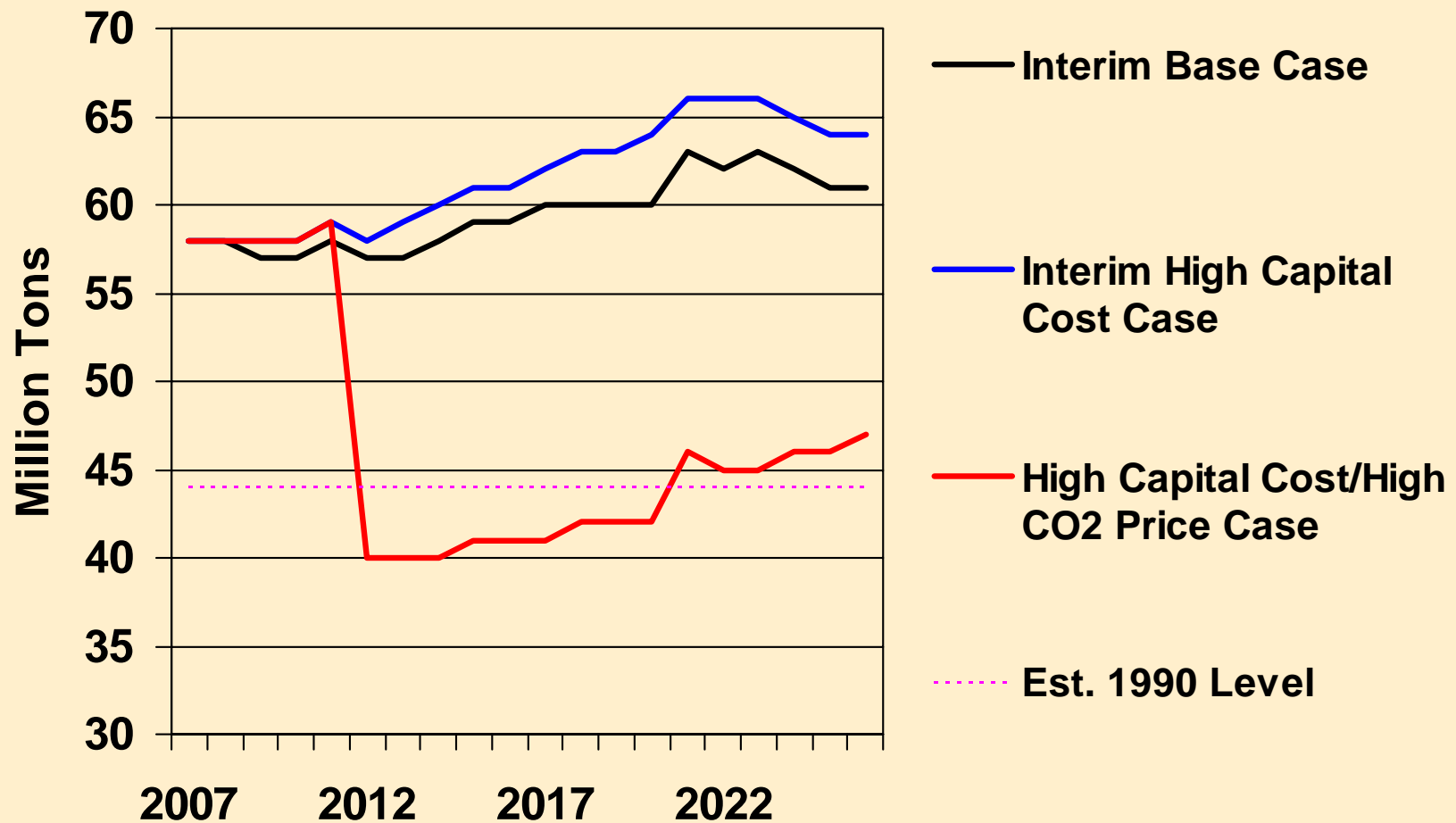
3. High Capital Cost/High CO₂ Price Case:

- Same as previous except:
 - CO₂ allowance prices at \$43 per ton of CO₂ (in 2006\$)

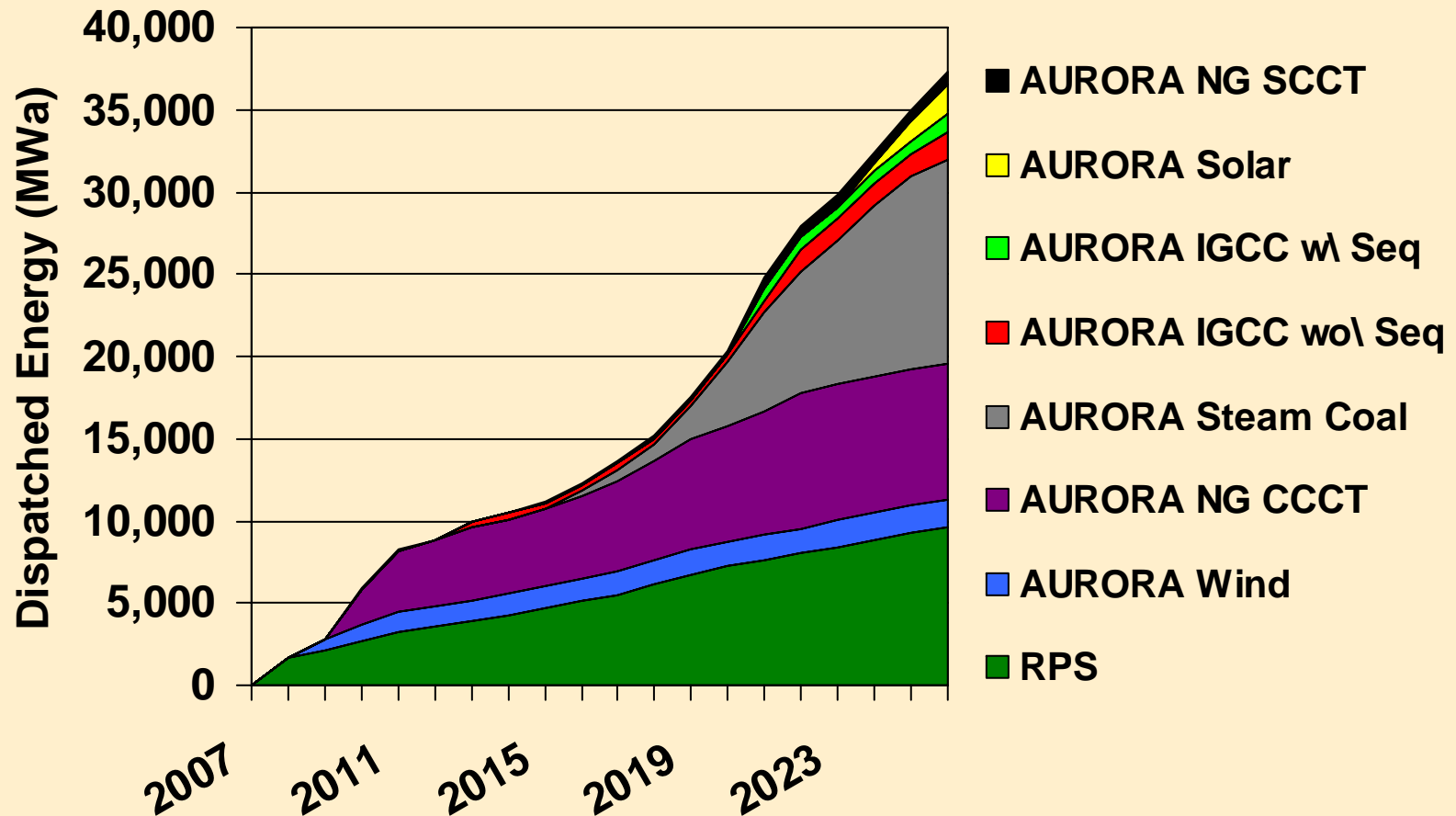
WECC Annual CO₂ Emissions



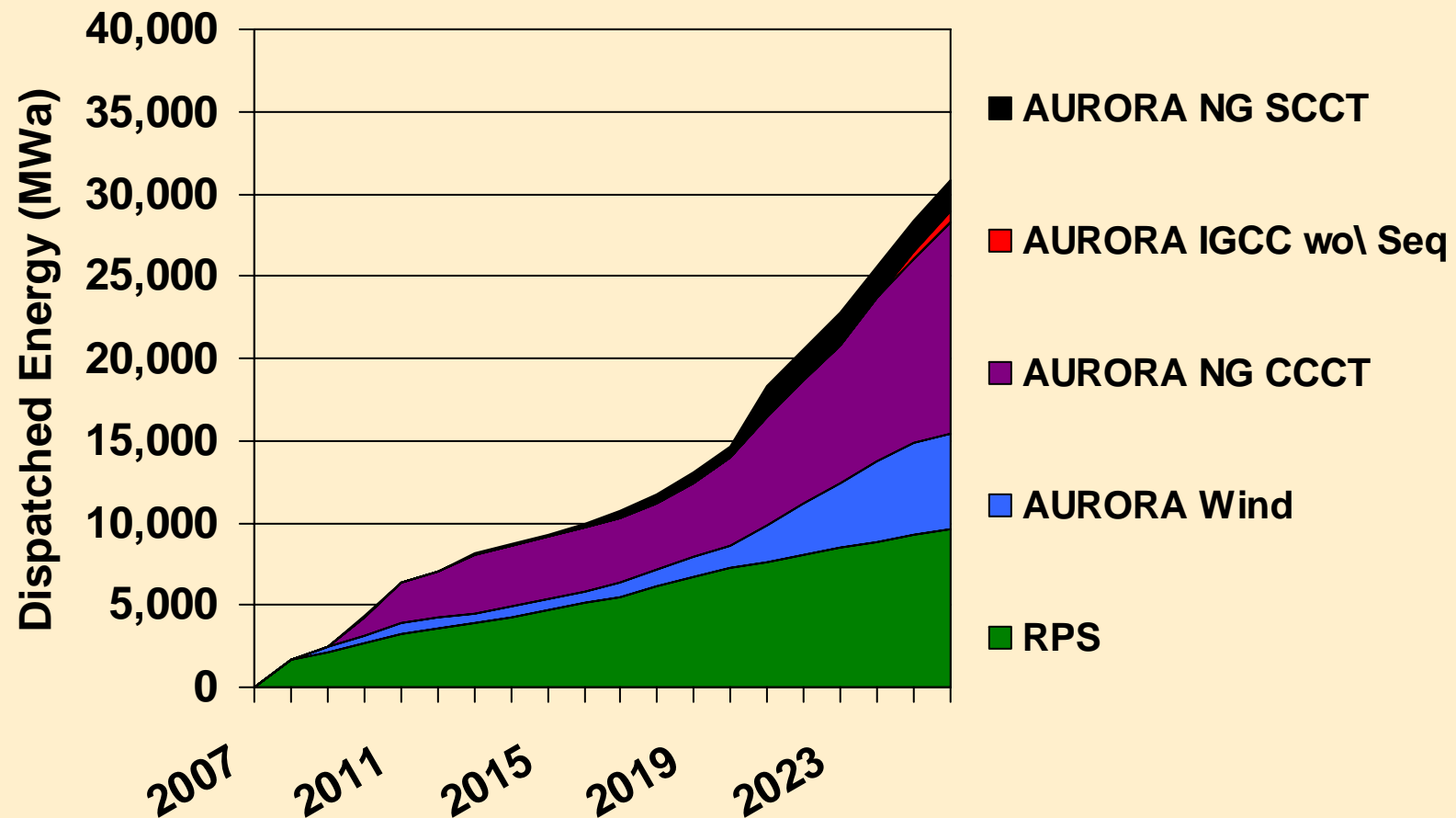
NW Power System Annual CO₂ Emissions



Interim Base Case WECC Resource Expansion 2007-26

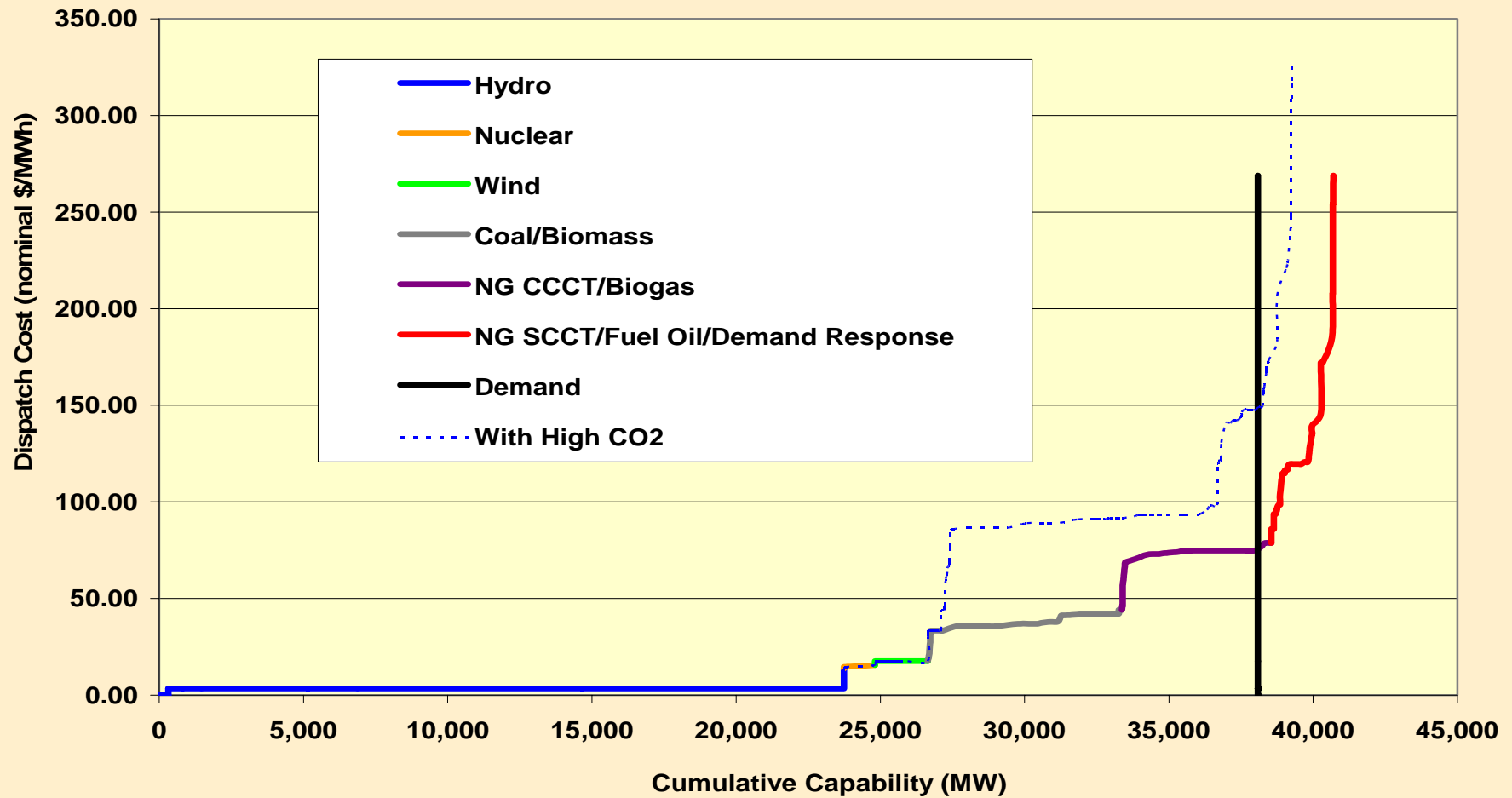


Interim High Capital Cost Case WECC Resource Expansion 2007-26

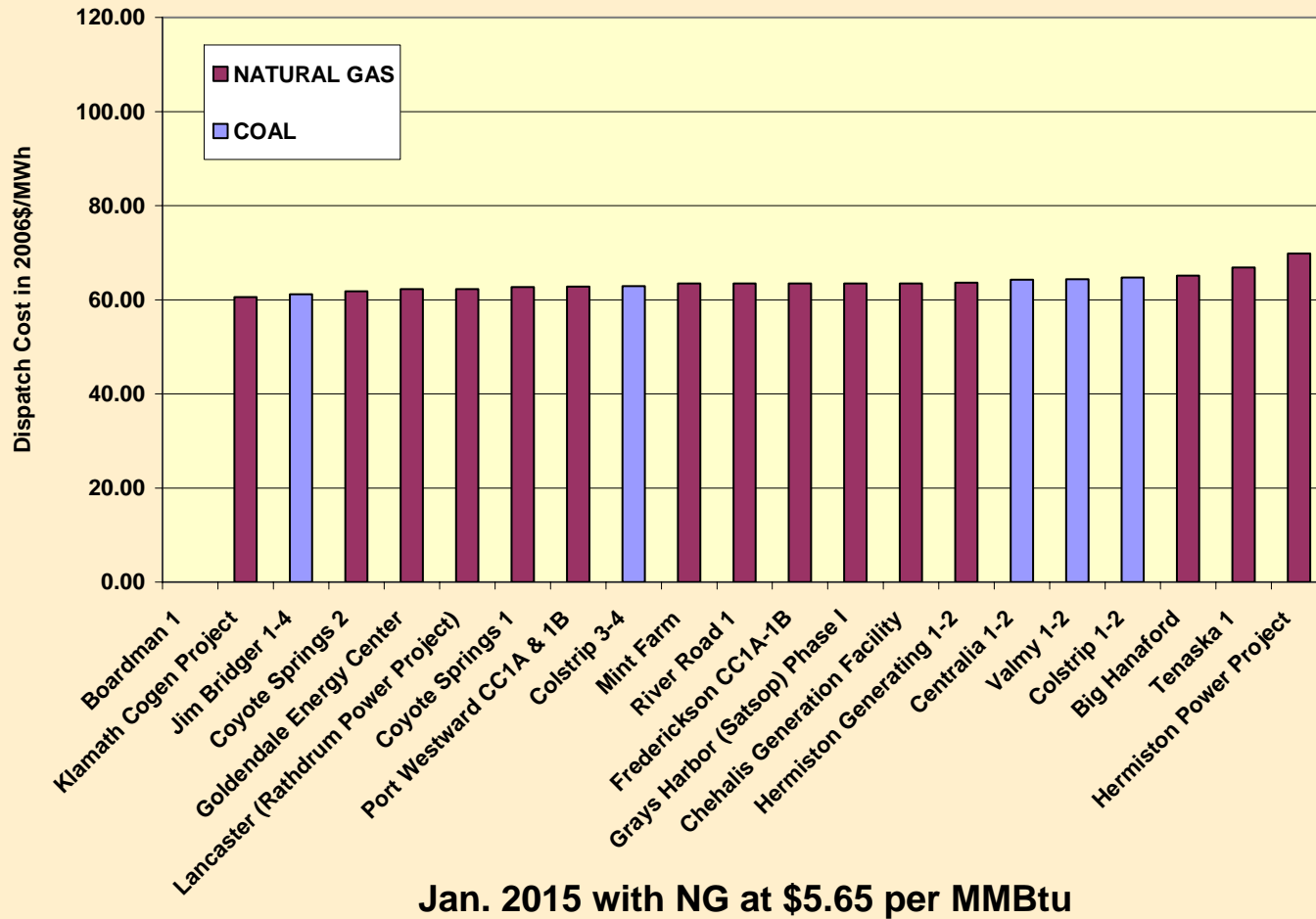


Impact of High CO₂ Prices on NW Supply

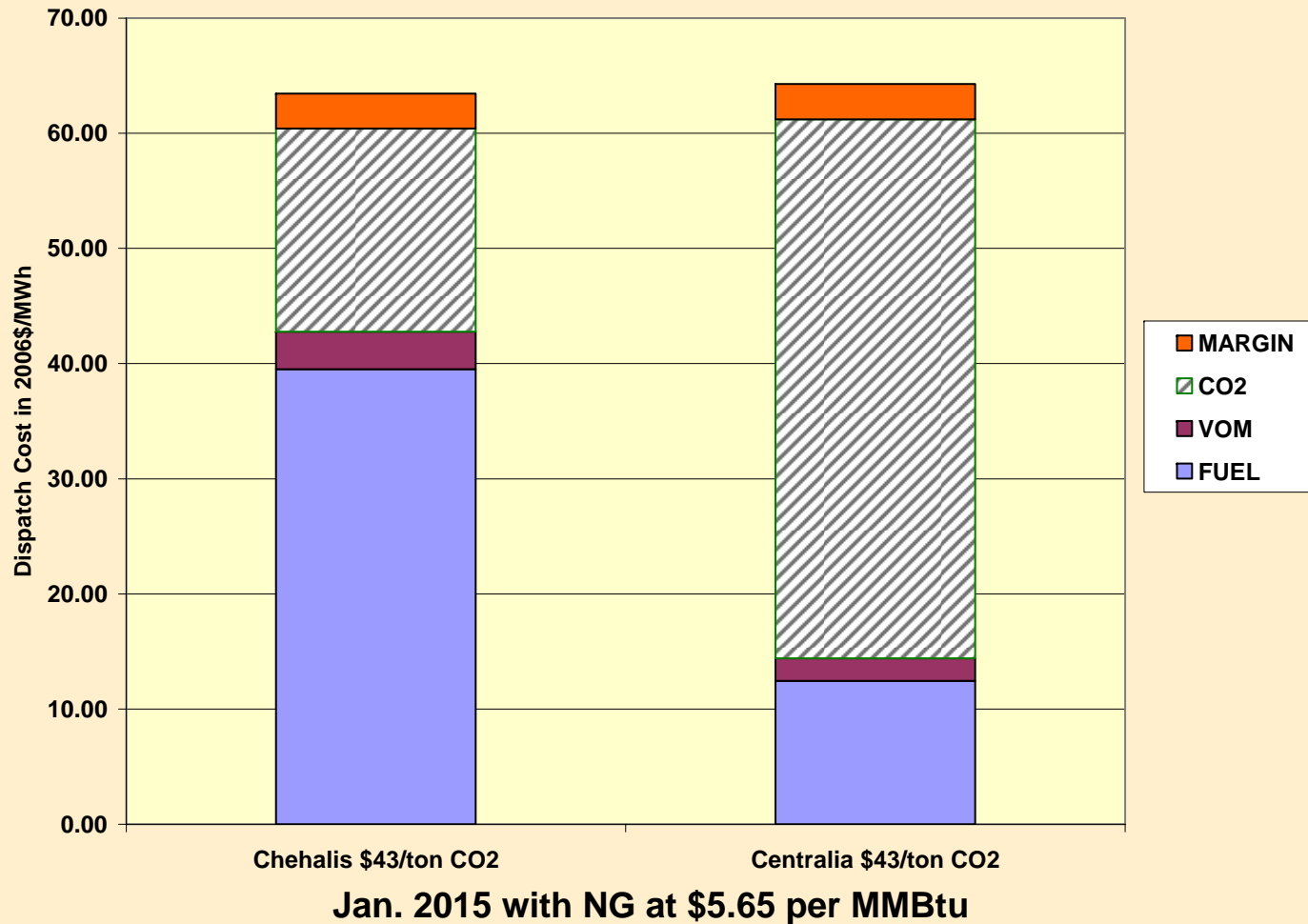
(e.g., Interim High Capital Cost Case: Jan. 15, 2020 HE 7:00 P.M.)



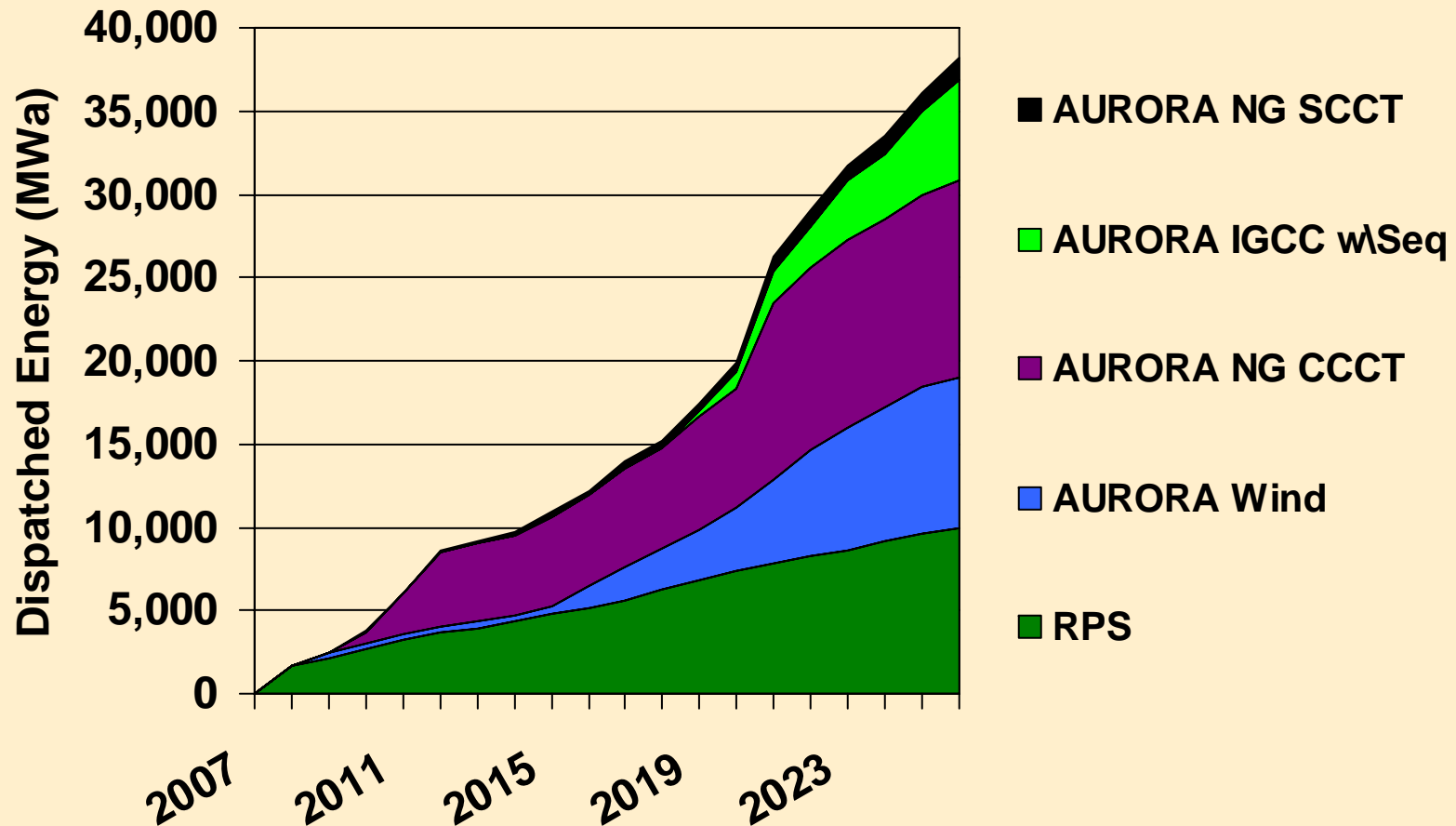
Medium Fuel/\$43 CO₂ Price Case: Coal and Natural Gas Unit Dispatch Costs



Medium Fuel/\$43 CO₂ Price Case: Chehalis (gas) and Centralia (coal) Dispatch Costs



High Capital Cost/High CO₂ Price Case WECC Resource Expansion 2007-26



High Fuel Price Cases

Natural gas prices from ~ \$8 to \$9 per MMBtu (in 2006\$)

4. High Fuel/High CO₂ Price Case:

- Same as High Capital Cost/High CO₂ Price Case except:
 - Natural gas prices from ~ \$8 to \$9 per MMBtu (in 2006\$)

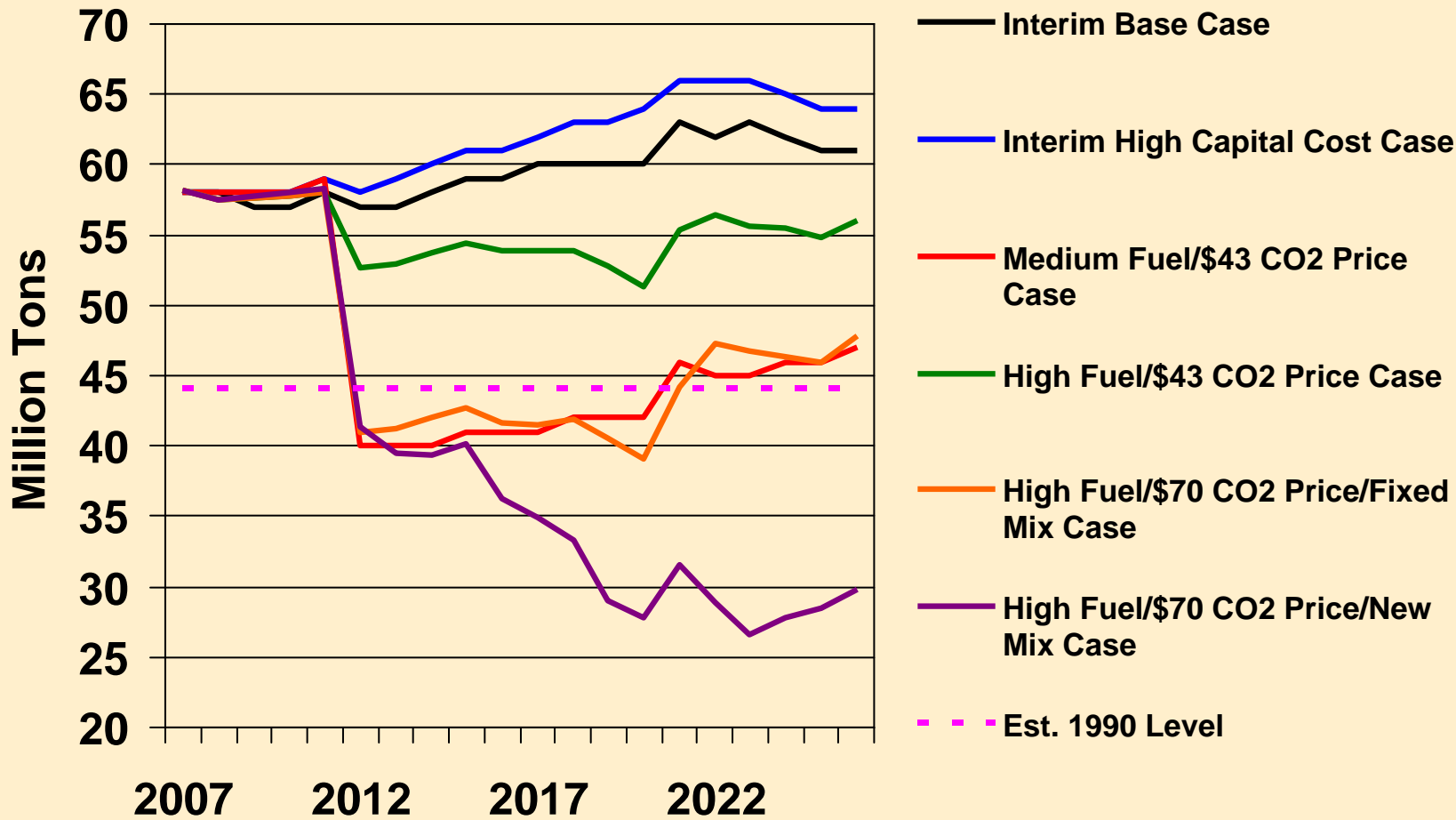
5. High Fuel/Very High CO₂ Price/Fixed Case:

- Same as previous except:
 - CO₂ allowance prices at \$70 per ton of CO₂ (in 2006\$)
 - Capacity expansion held constant

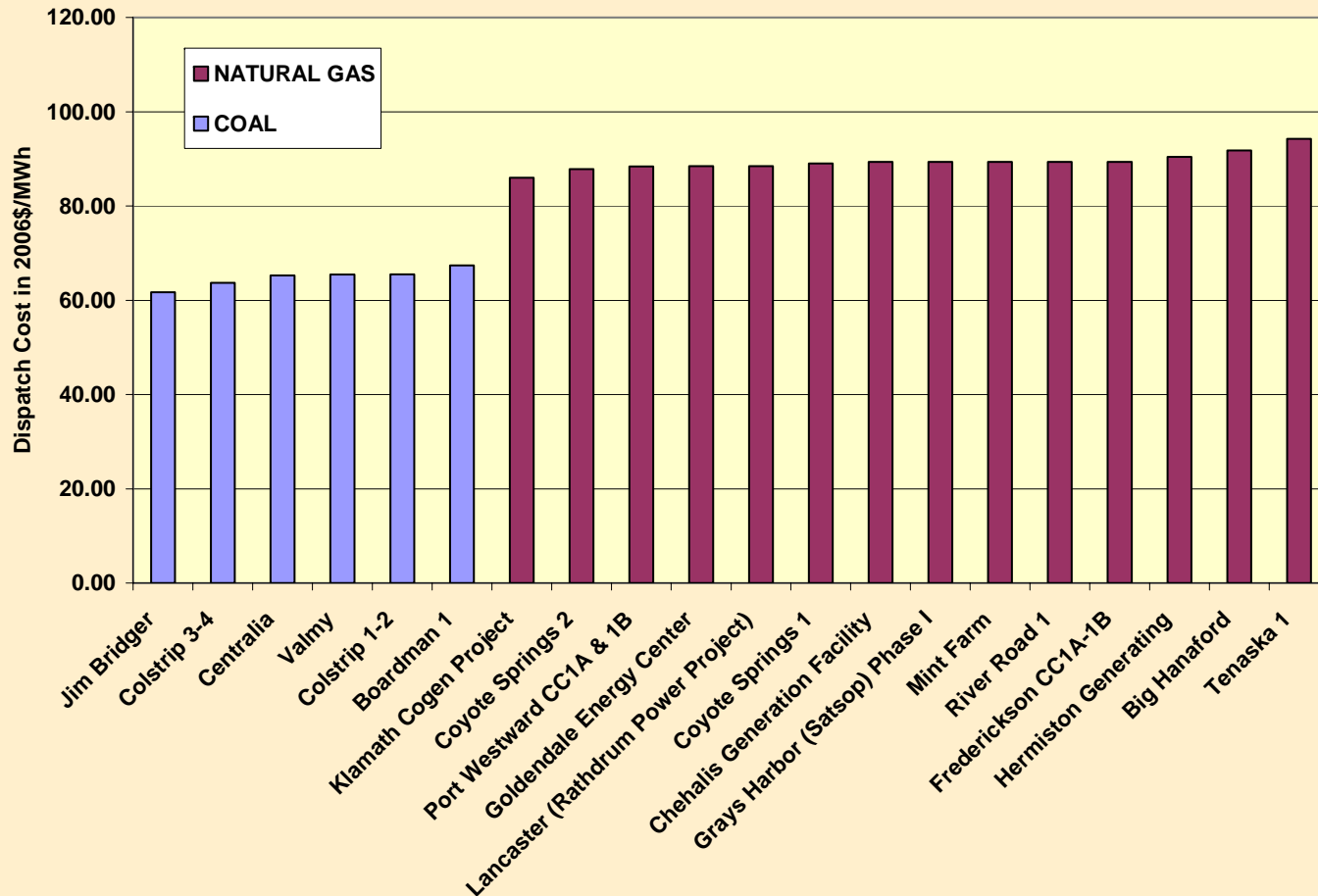
6. High Fuel/Very High CO₂ Price/Expansion Case:

- Same as previous except:
 - Updated capacity expansion

NW Power System Annual CO₂ Production

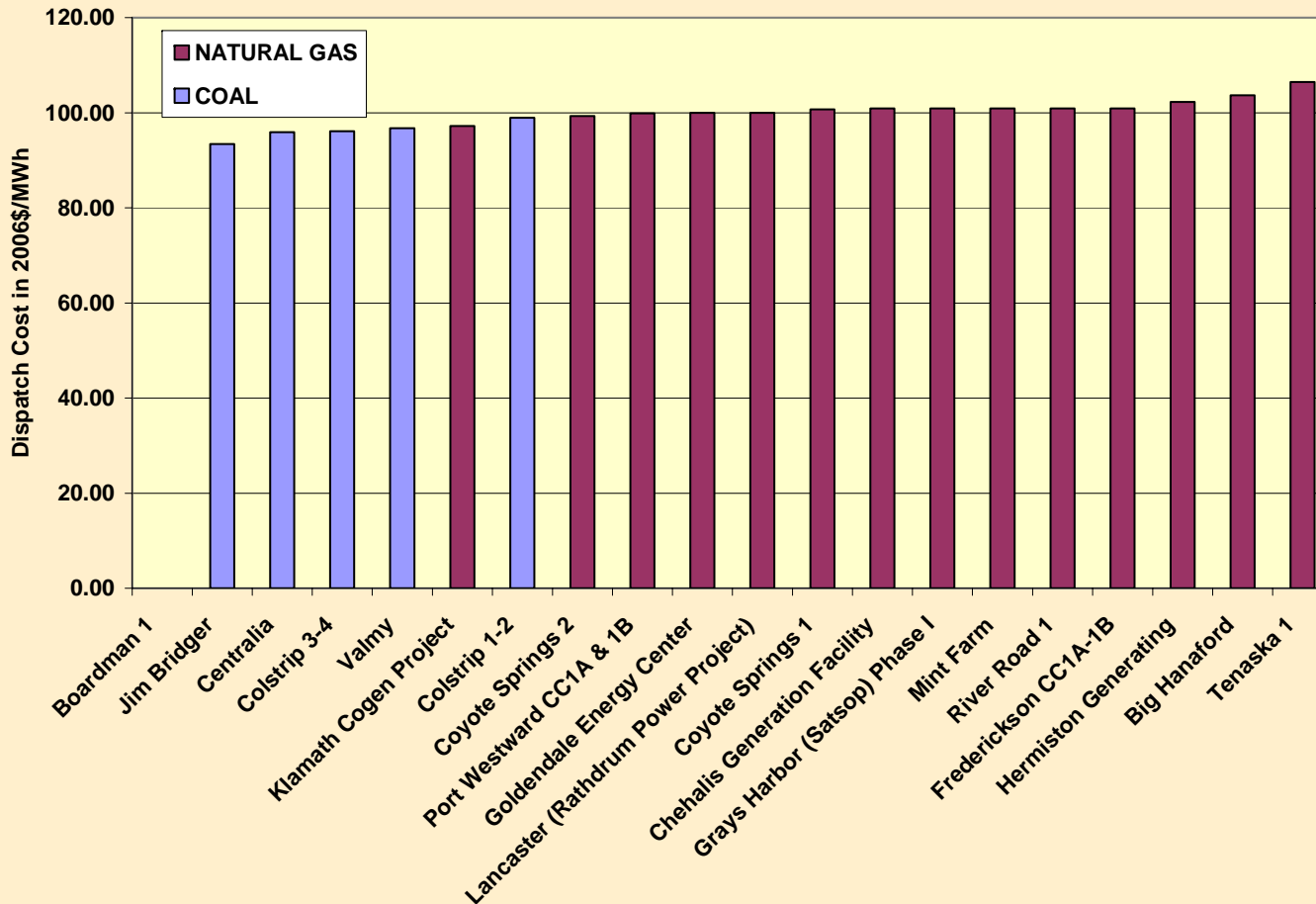


High Fuel/\$43 CO₂ Price Case: Coal and Natural Gas Unit Dispatch Costs



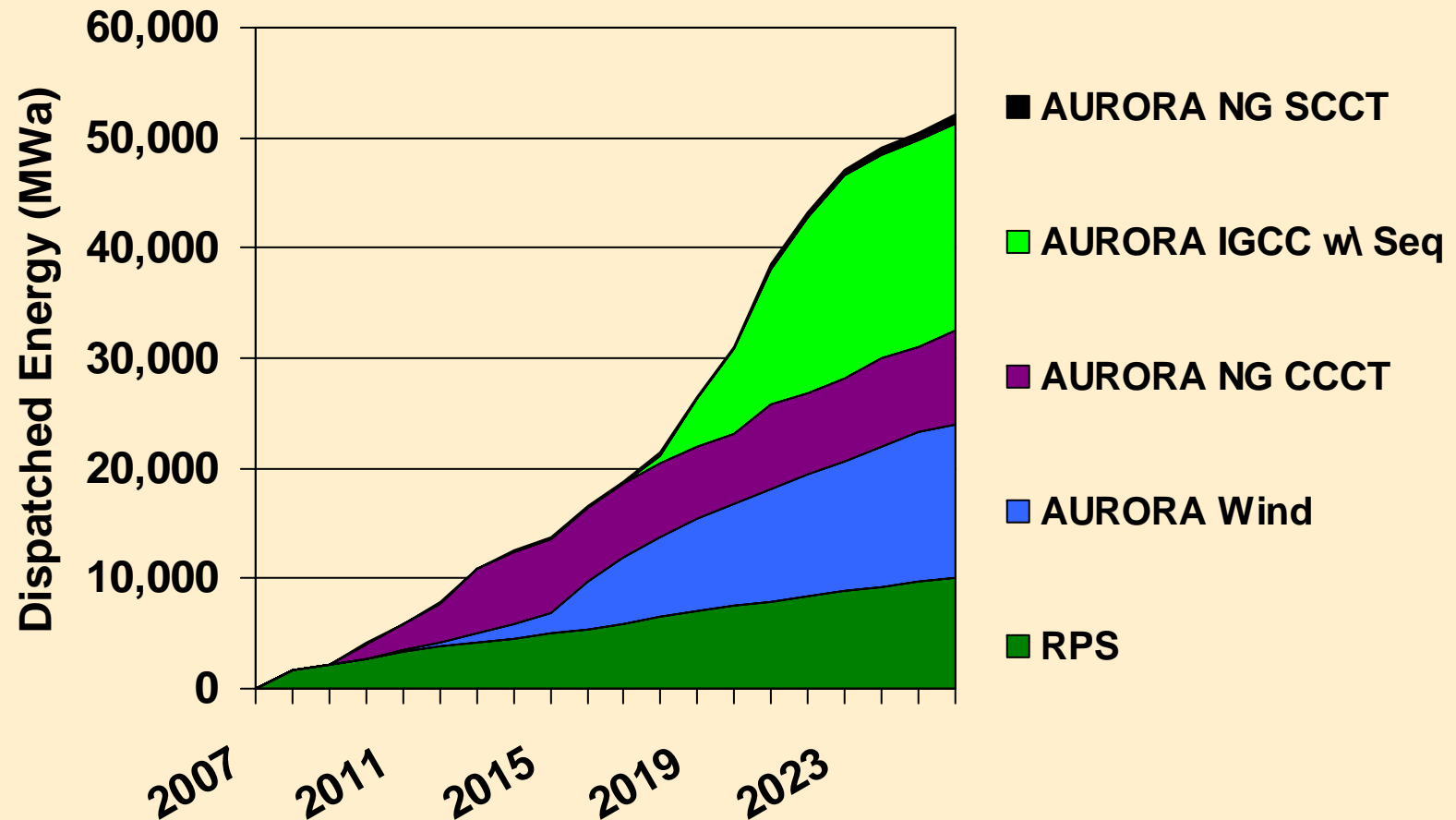
Jan. 2015 with NG at \$9.17 per MMBtu

High Fuel/\$70 CO₂ Price Case: Coal and Natural Gas Unit Dispatch Costs



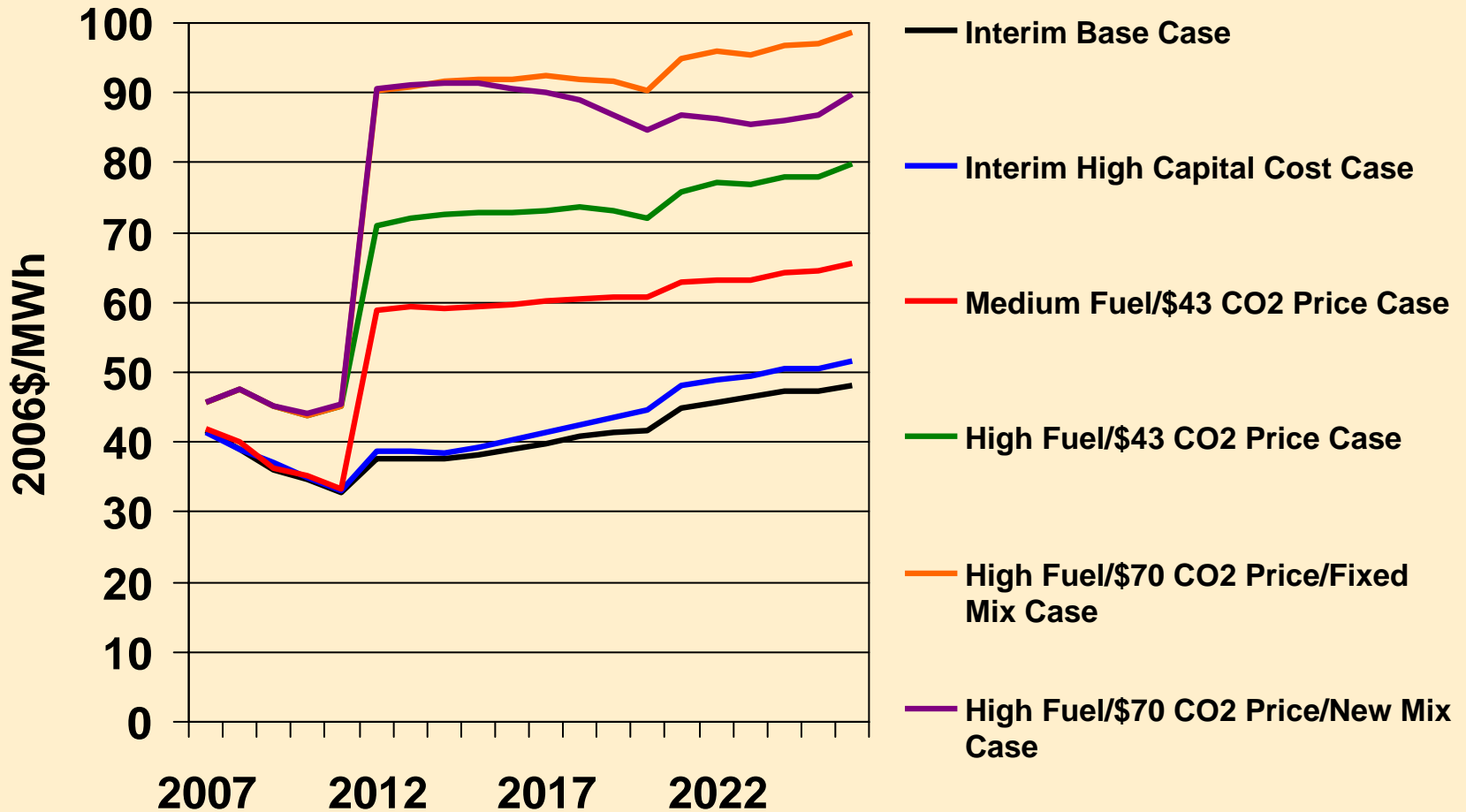
Jan. 2015 with NG at \$9.17 per MMBtu

High Fuel/\$70 CO₂ Price Case WECC Resource Expansion 2007-26



Wholesale Power Market Prices

Mid-C Annual Average Prices



Conclusions

- 5th Power Plan level of conservation and state mandated renewable resource development would likely stabilize the Northwest power system's annual CO₂ production
- Significant reductions in annual CO₂ production (e.g., to 1990 level) would require reduced use of conventional coal-fired generating units
- CO₂ allowances prices would need to climb to the \$40 to \$70 per ton range in order to move coal-fired generation to the margin
- High natural gas prices tend to work against efforts to reduce annual CO₂ emissions by increasing CO₂ allowance prices and raising the overall cost of achieving targeted levels of emissions

Interim Wholesale Power Price Forecast Paper

<http://www.nwcouncil.org/library/2008/2008-05.htm>