Summary of Preliminary Results

ISO new england

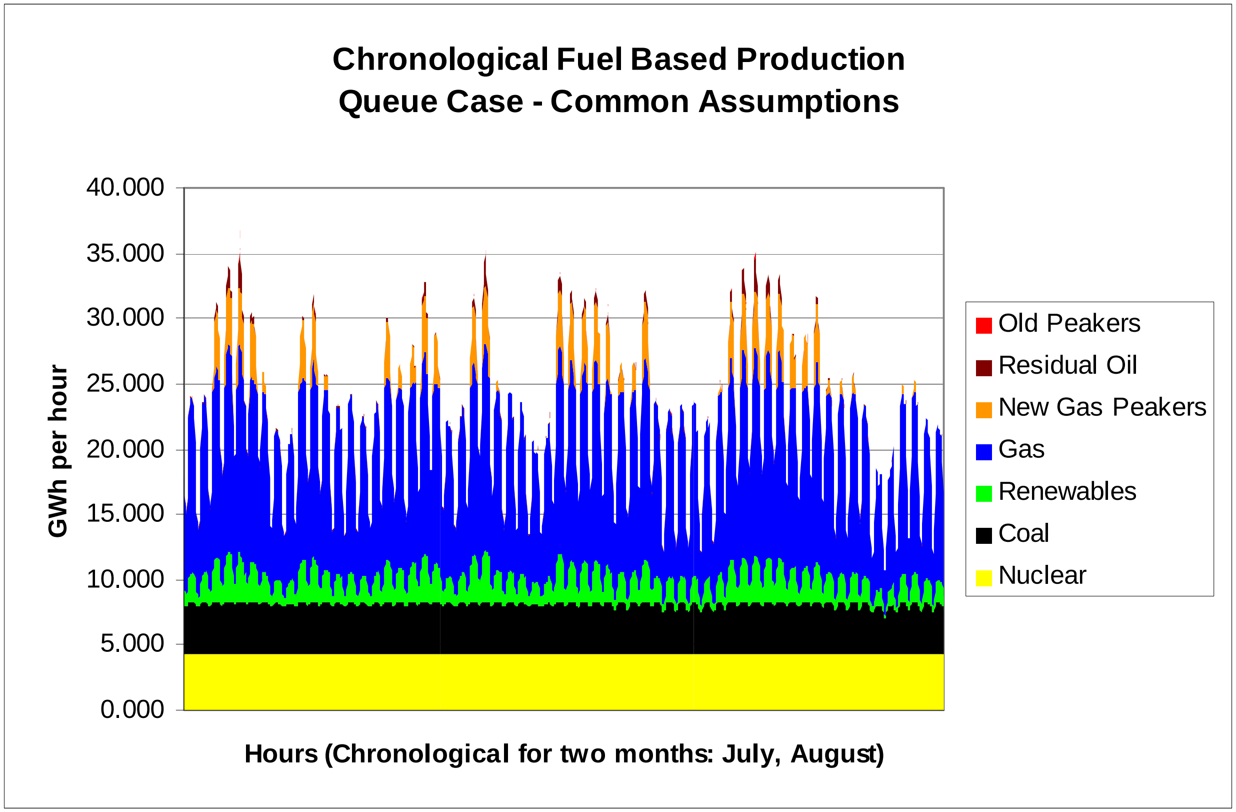
Major Results – Production Simulation

- ***Lower clearing prices and reduced air emissions are possible by adding resources that***
  - ***Provide relatively high amounts of electric energy***
  - ***Have low fuel costs***
  - ***Emit few pollutants***
- Fuel prices are a key driver
  - Production costs
  - Average wholesale Load Serving Entity (LSE) expense for wholesale electric energy
  - Emissions
- All scenarios still retain a high percentage of hours where natural gas sets the clearing price in the energy market
  - Cost of natural gas is driver for wholesale LSE expense for wholesale electric energy
  - Because the order for dispatching resources doesn't change, the costs for emission allowances doesn't have a large effect on the cost of energy from LSE perspective
- Meeting the Regional Greenhouse Gas Initiative (RGGI) Cap (50.2 Mtons) will be challenging for New England
- Replacing old fossil fuel generators with scenario expansion technologies tends to reduce production costs and emissions

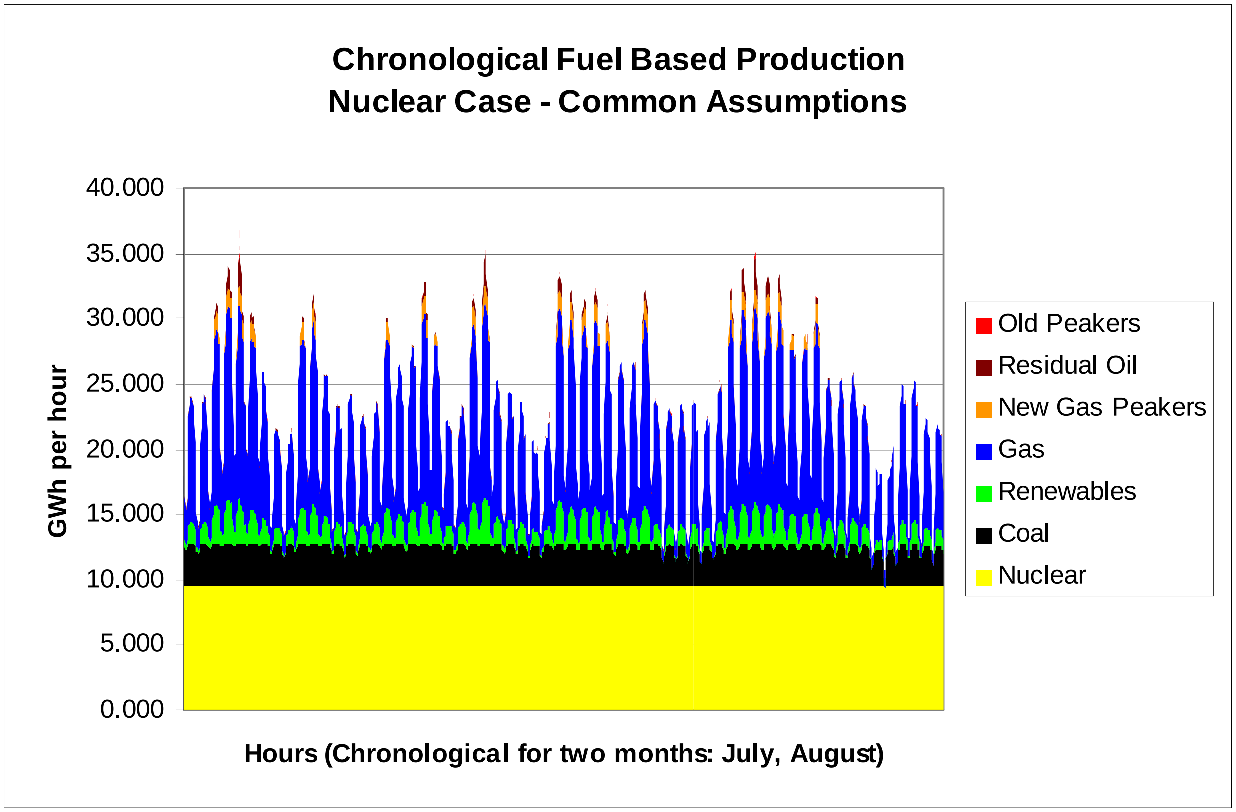
Explanation of Results

- For purposes of understanding outputs, two core assumption cases will now be compared
- A comparison of results from the Queue and the Nuclear expansion scenarios can show the effects of large additions of relatively inexpensive energy that produces low emissions
  - Baseload Energy Efficiency has the same characteristics as nuclear
- Production simulation outputs can show sources of electric energy by fuel type
  - Chronologically over the summer peak months
  - As an annual energy duration production curve
- These outputs can illustrate:
  - The overall sources of electric energy that drive production costs and emissions
    - The extent of reliance on expensive and high emitting sources of electric energy
  - The sources of electric energy on the margin that drive clearing prices and emissions during the highest peak load days – typically high ozone days

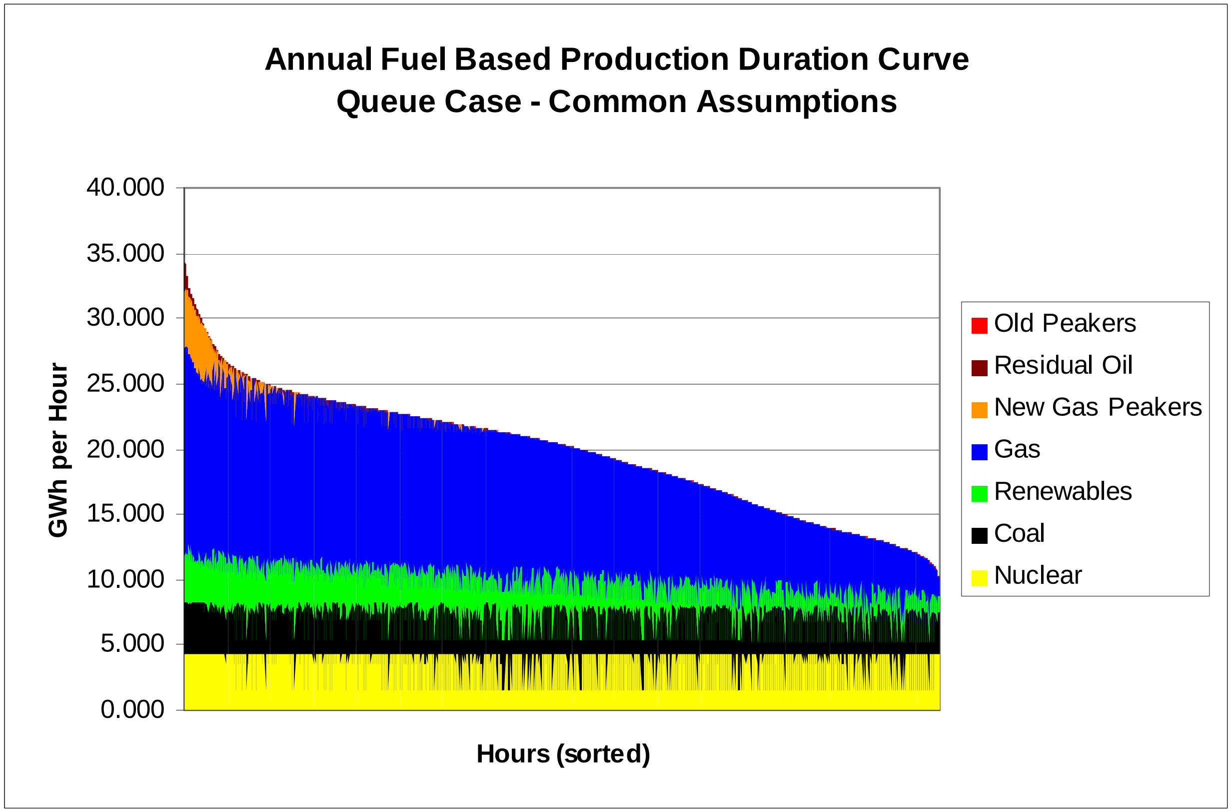
Summer Chronological GWh: Queue



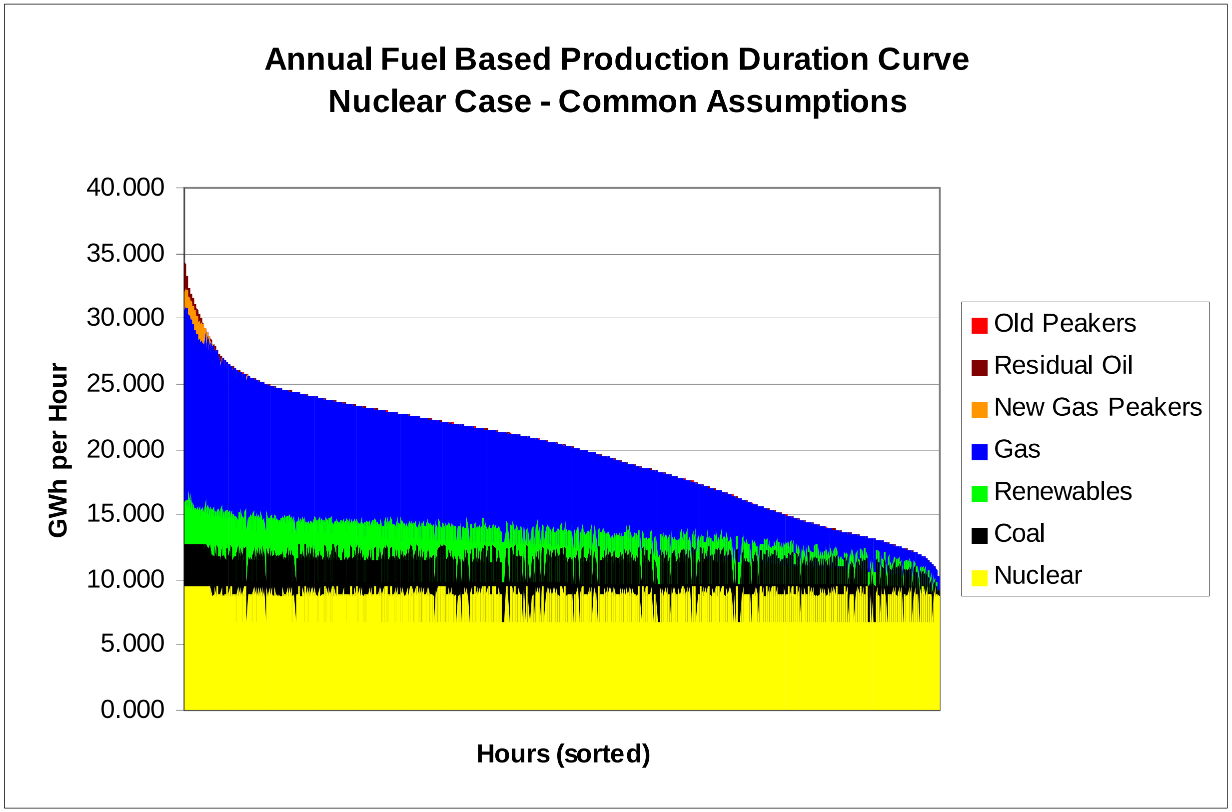
Summer Chronological GWh: Nuclear



Annual Energy Duration Curves: Queue



Annual Energy Duration Curves: Nuclear



Major Results - Operable Capacity Analysis

- Operable Capacity Analysis (OCA) examines the ability to operate the system under peak load conditions
- Similar to RSP06 analysis, OCA was used to show the system-wide dependence on various types of capacity
- Results show that natural gas-fired generation is the largest source of capacity across all scenarios
- This suggests a continued need for
  - Alternate sources of capacity and energy
  - Firm natural gas contracts and enhanced natural gas and Liquefied Natural Gas (LNG) infrastructure
  - Dual-fuel capability of natural gas units

Major Results - Cost for Generic Transmission Expansion

- Cost for transmission expansion varies for scenarios
- Regional System Plan (RSP) transmission expansion assumed common to all scenarios
  - Assume $6.40/MWh to $7.75/MWh rate for Regional Network Service (RNS)
  - All supply side scenarios have incremental transmission identified beyond the RSP expansion case
  - By contrast, Demand Side Resources do not assume incremental transmission beyond RSP
- A wide range of assumptions were used to estimate incremental transmission costs associated with each scenario
- Installed transmission costs to support each scenario range from
  - $61M - $288M for natural gas-fired combined cycle units
  - $61M - $1,814M for nuclear, coal, and queue scenarios
  - $581M - $3,936M for renewable resources
  - $3,060M - $8,928M for imports from Canada
    - Low range is Millbury to Quebec border (low costs for transmission, routing. etc.)
    - High range is Millbury to New Brunswick border (high costs for transmission, routing, etc.)
  - $1,040 - $2,448 for imports from New York
    - Millbury to the New York border
- Annual Revenue Requirements
  - 18% - 22% of installed costs

Major Result - Energy Efficiency and Demand Response Savings on Generic Distribution System Expansion

- Distribution system capital improvements are required for many reasons
  - Normal maintenance and replacement of equipment
  - Repair storm damage
  - Connect new customers
  - Power quality and reliability
- Improvements to the distribution system are assumed common to all cases except for the energy efficiency and demand response scenarios
- Not all distribution circuits are fully loaded
- A total of 5,400 MW of energy efficiency and demand response would save $100M - $325M in installed distribution system costs

Major Result – Land Use

- Site requirements estimated for generation and transmission
- Examined existing and proposed project sites to determine land use
- Multiple use of land for siting possible for many technologies
- Range of total land use for generation across scenarios varies widely
  - 9,100 - 54,000 acres for queue expansion
  - 0 acres assumed for energy efficiency and demand response
  - 1,000 - 2,000 acres for nuclear expansion
  - 400 - 2,700 acres for coal
  - 130 acres for 5,400 MW expansion of natural gas combined cycle units
  - 126,000 - 221,000 acres for renewable technologies
    - Wind is the main driver
- 9.9 - 19.8 acres per mile assumed for transmission expansion
  - 3,000 – 7,400 acres required in New England for transmission to the Canadian border
  - 1,000 – 2,000 acres required in New England for transmission to the New York border

Major Result – Water Use for Cooling

- Assumed the larger thermal generation plants would require wet cooling towers
- Estimated total scenario required cooling water use in gallons per minute at full load
  - Queue 12,100
  - Nuclear 85,200
  - IGCC 65,900
  - NGCC 20,700
- Assumed other scenarios required less significant cooling water or none

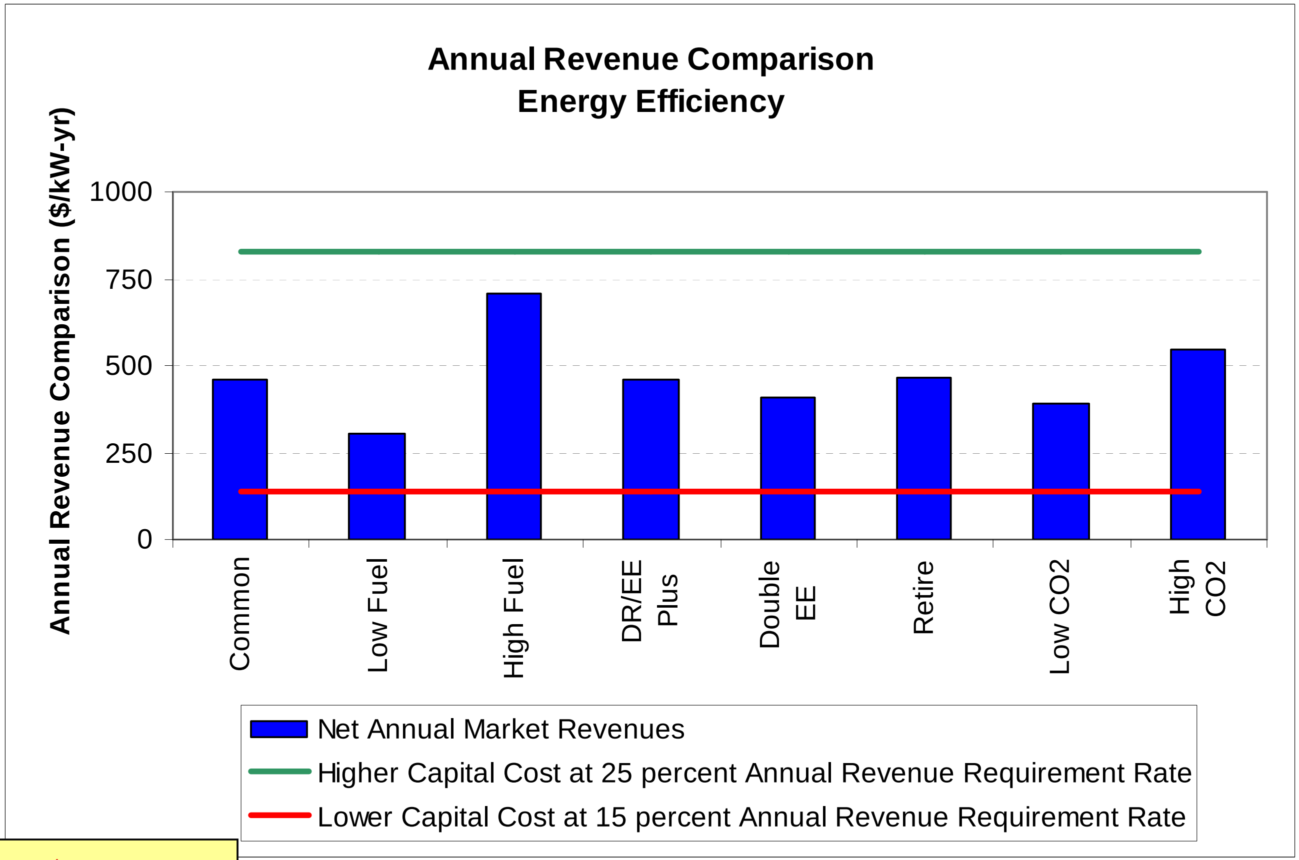
Major Result - Generic Gas Infrastructure Expansion Costs

- 5,400 MW of new gas-fired combined-cycle units require a combination of pipeline and/or LNG at a cost of $.15B - $1.5B
- For the retirement sensitivity case, addition of 8,900 MW of gas-fired combined-cycle units costs require a combination of pipeline and/or LNG at a cost of $0.45B - $3B
- Distributed resource scenarios would require only local improvements in the Local Distribution Company (LDC) natural gas system
- Other scenarios would not require additional build-out of the natural gas system

Generic resource revenues and costs

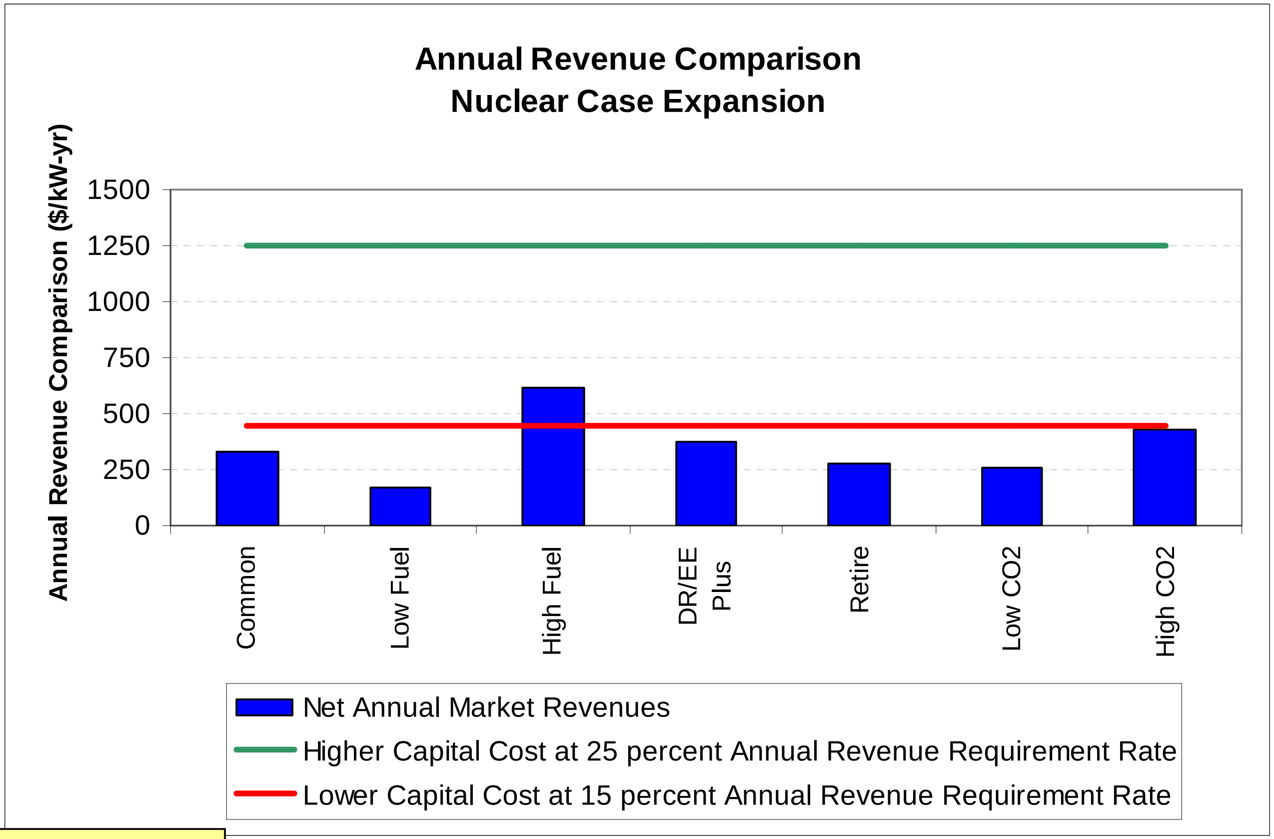
- Several expenses were not the result of detailed modeling
- Broad ranges of expenses were developed for illustrative purposes
- Revenues
  - Net electric energy revenues for expansion resources (million $; $/kW-year)
    - Results of production simulations
- Other potential revenues
  - Capacity
    - Stakeholders can assume range ($4.50 to $10.50 in settlement agreement)
  - Ancillary services
    - Stakeholders can assume range (1% to 2%) of net electric energy revenues is typical)
  - Stakeholders can assume revenue for public policy incentives, such as renewable energy credits, clean energy funds, tax incentives, subsidies, etc. (amount is unknown to ISO)
- Costs
  - Use capital cost estimates developed with stakeholders
  - Assume annual revenue requirements (15%-25%) capture all non-fuel and non-environmental allowance cost requirement costs, including return of and return on investment, taxes, fixed operations and maintenance, and other expenses

EE/DR Expansion: Energy Efficiency



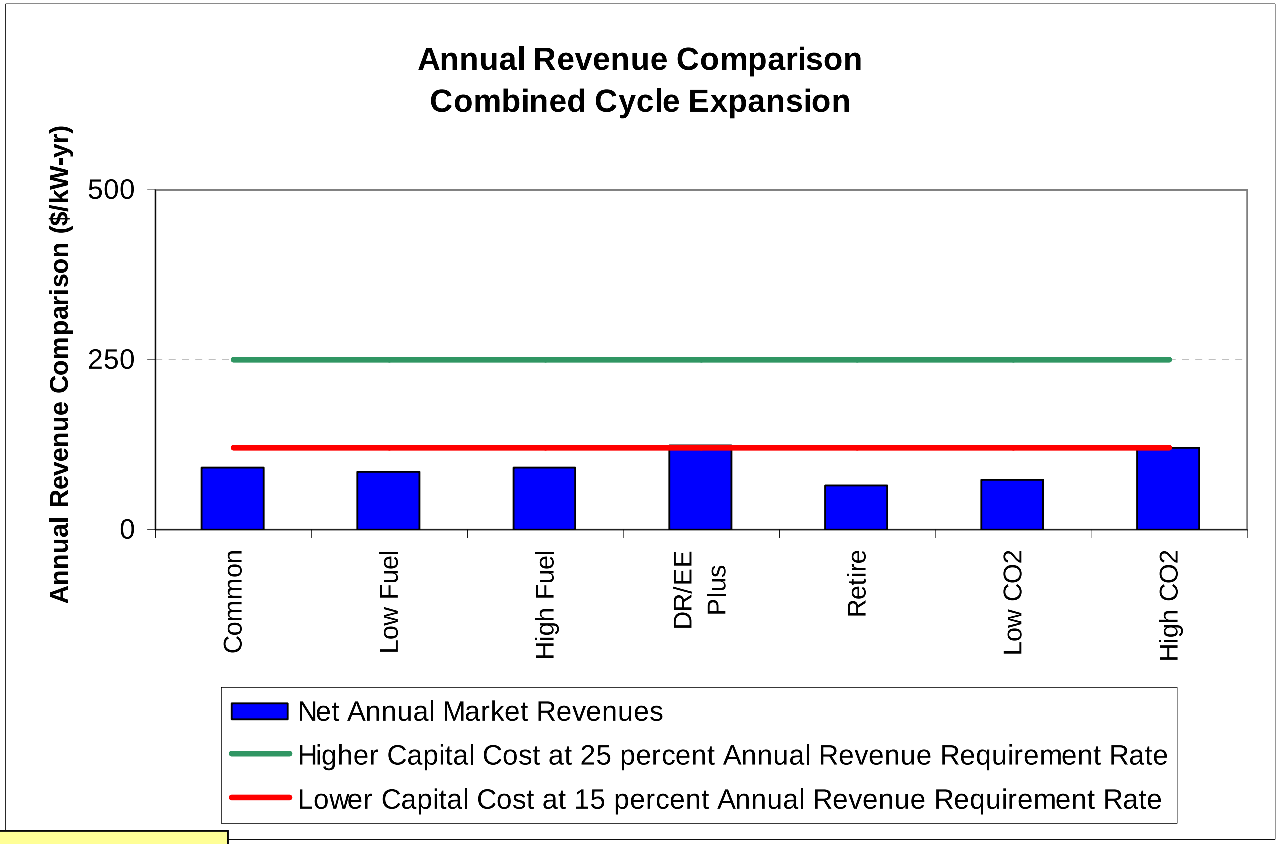
Lower Capital Cost: $ 920/kW
Higher Capital Cost: $3300/kW

Nuclear Expansion: Nuclear



Lower Capital Cost:$3000/kW
Higher Capital Cost: $5000/kW

Combined Cycle Expansion

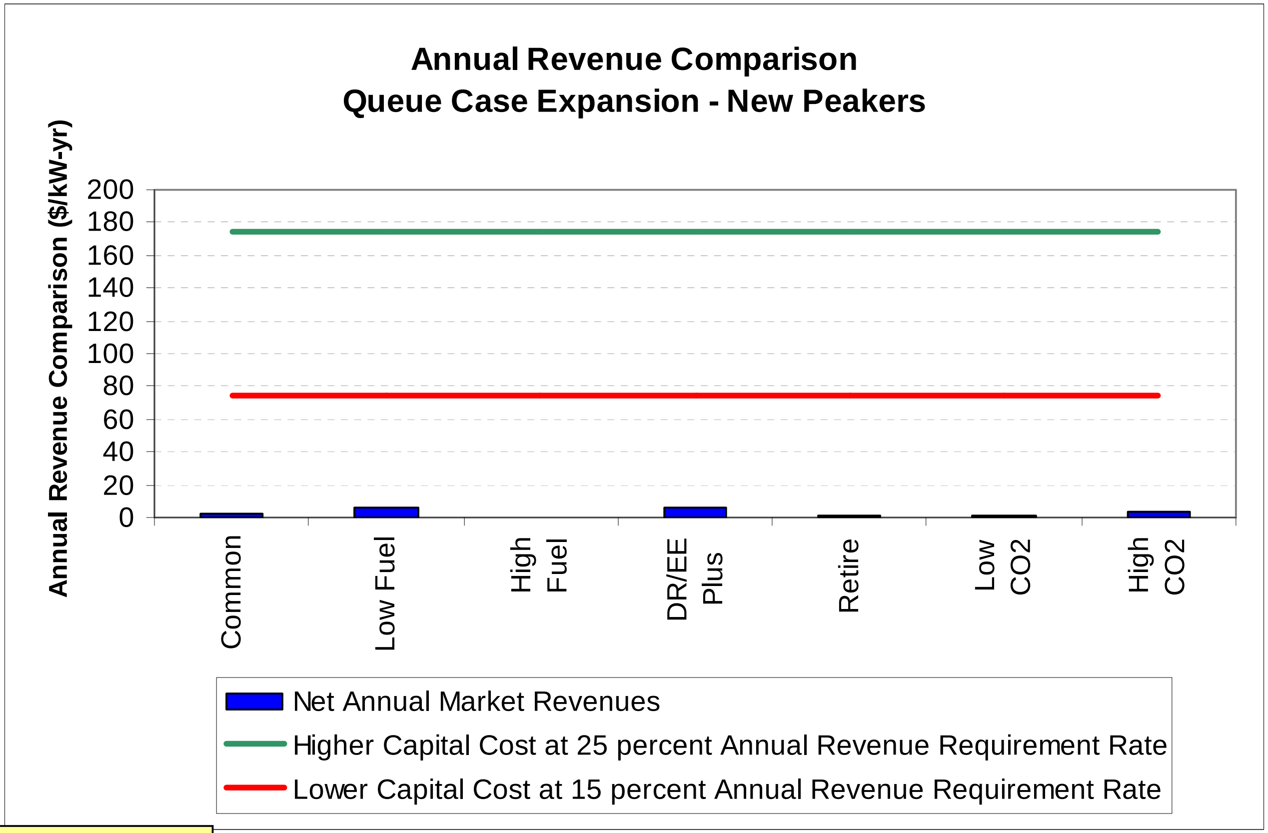


Lower Capital Cost: $ 800/kW
Higher Capital Cost: $1000/kW

Queue Case: Combustion Turbines

Queue Case Technologies

Small Hydro
Biomass
Gas CC
IGCC
=> New CT
Fuel Cell
Queue Wind

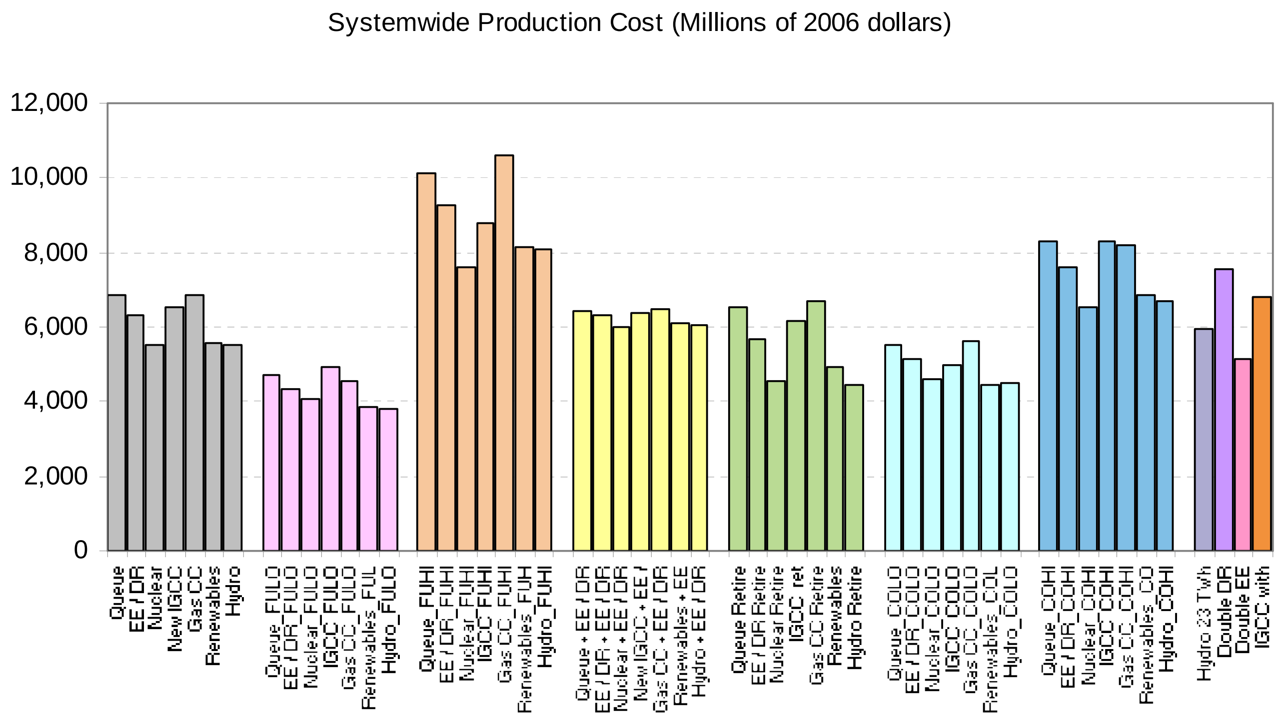


Lower Capital Cost: $ 500/kW
Higher Capital Cost: $ 700/kW

Background Slides

Systemwide Production Cost ($ Million)

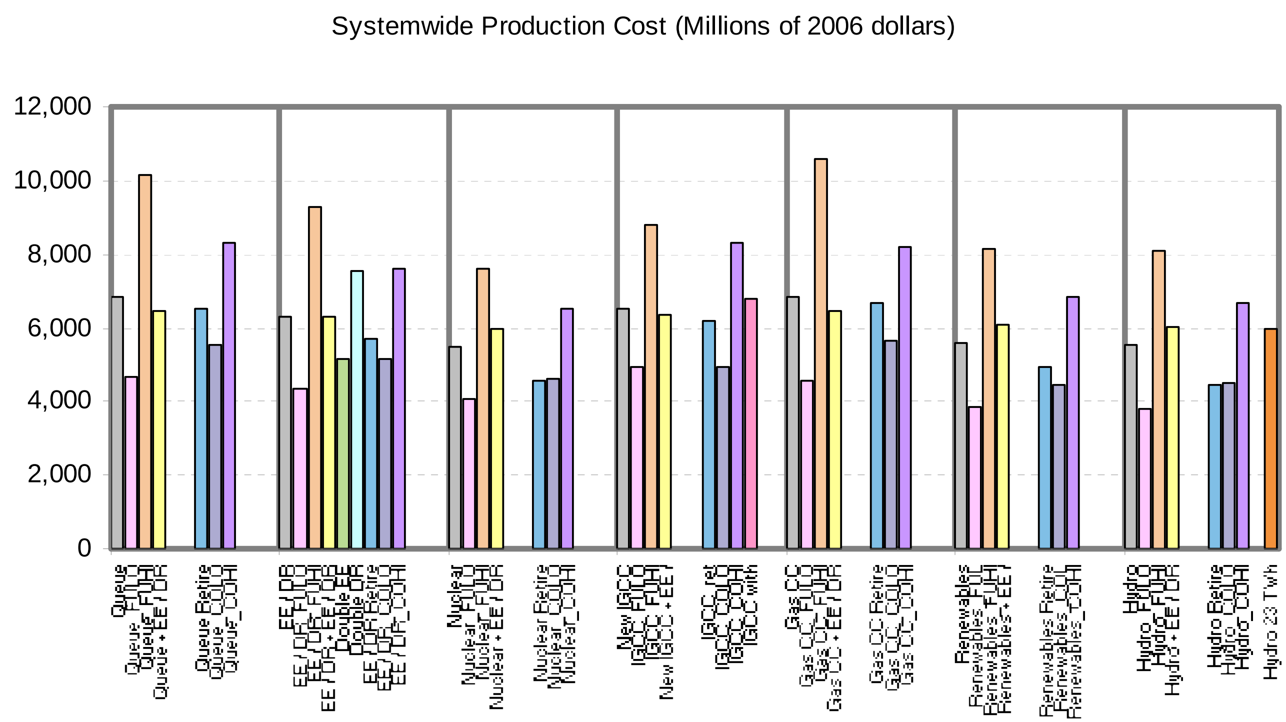
Grouped by Sensitivity



Common Assumptions | **Low Fuel** | **High Fuel** | **More EE / DR Less Scenario Technology** | **Retire 3,500 MW** | **Low CO_2 Emission Values** | **High CO_2 Emission Values** | **Misc. Sensitivity Cases**

Systemwide Production Cost ($ Million)

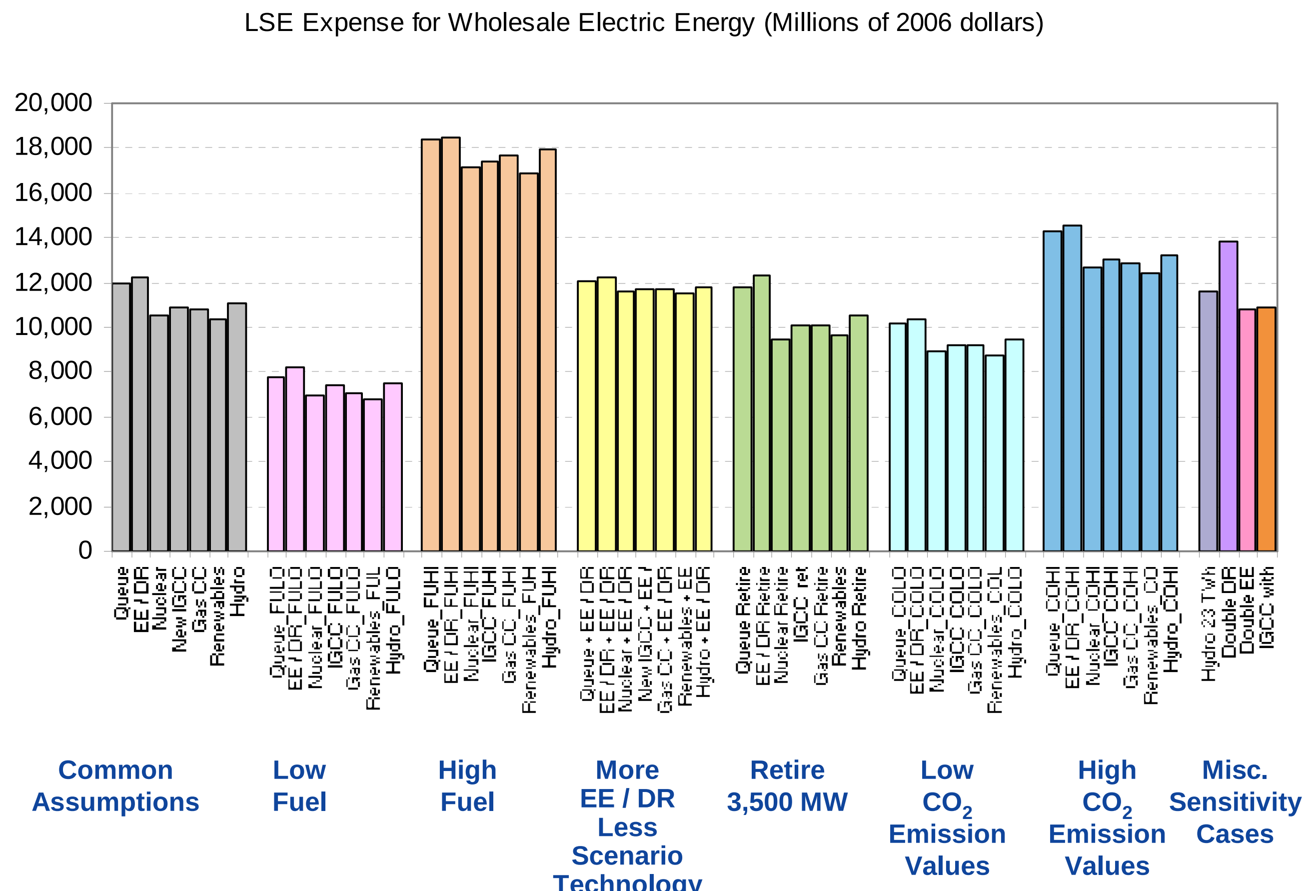
Grouped by Scenario



Queue | **Half Demand Response Half Energy Efficiency** | **Nuclear** | **Integrated Gasification Combined Cycle** | **Gas Combined Cycle** | **Renewables** | **Hydro Imports**

LSE Expense For Wholesale Electric Energy ($ Million)

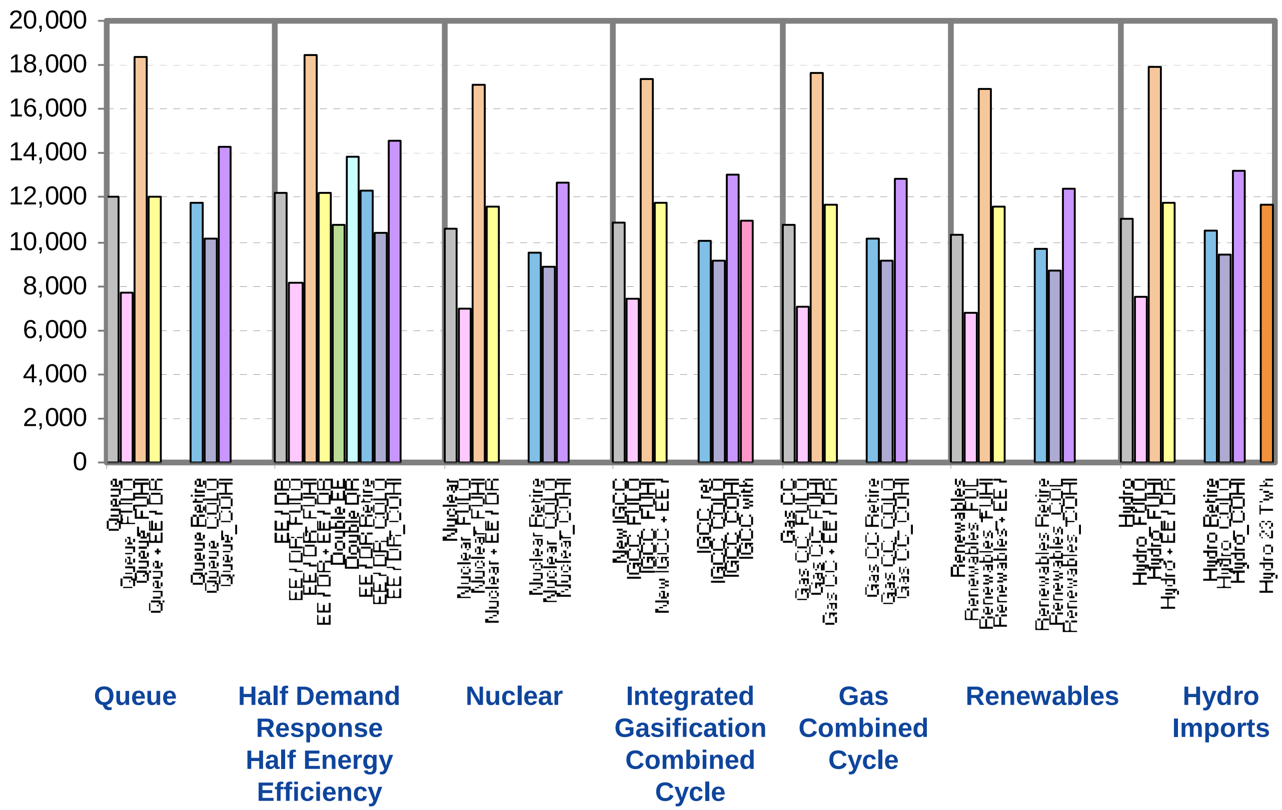
Grouped by Sensitivity



LSE Expense For Wholesale Electric Energy ($ Million)

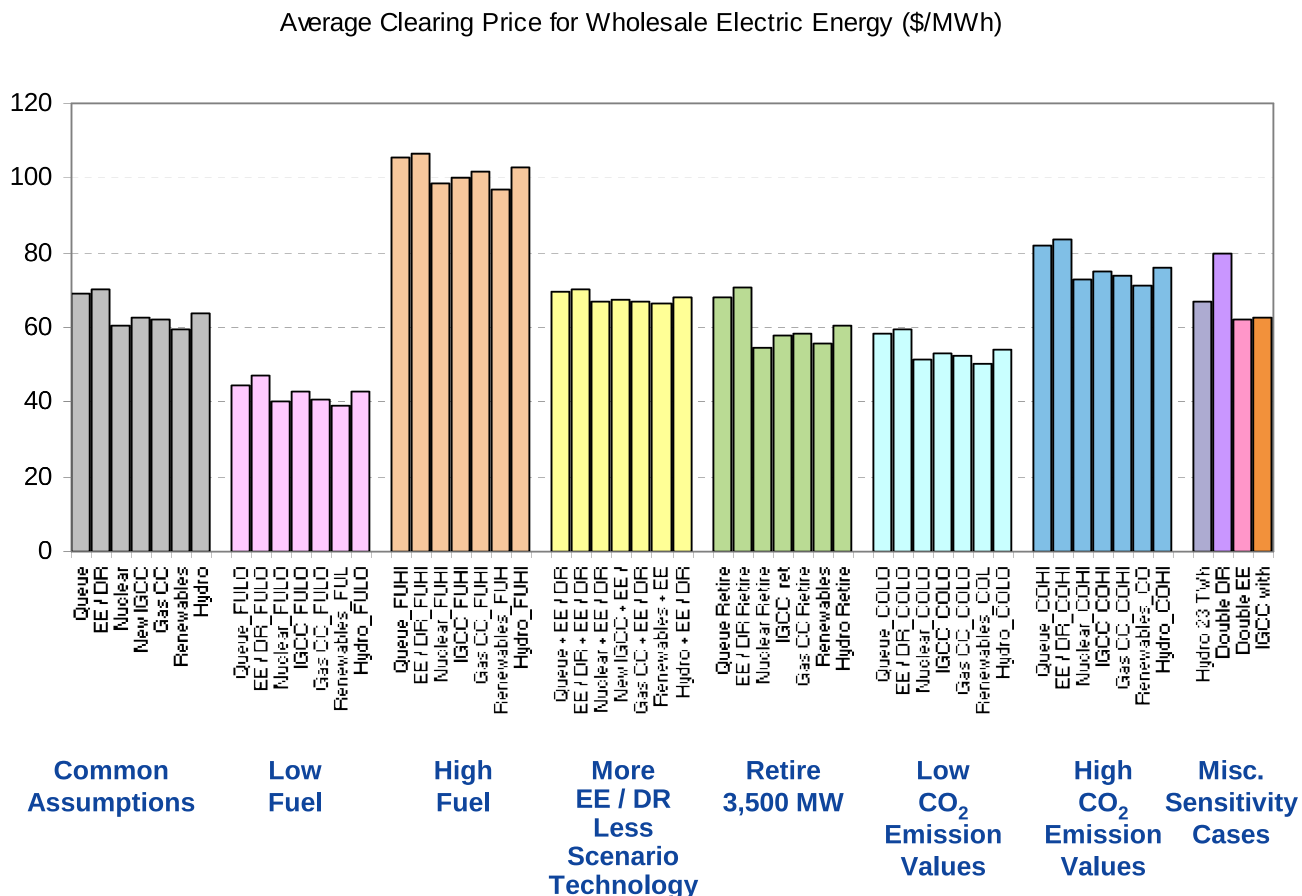
Grouped by Scenario

LSE Expense for Wholesale Electric Energy (Millions of 2006 dollars)



Average Clearing Price For Wholesale Electric Energy ($/MWh)

Grouped by Sensitivity



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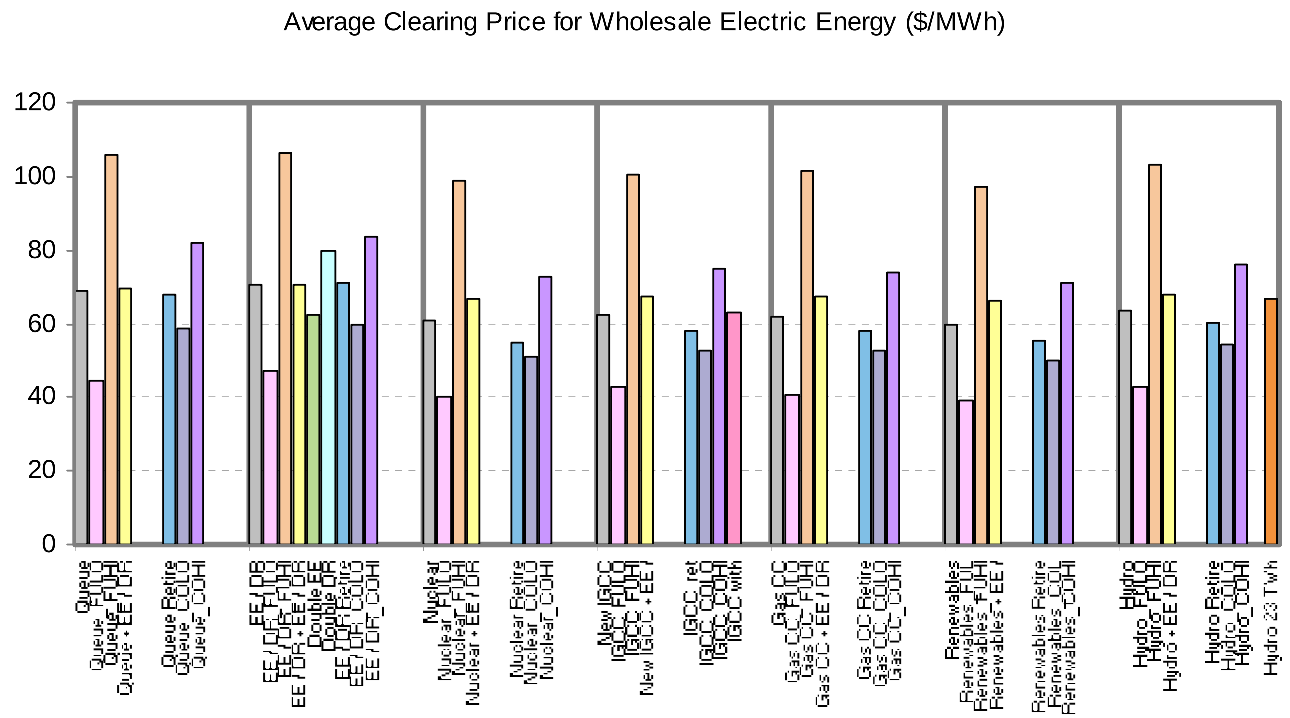
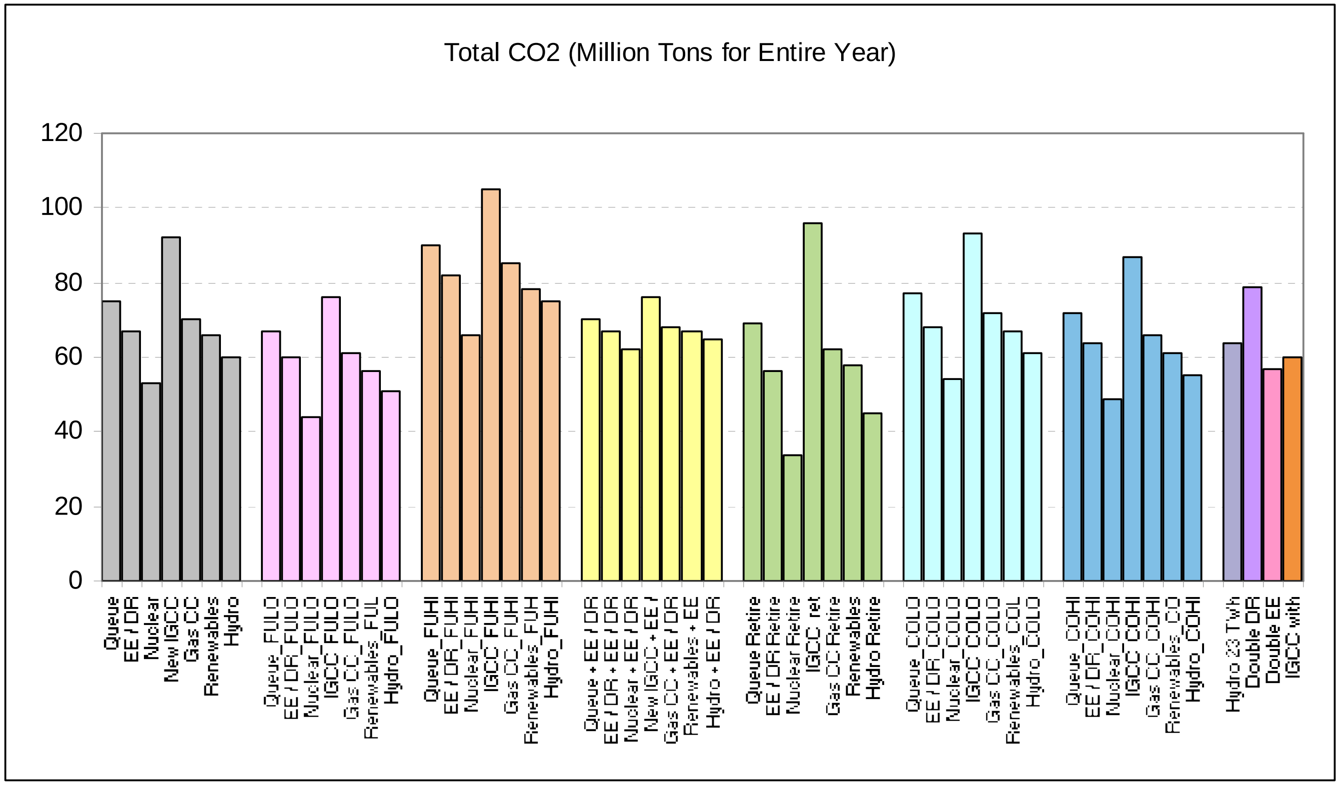


Queue | Half Demand Response Half Energy Efficiency | Nuclear | Integrated Gasification Combined Cycle | Gas Combined Cycle | Renewables | Hydro Imports

CO2 Emissions (Million Tons)

Grouped by Sensitivity



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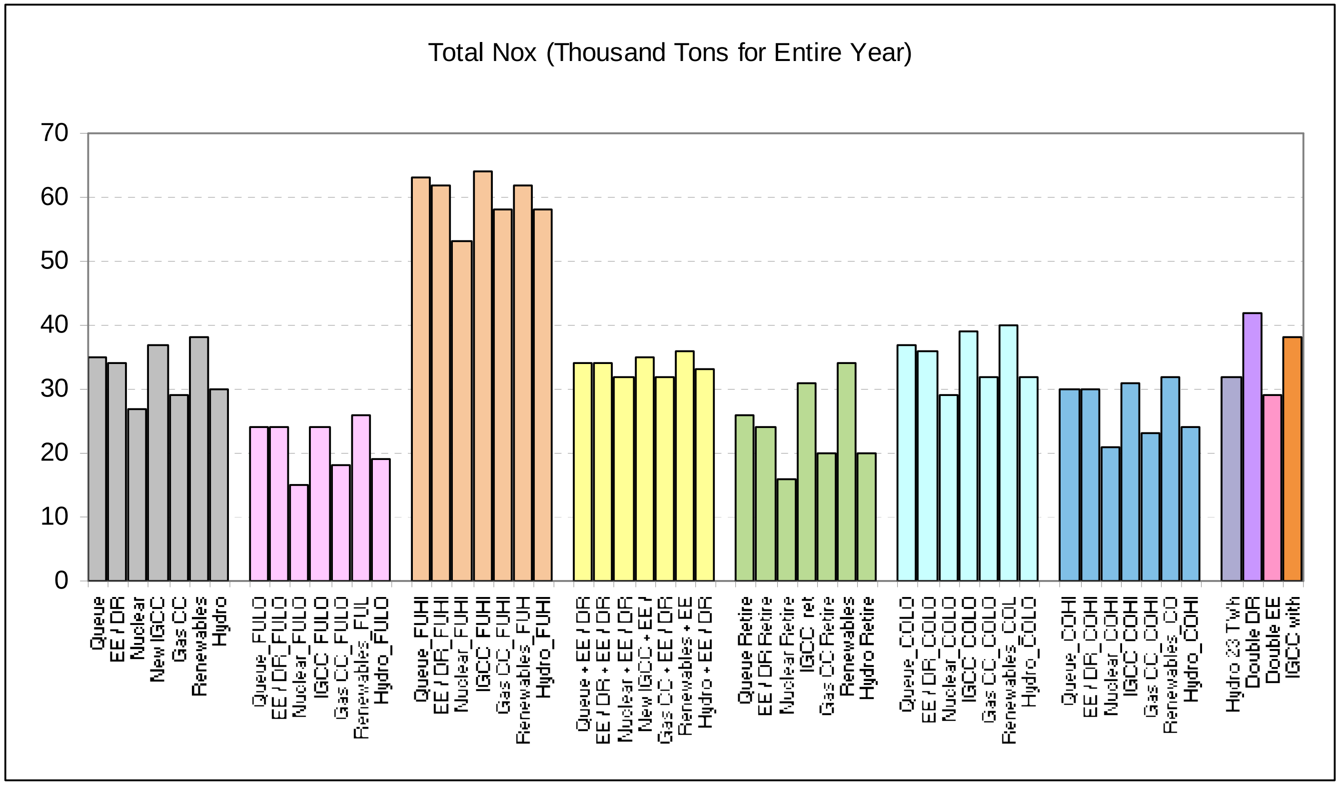
SO2 Emissions (Thousand Tons)

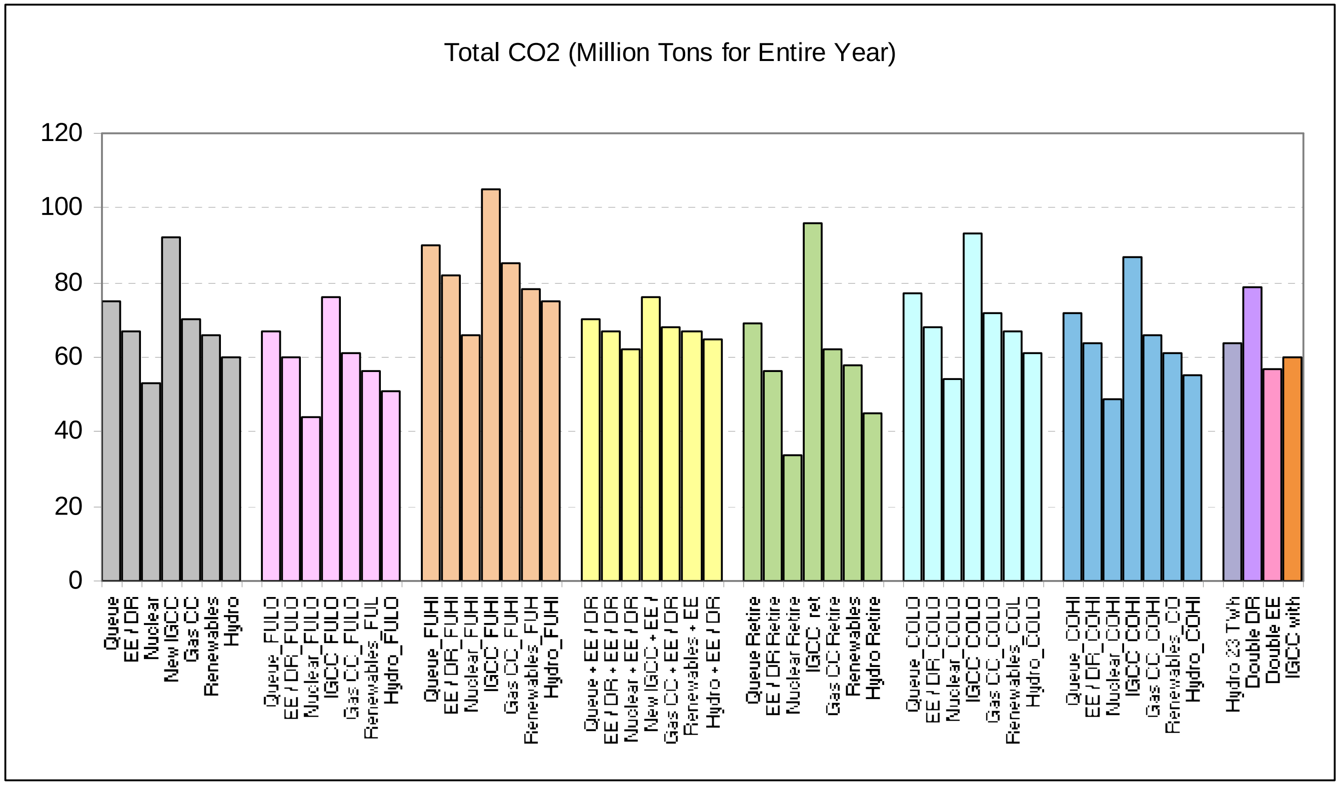
Grouped by Sensitivity



Common Assumptions	Low Fuel	High Fuel	More EE / DR Less Scenario Technology	Retire 3,500 MW	Low CO_2 Emission Values	High CO_2 Emission Values	Misc. Sensitivity Cases

NOx Emissions (Thousand Tons)

Grouped by Sensitivity



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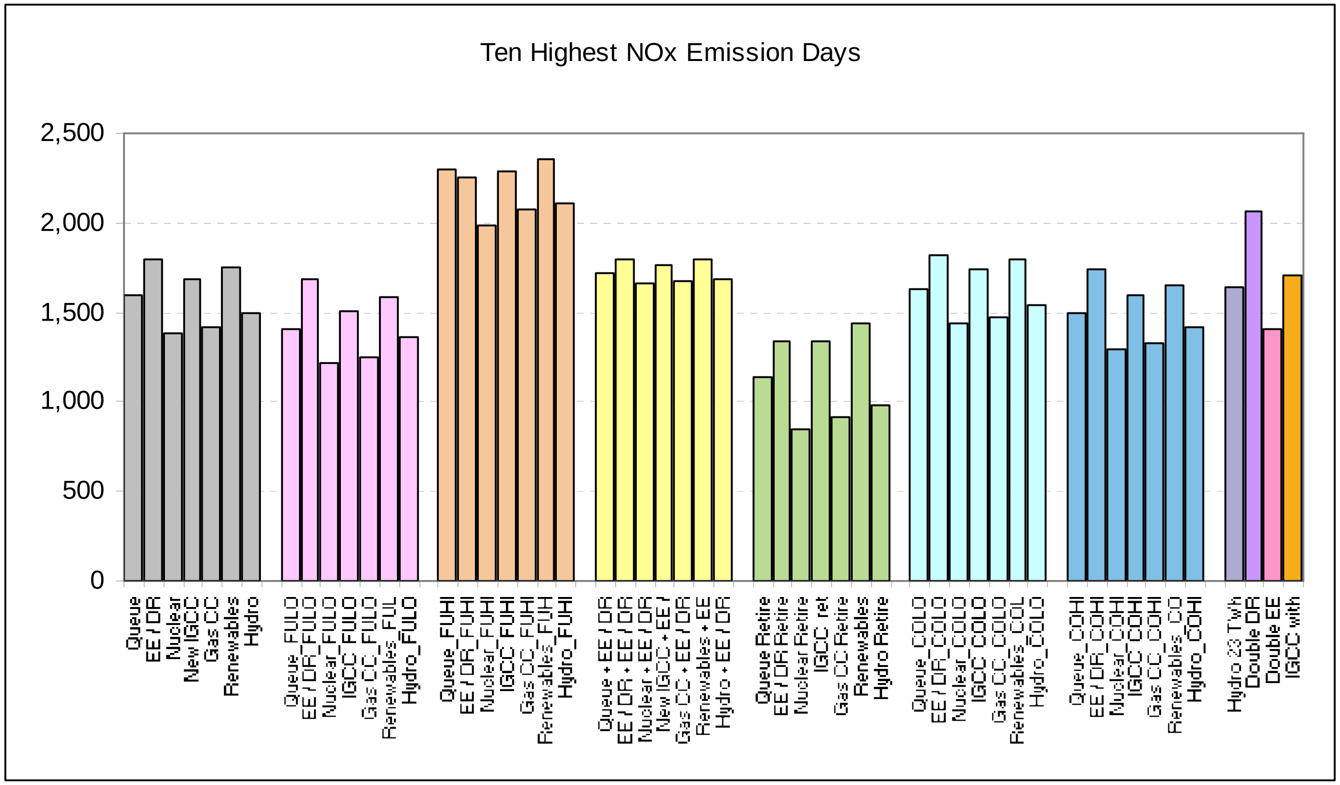
Sum of Top Ten Days NOx Emissions (Tons)

Grouped by Sensitivity



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