

**Summary of Analysis of Scenarios: Synapse M and Synapse P**  
ISO New England System Planning Department  
April 2008

## **Goals and Caveats of the Scenario Analysis<sup>1</sup>**

ISO New England's (ISO) intention for the Scenario Analysis initiative was to present a one-year snapshot of a comparable set of diverse outcomes, directions, and impacts that reasonably might be expected to occur *if* one electric technology were pursued over another. The aim of the initiative was to provide a public venue for examining and discussing how the various ways of supplying electricity to the region that were presented in the analysis could affect the costs to provide power, the system's overall reliability, and the environment. Another goal was to provide information and data that regional policymakers and other stakeholders could consider as they develop policies and investments and take other actions in the near term that can affect New England's electricity markets, power system reliability, environmental performance, and meeting consumer electricity needs in the long term.

Due to the global uncertainties involved in predicting oil and gas prices, the Scenario Analysis did not predict what the future would look like in New England or prescribe one particular scenario over another.<sup>2</sup> Rather, it presented a range of results for the different technologies. Furthermore, the analysis did not consider a full economic model of the region, such as overall regional economic development, demographic changes, job impacts, patterns of urbanization, technological innovation, and the adoption of electro technologies.<sup>3</sup> Other external revenues and costs, such as renewable energy certificates (credits), production tax credits, costs for implementing energy-efficiency programs, and possible electricity infrastructure investments needed for significant penetration of intermittent resources, also were not considered.

Although the analysis presented a variety of economic results for comparison, it was not a least-cost plan or multi-year, present-worth analysis, and it did not include a "feedback loop" that accounted for how consumers or investors would react to these different sets of circumstances presented. Additionally, the analysis did not identify "right" or "wrong" technologies, attempt to build consensus about "preferable" technologies or outcomes, or develop a plan for what the region *should* or *will* do.

## **Background**

Shortly after ISO New England completed its Scenario Analysis report, Synapse Energy Economics, Inc. issued a "Companion Report" that commented on the ISO's report and requested that the ISO analyze two additional scenarios. After some discussion to clarify this request, the ISO analyzed two additional scenarios: Synapse M and Synapse P. Scenario Synapse M includes more generator

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<sup>1</sup> Adapted from the original report, August 2, 2007.

<sup>2</sup> Consistent with its mission, the ISO remained relatively neutral in depicting the technologies and avoided taking a position on any technology outcome. It selected simplifying modeling assumptions and approaches to provide insights into the issues rather than specific approaches to developing any specific technology.

<sup>3</sup> Other entities may be able to analyze these other factors using the results of this Scenario Analysis.

retirements than were studied by the ISO's Scenario Analysis and more energy efficiency (EE) to offset these retirements. Scenario Synapse P retires virtually all oil and coal generation and replaces it with energy efficiency plus the resource additions in ISO's Renewable Scenario, but with adjustments in the amounts of fuel cells and combined heat and power (CHP) systems. This summary provides the numerical results of these additional scenarios, but provides no interpretation of the results.

### **Summary of Results**

ISO's System Planning Department analyzed scenarios Synapse M and Synapse P with the Interregional Electric Market Model (IREMM), a production simulation model consistent with the methodology used in the ISO's Scenario Analysis. The Synapse M and Synapse P scenarios were created from the EE/DR (energy efficiency/demand response) scenario with retirements. The original results for the EE/DR scenario and the EE/DR case with retirements are included here for comparison.

Table 1 provides the key assumption changes made from the EE/DR case with retirements to create Scenarios M and P. The table includes:

1. EE/DR scenario assumptions
2. EE/DR with Retirements case assumptions
3. Scenario Synapse M: EE/DR with Retirements plus the retirement of 1,000 MW of coal-fired resources (existing plus integrated gasification combined-cycle [IGCC] units in the ISO's Generation Interconnection Queue) and replacement with 1,000 MW of EE
4. Scenario Synapse P: EE/DR with Retirements plus the replacement of virtually all residual oil and coal resources with increased EE and renewable energy technologies

**Table 1**  
**Resource Assumptions: Additions and Retirements**

	EE/DR Common Assumptions	EE/DR with Retirements	Scenario Synapse M	Scenario Synapse P
<b>RESOURCE ADDITIONS</b>	<b>Capacity Values in MW</b>			
EE	2,700	4,450	5,400	6,800
DR	2,700	4,450	4,450	4,450
Onshore wind	0	0	0	675
Offshore wind	0	0	0	675
Landfill gas	0	0	0	675
CHP	0	0	0	800
Biomass	0	0	0	675
Small hydro	0	0	0	675
PV	0	0	0	675
Fuel cells	0	0	0	500
<b>Total Additions</b>	<b>5,400</b>	<b>8,900</b>	<b>9,850</b>	<b>16,600</b>
<b>RETIREMENTS</b>				
Base retirements	0	-3,500	-3,500	-3,500
Additional retirements	0	0	-690	-7,154
Forego construction of new IGCC	0	0	-310	-310
Total retirements	0	-3,500	-4,500	-10,964
<b>Net Additions</b>	<b>5,400</b>	<b>5,400</b>	<b>5,350*</b>	<b>5,636**</b>

\* This does not match 5,400 MW exactly due to retiring discrete unit sizes.

\*\* Scenario P has a large amount of nondispatchable wind and photovoltaic energy plus large amounts of energy efficiency. Therefore, an extra 236 MW of capacity was added to avoid energy shortages.

Table 2 shows the annual economic metrics (load-serving entity [LSE] expense, production costs, and average clearing price) that were calculated by IREMM for these two scenarios compared with two cases in the original Scenario Analysis report, EE/DR and EE/DR with Retirements. As in these two Scenario Analysis EE/DR cases, the additional energy efficiency and demand-response resources were assumed as having zero energy costs. They were viewed similar to generation resources, and the model “dispatched” these “supplies” the same way as generation resources. For the given amount of reduced energy consumed, an “energy payment” was assumed to be available to compensate the entity that provided the demand-side resources. In reality, however, the system operator does not dispatch demand-response and energy-efficiency resources. Instead, when customers use demand-response and energy-efficiency measures, the result is reduced demand (energy consumption) in the electric system, and the system operator dispatches generation resources to meet the remaining physical load on the system. . Customer electric rates could increase in these scenarios compared with the other scenarios, as the megawatt-hour energy base is much less with Scenario P, even if the LSE costs have dropped.<sup>4,5</sup>

**Table 2**  
**Annual Economic Metrics (2006 \$)**

<b>Scenario</b>	<b>Energy (GWh)</b>	<b>LSE Expense (million \$)</b>	<b>Prod Cost (million \$)</b>	<b>Average Clearing Price (\$/MWH)</b>
<b>EE/DR</b>	173,778	12,235	6,298	70
<b>EE/DR w/ Retirements</b>	173,778	12,321	5,693	71
<b>Synapse M</b>	173,778	12,331	5,410	71
<b>Synapse P</b>	173,778	9,127	3,493	53

Analysis of these two scenarios was done similarly to the others in the Scenario Analysis report. Figure A shows the Synapse M and P results, which have been added to Figure 5-5 of Scenario Analysis report.

<sup>4</sup>Although it is not exactly how these resources actually perform, when consumers pay less total energy costs due to lower energy use, this modeling approach is a reasonable representation of how entities that adopt energy efficiency get compensated for their investment. In effect, the reduced bill represents lower energy use, and the value of the avoided energy is akin to these “energy payments.” These entities include, for example, consumers that fully invest in energy-efficiency equipment, third-party suppliers of energy-efficiency services, or both. In the latter case, such costs and revenues (savings) are shared between the two entities.

<sup>5</sup> Because energy-efficiency and demand-response resources were modeled as if they offered “energy” supply at no cost to the system (rather than being modeled as a reduction to the load curve), the outcome of the model was that the party that invested in these measures was paid the calculated net energy revenues. These revenues are equivalent to the dollar savings gained as a result of the reduced energy consumed by “using” these resources. Scenario #2 (EE/DR) was assumed to “dispatch” 18 million MWh of no-cost energy, and the Double EE case was assumed to “dispatch” 36 million MWh of no-cost energy. While this approach did not affect production costs or average clearing prices, it did affect total LSE costs, since it overestimated the amount of electric energy that needed to be purchased. Because being more energy efficient would reduce the total amount of energy that LSEs would need to purchase, their total expense would go down (even though the price per unit of electricity purchased would be unaffected). These savings were not subtracted from the results for the energy-efficiency scenarios posted in the column labeled “Annual Wholesale Electric Energy Market Cost to LSEs.”

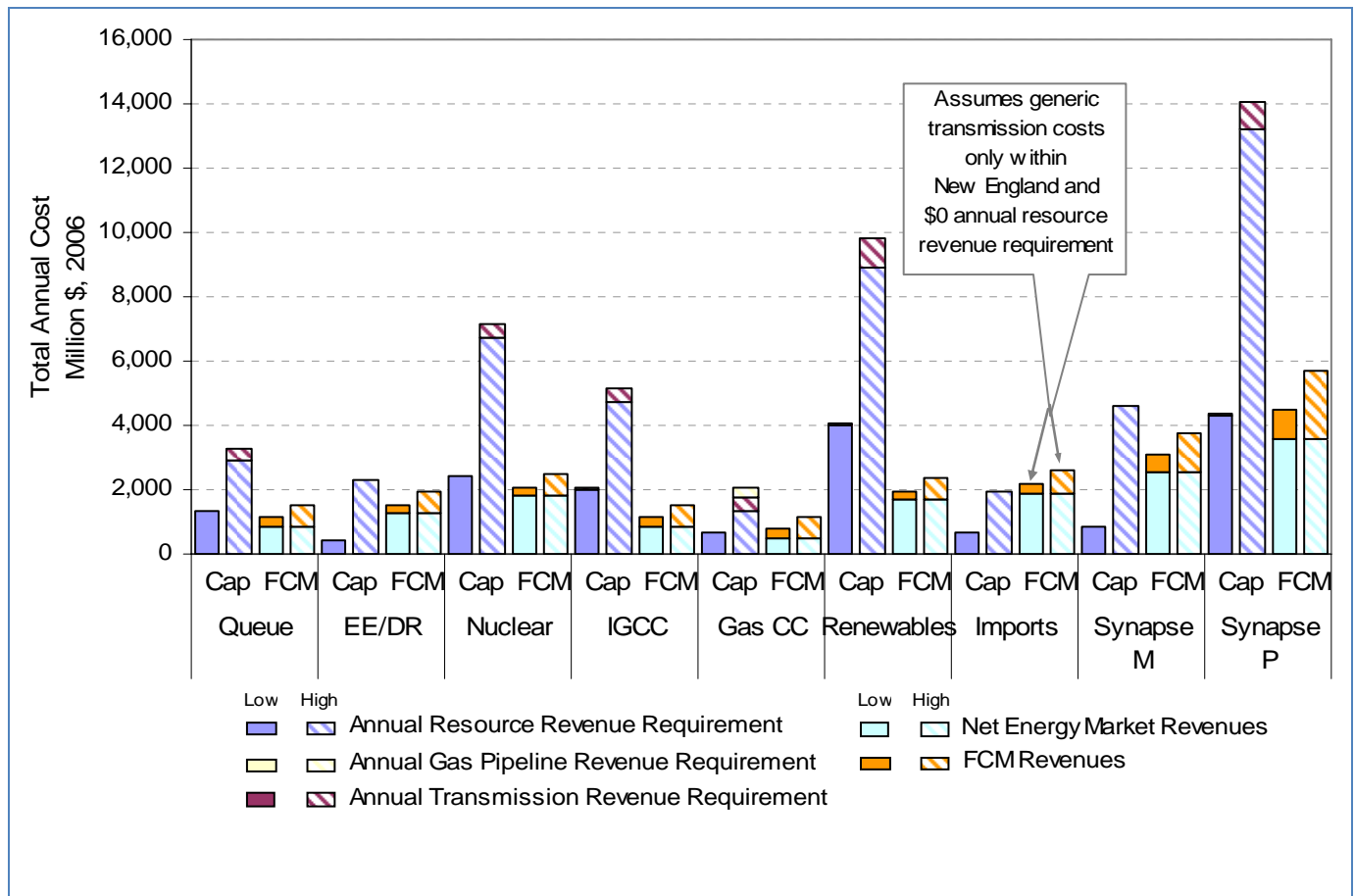


Figure A: High and low annual revenue requirements compared with Forward Capacity Market plus net energy market revenues for the scenario technologies under the common set of assumptions—Scenarios M and P added to Figure 5-5 in the ISO’s Scenario Analysis report.

The figure shows that Scenario M revenues from the energy market could cover the investment costs assumed. However, for Scenario P, the revenues only would cover the low investment assumption and only cover about a third of the investments for the high case of EE/DR investments. *The ISO assumed the same costs for a much less aggressive amount of EE/DR than in Scenario P, and it is possible that higher costs would be experienced as the amount of EE/DR increases. Also, with the greater amount of DR, additional system operating infrastructure costs may be incurred, but these are uncertain.*

Not unlike the other scenarios examined in the Scenario Analysis, Scenario P has additional considerations that are important to its feasibility. One is the need to operate with a high amount of intermittent resources. This may require additional infrastructure investment that was not included as it is unknown at present. Because of lower energy clearing prices, the revenues for EE/DR and renewable resources as well as the other generators would be reduced. Additional revenues may be required to support these programs.

Table 3 shows the annual sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), and carbon dioxide (CO<sub>2</sub>) emissions for the EE/DR Common Assumptions case and EE/DR with Retirements case compared with the Synapse M and Synapse P cases.

**Table 3**  
**Annual Emissions Metrics**

Scenario/Case	ID	Ktons		Million tons
		SO <sub>2</sub>	NO <sub>x</sub>	CO <sub>2</sub>
EE/DR	2	72	34	67
EE/DR w/ Retirements	8	45	24	56
Synapse M	9	20	19	48
Synapse P	10	10	17	33

The following graphs are similar to those provided in the Scenario Analysis Spreadsheet Tool on the ISO Website. Four sets of figures follow:

- Figures 1–12 show energy production by fuel category. A series of graphs is presented for each scenario that illustrates energy production for different time frames. The first is the peak load day, the second shows the summer season chronologically (i.e., July and August), and the third is an annual duration graph.
- Figures 13–24 show NO<sub>x</sub> emissions. A series of graphs is presented for each scenario that illustrates NO<sub>x</sub> emissions for different time frames. The first is the peak load day, the second shows the summer season chronologically (i.e., July and August), and the third is an annual duration graph.
- Figures 25–28 show marginal costs as an annual clearing price duration graph for each scenario.

Figure 1: Peak Day Energy Production by Fuel Category for EE/DR Case

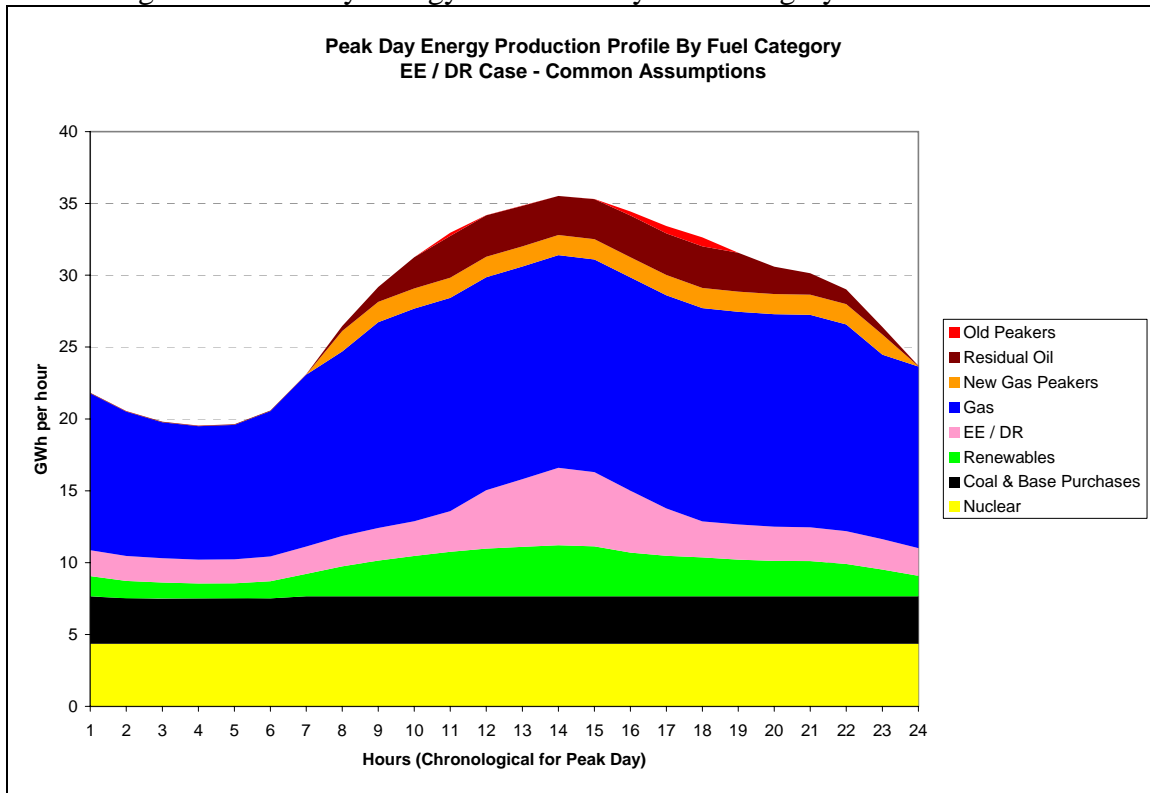


Figure 2: Summer Season Energy Production by Fuel Category for EE/DR Case

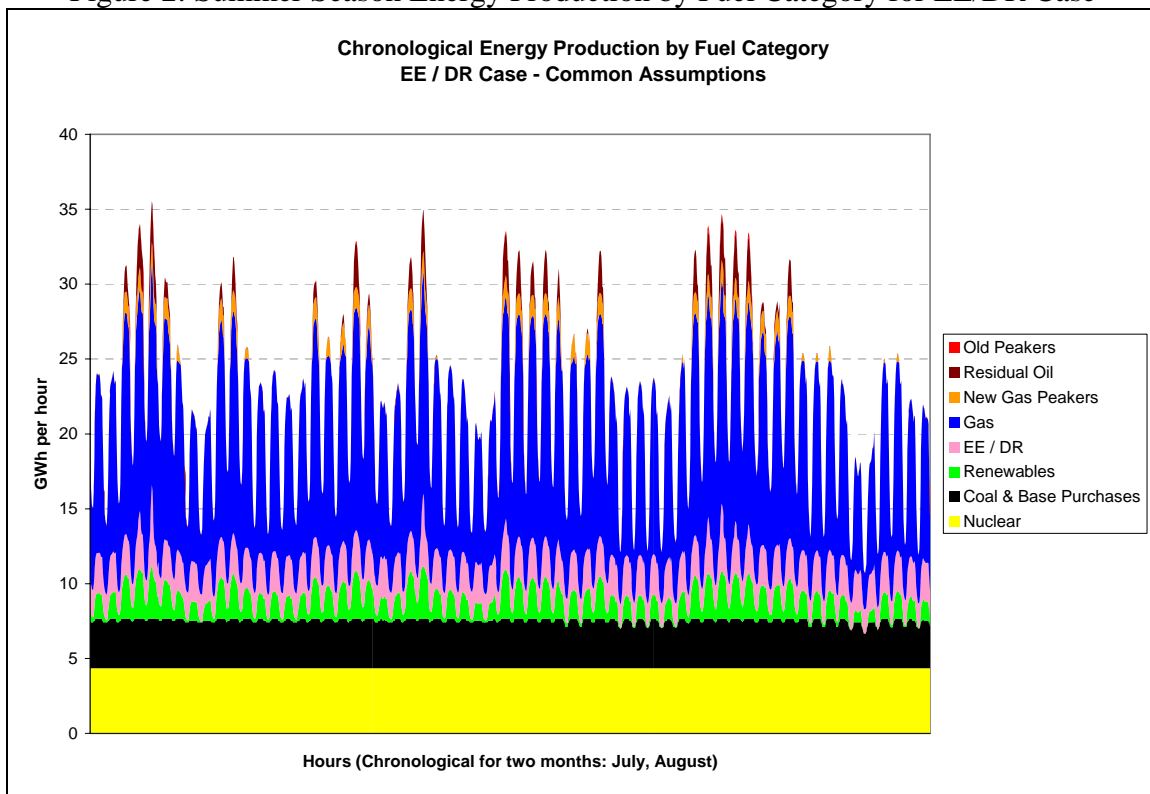


Figure 3: Annual Energy Production Duration by Fuel Category for EE/DR Case

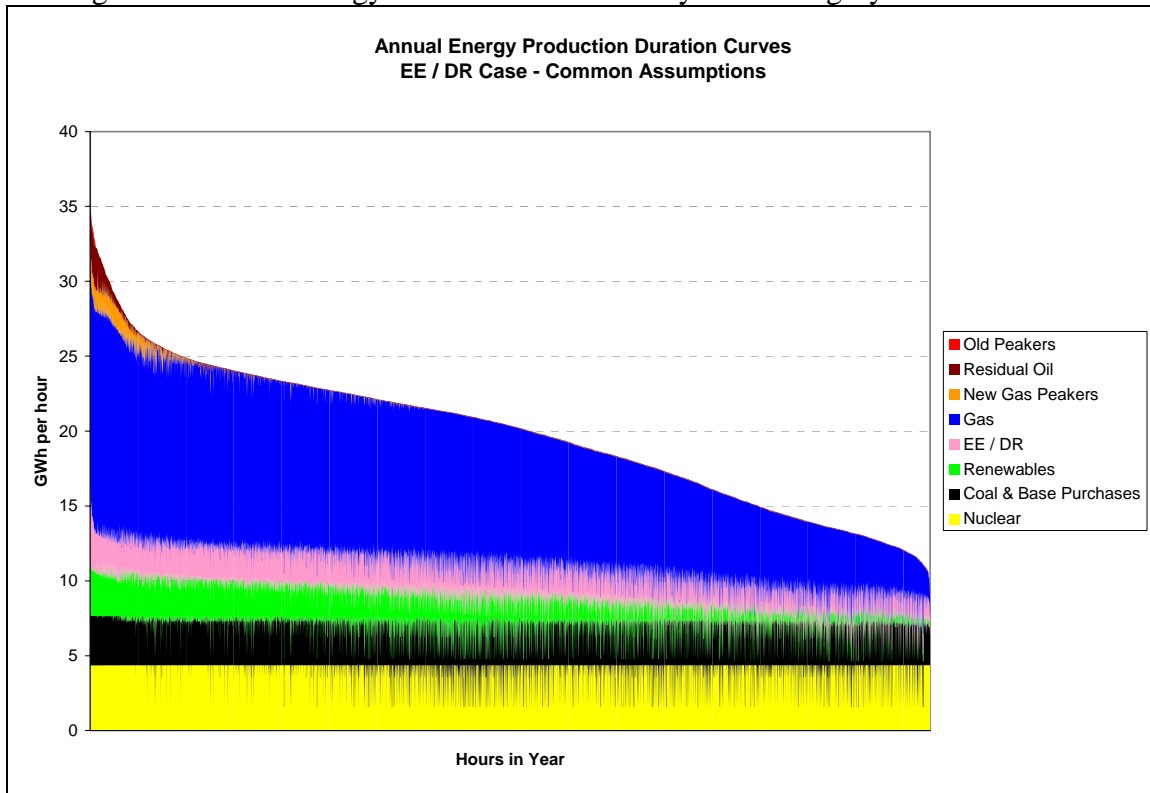


Figure 4: Peak Day Energy Production by Fuel Category for EE/DR Retirement Case

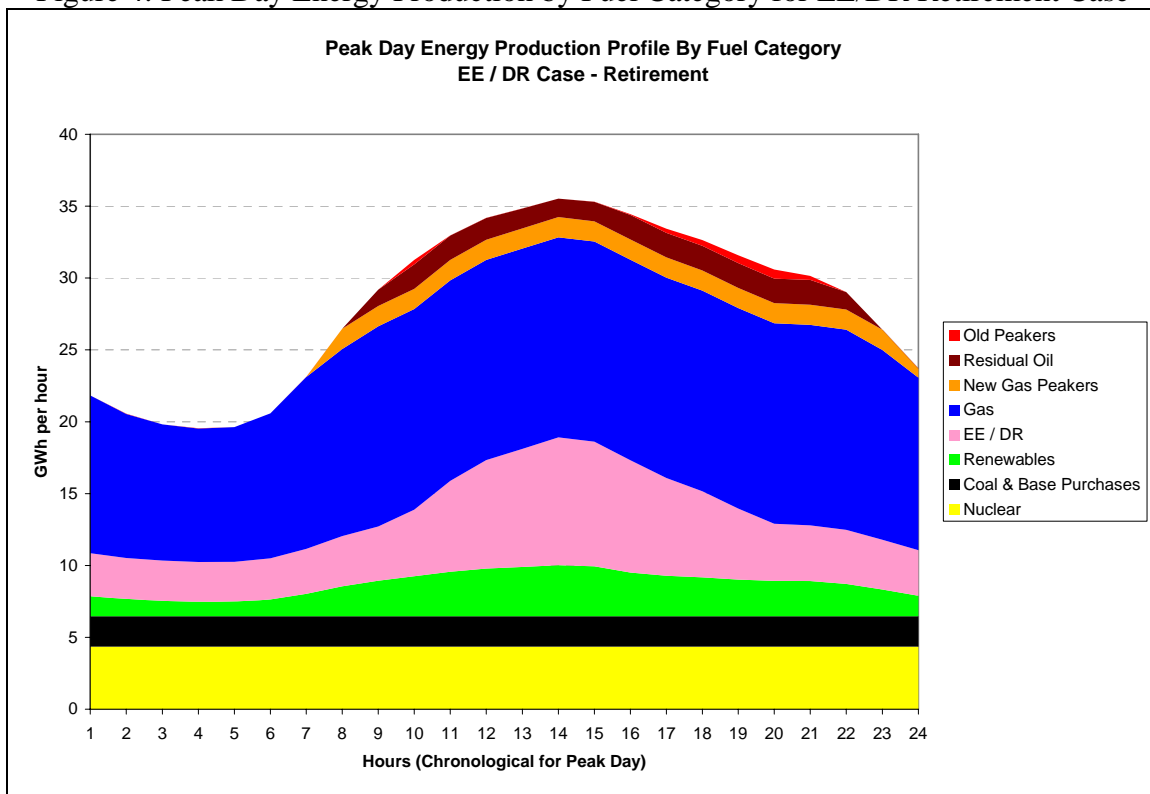


Figure 5: Summer Season Energy Production by Fuel Category for EE/DR Retirement Case

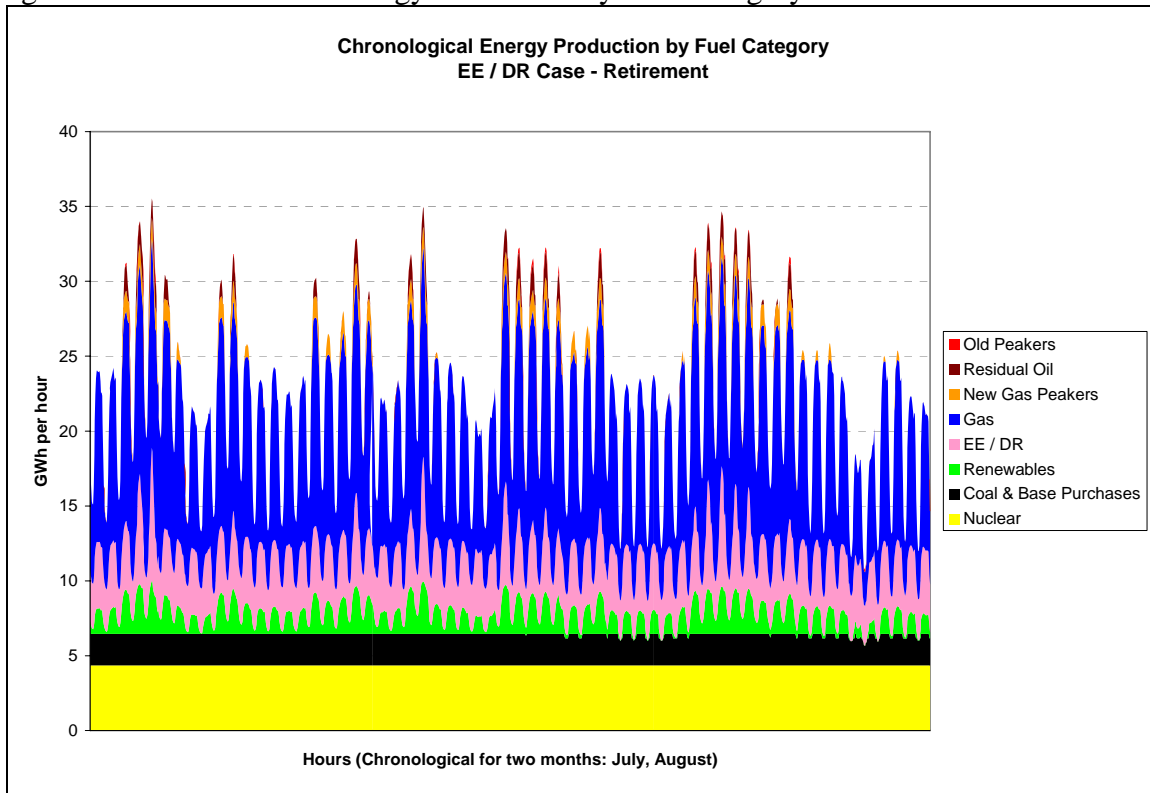


Figure 6: Annual Energy Production Duration by Fuel Category for EE/DR Retirement Case

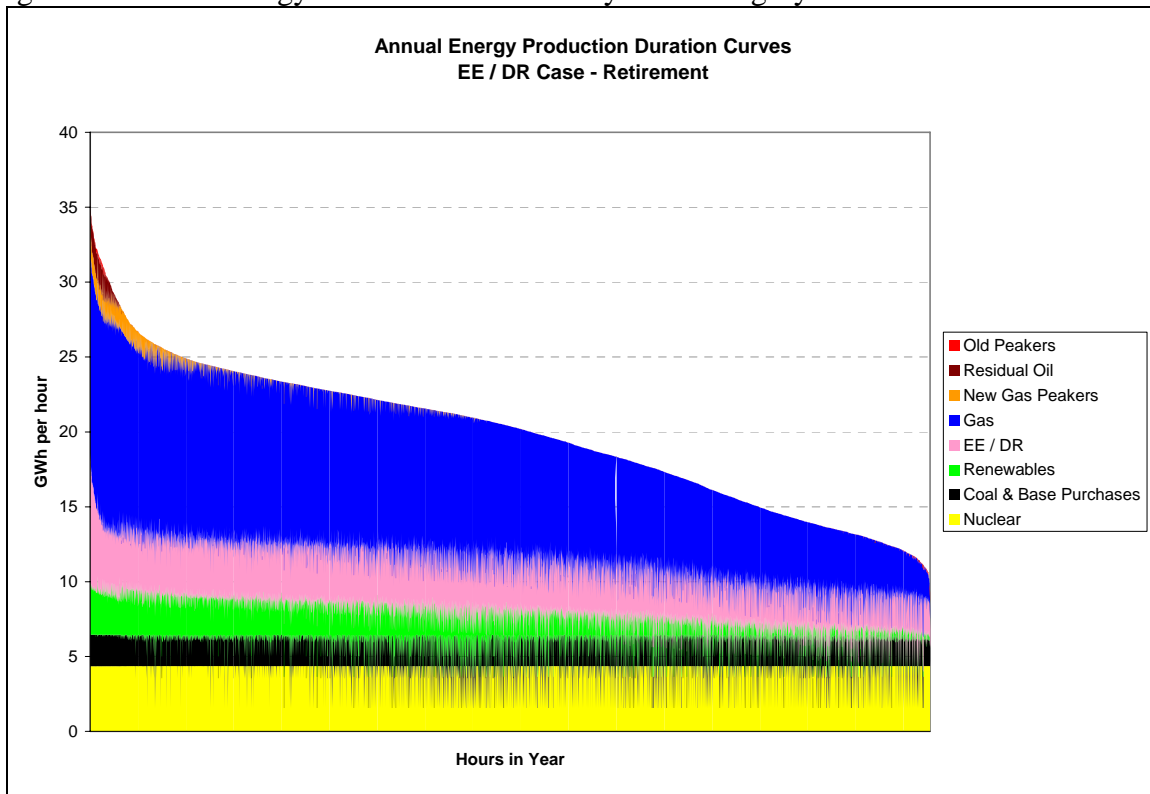


Figure 7: Peak Day Energy Production by Fuel Category for Synapse M Case

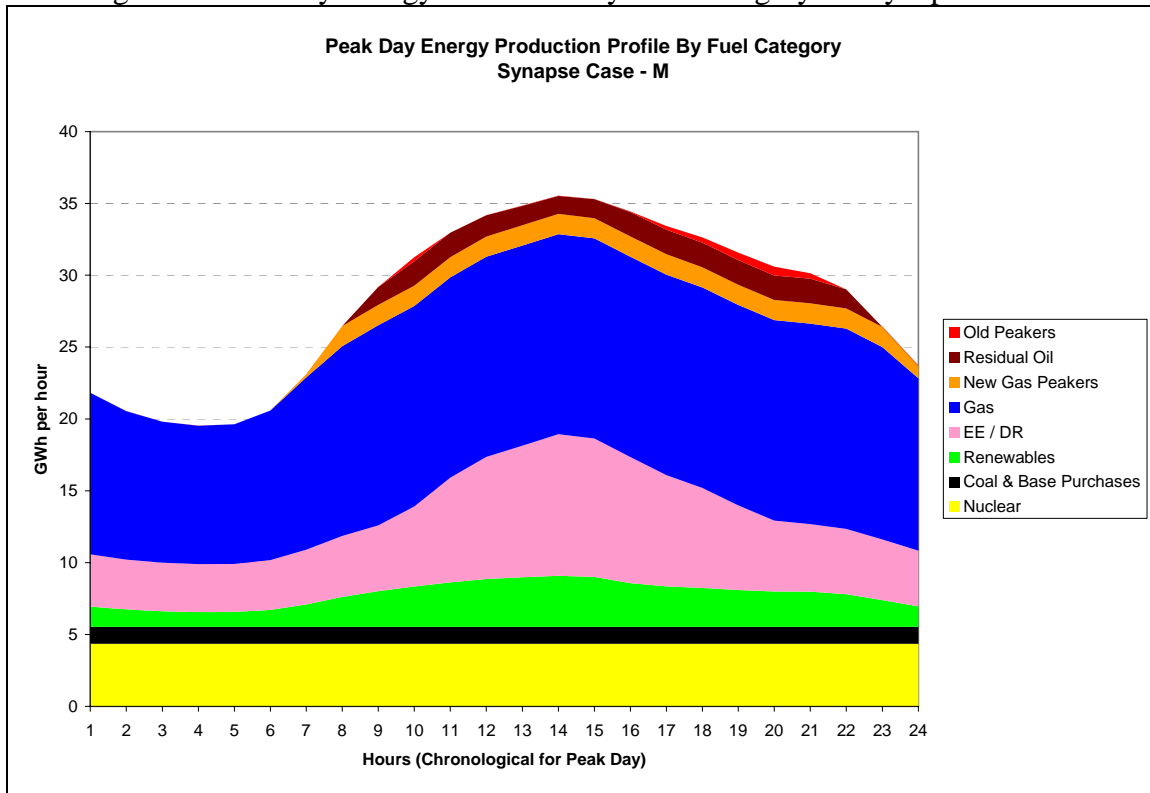


Figure 8: Summer Season Energy Production by Fuel Category for Synapse M Case

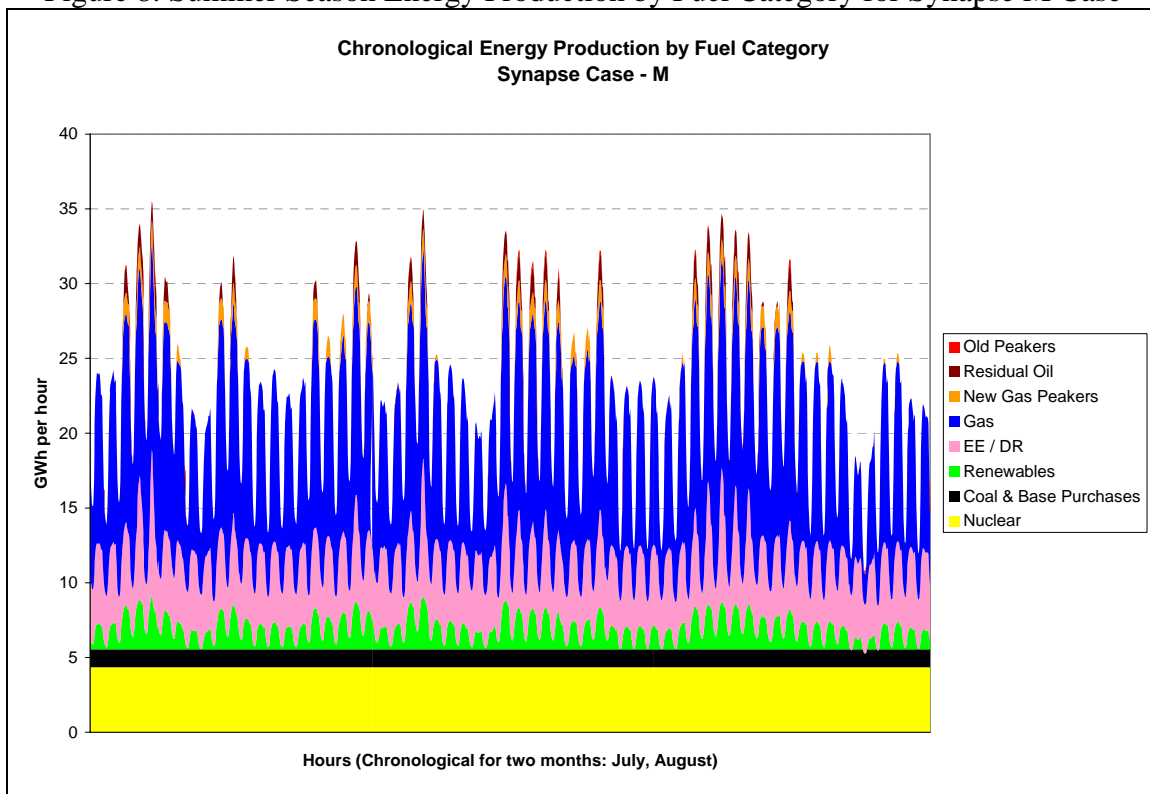


Figure 9: Annual Energy Production Duration by Fuel Category for Synapse M Case

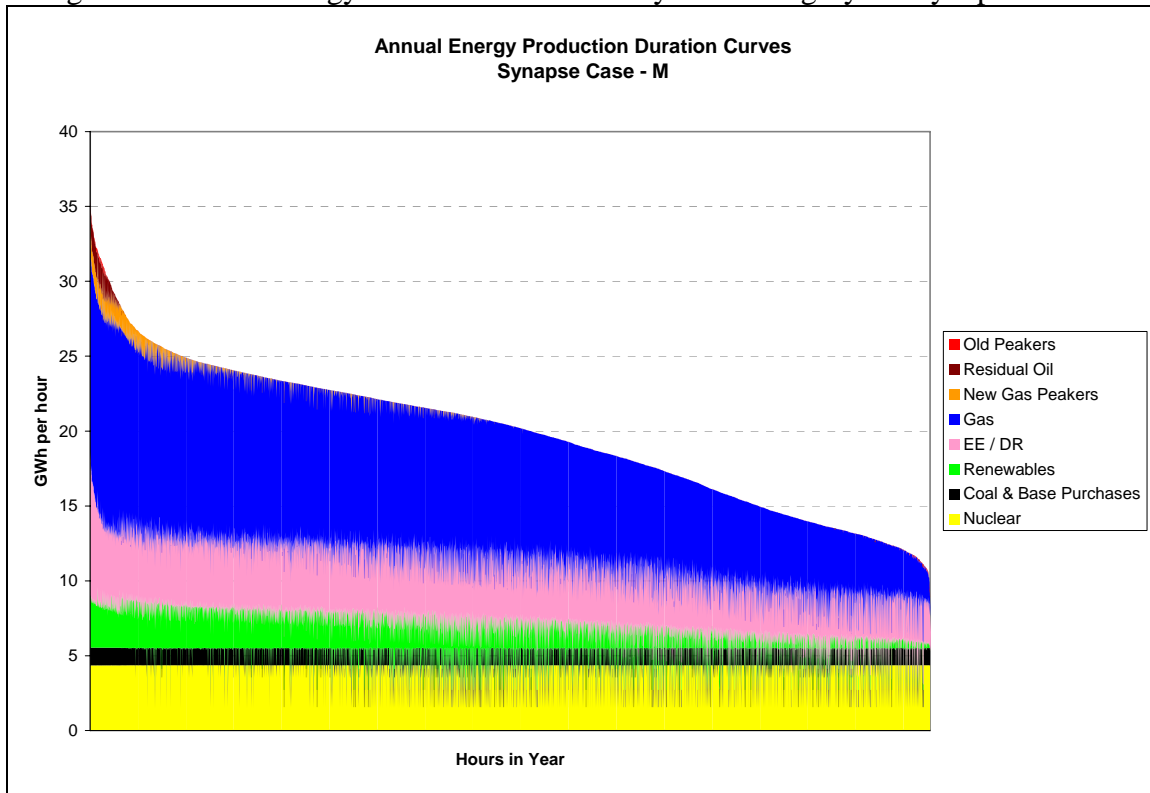


Figure 10: Peak Day Energy Production by Fuel Category for Synapse P Case

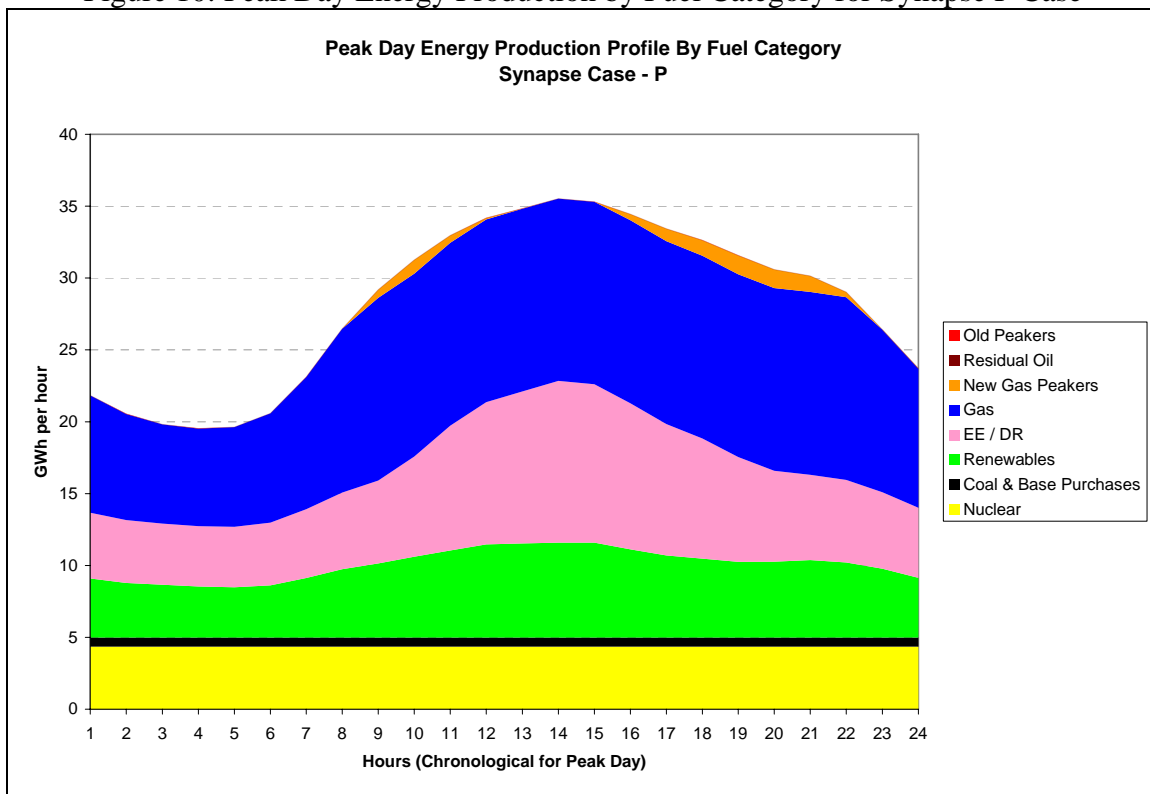


Figure 11: Summer Season Energy Production by Fuel Category for Synapse P Case

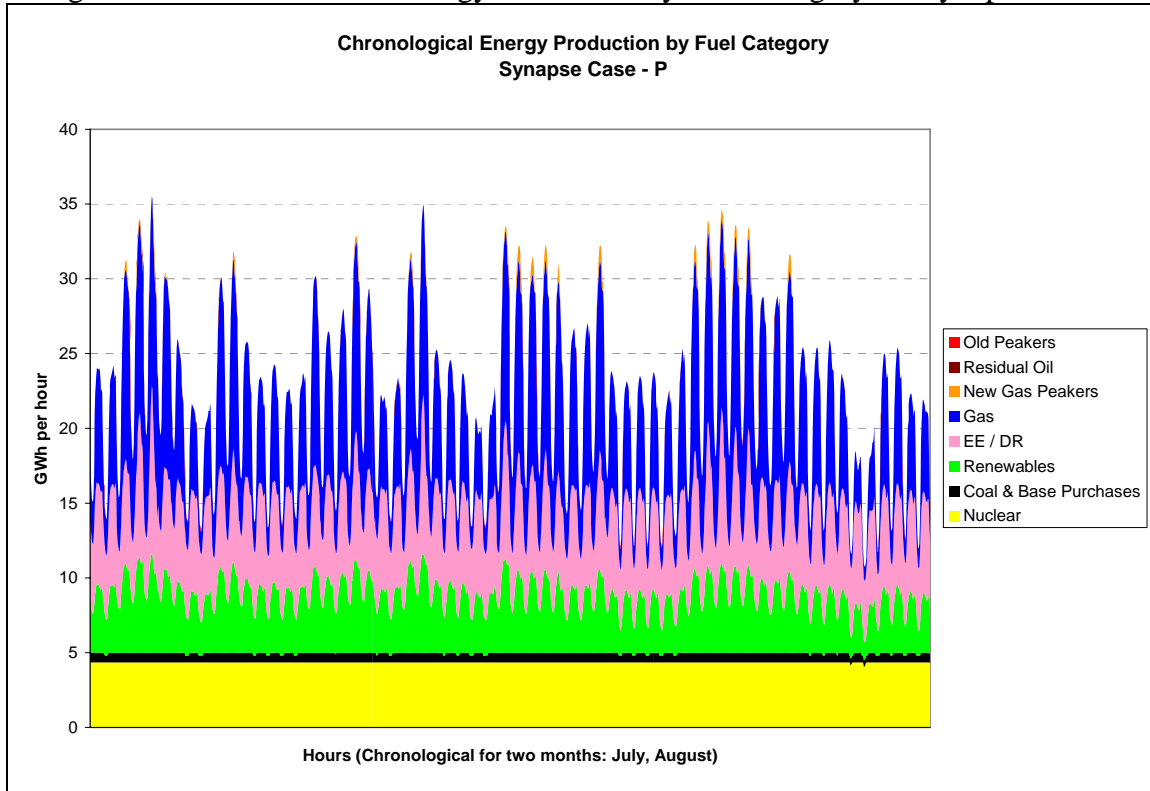


Figure 12: Annual Energy Production Duration by Fuel Category for Synapse P Case

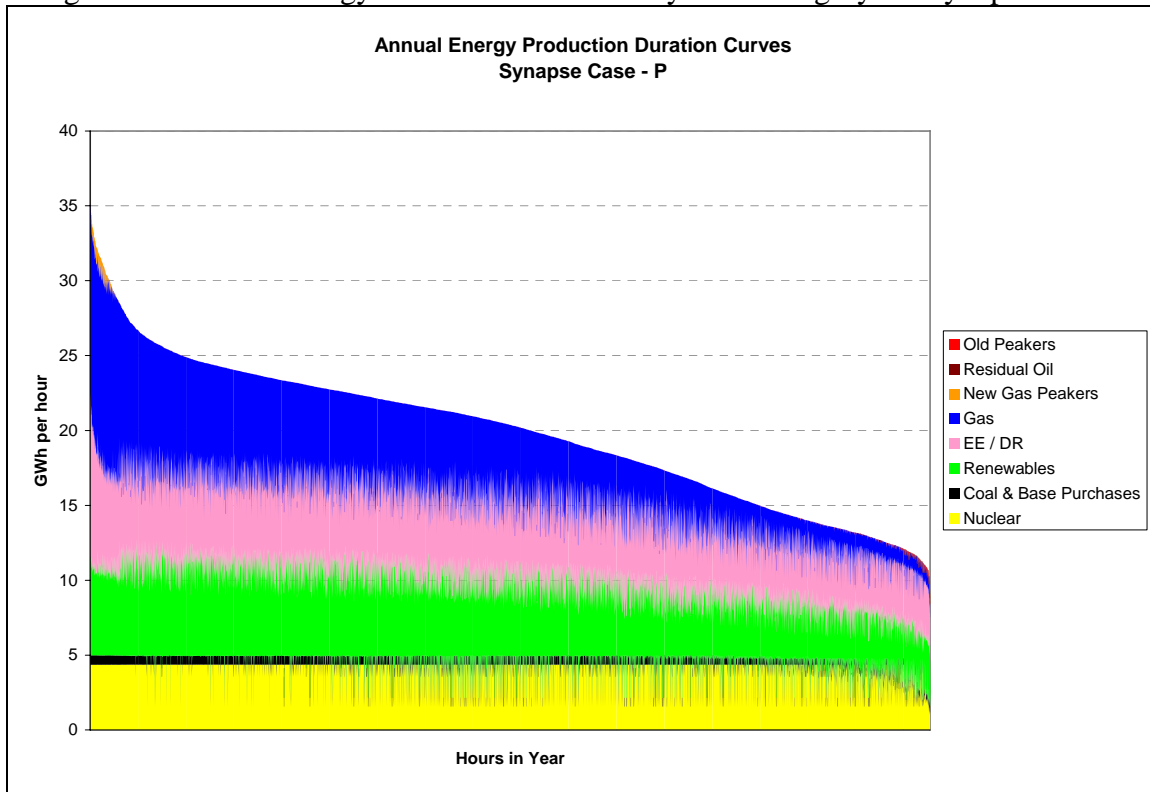


Figure 13: Peak Day NO<sub>x</sub> Emissions by Fuel Category for EE/DR Case

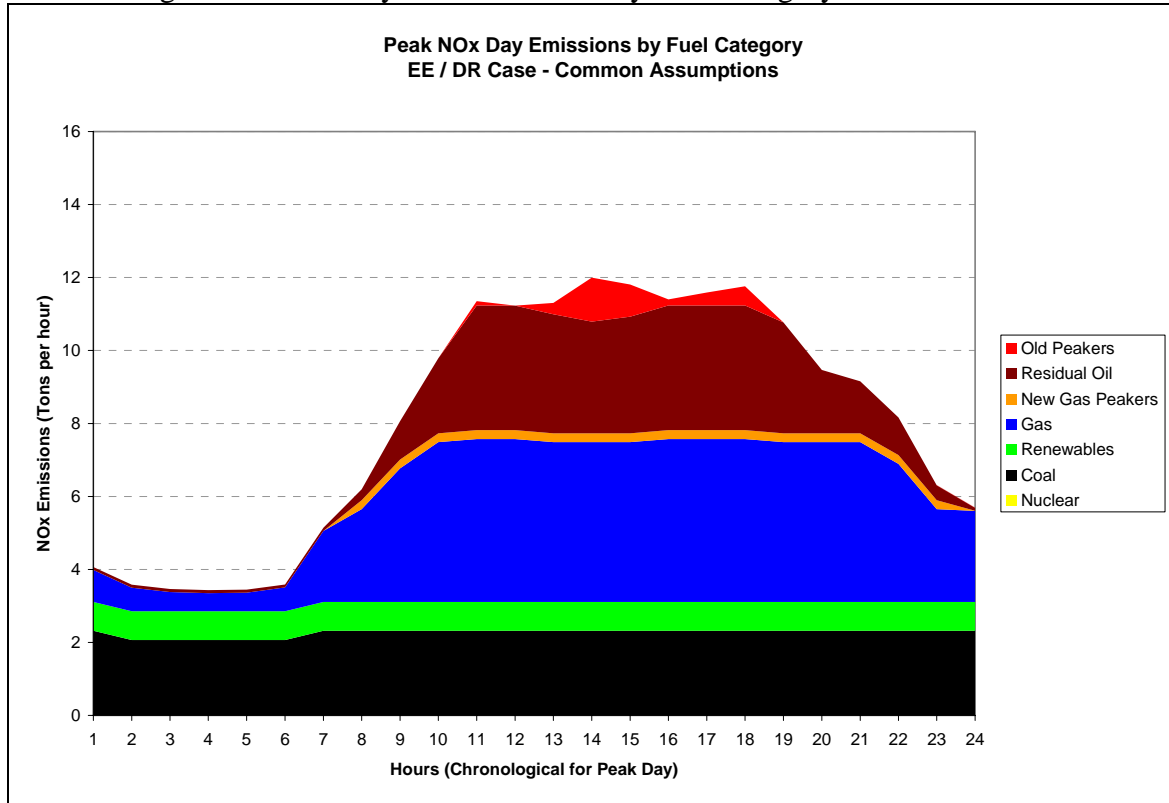


Figure 14: Summer Season NO<sub>x</sub> Emissions by Fuel Category for EE/DR Case

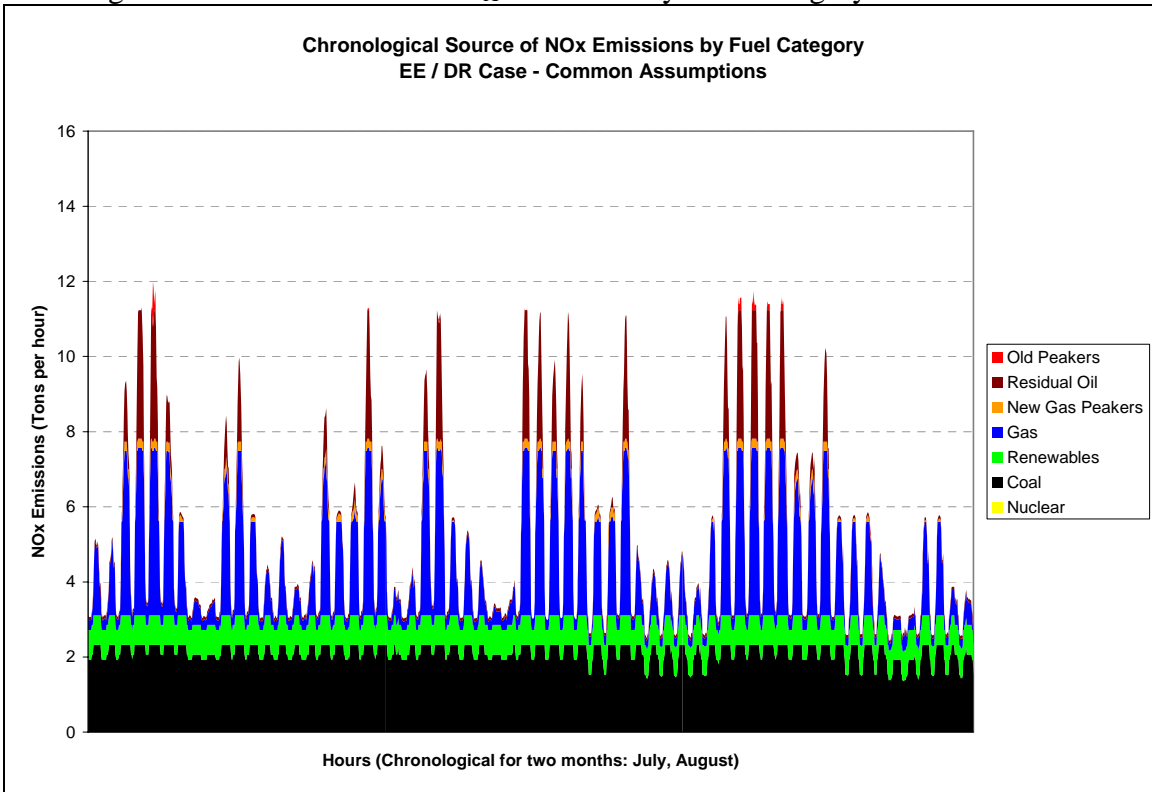


Figure 15: Annual NO<sub>x</sub> Emission Duration by Fuel Category for EE/DR Case

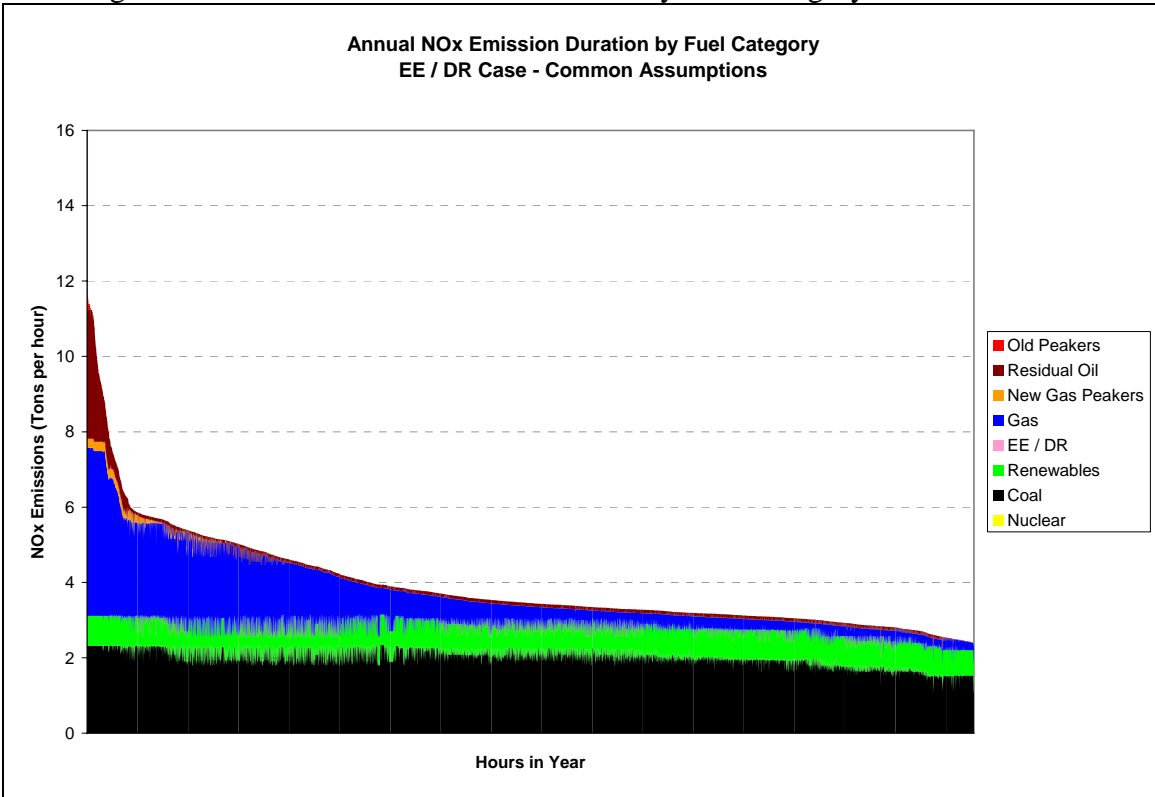


Figure 16: Peak Day Energy Production by Fuel Category for EE/DR Retirements Case

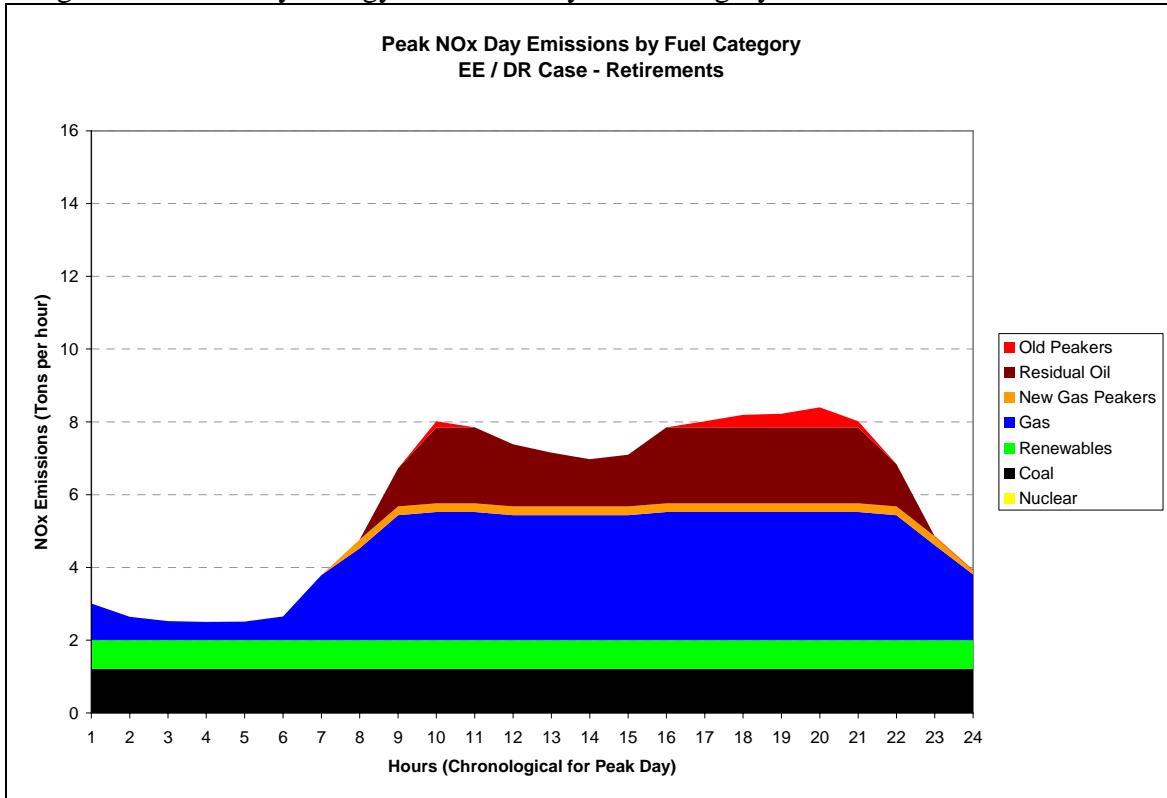


Figure 17: Summer Season NO<sub>x</sub> Emissions by Fuel Category for EE/DR Retirement Case

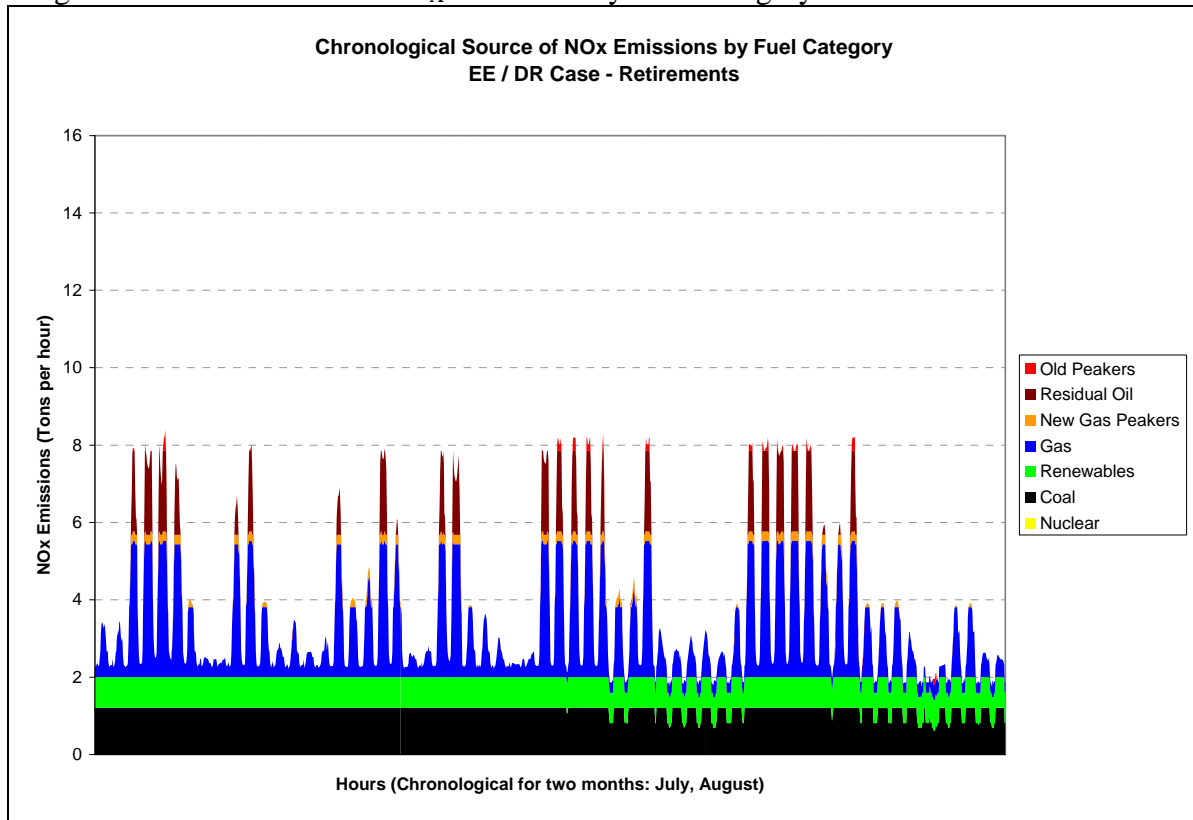


Figure 18: Annual NO<sub>x</sub> Emission Duration by Fuel Category for EE/DR Retirement Case

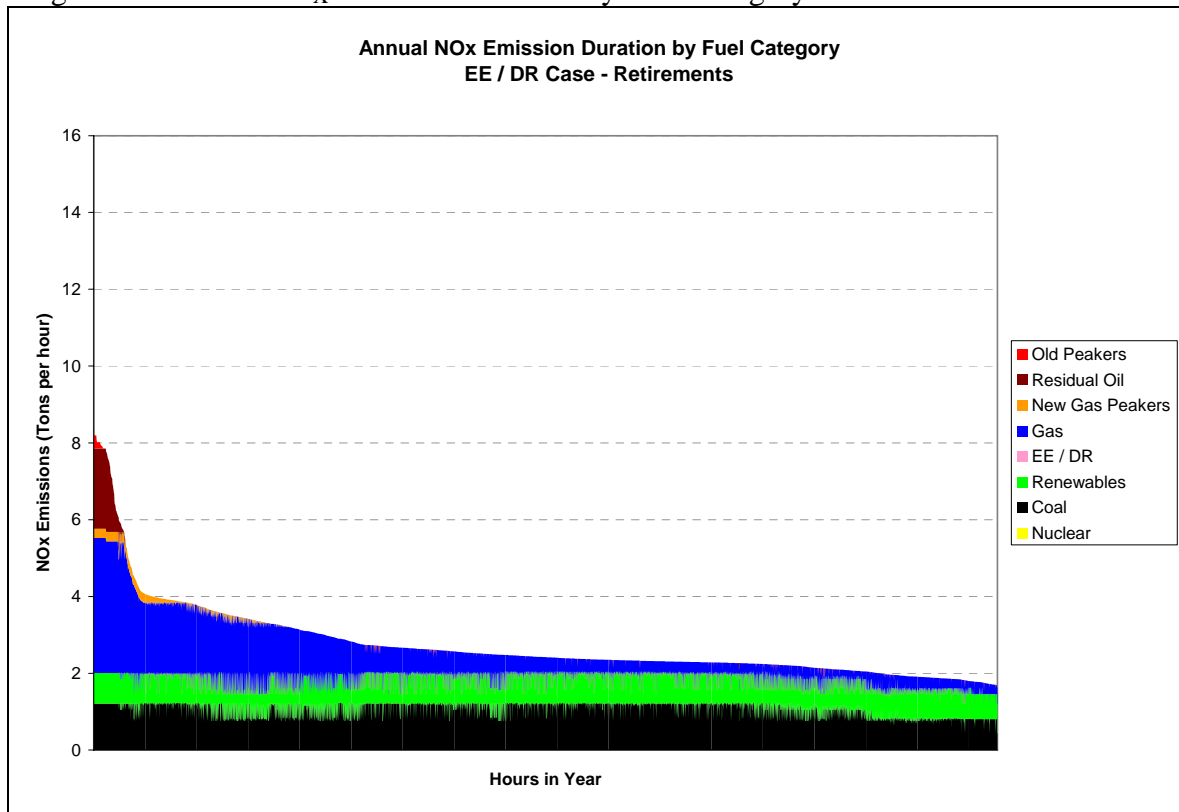


Figure 19: Peak Day NO<sub>x</sub> Emissions by Fuel Category for Synapse M Case

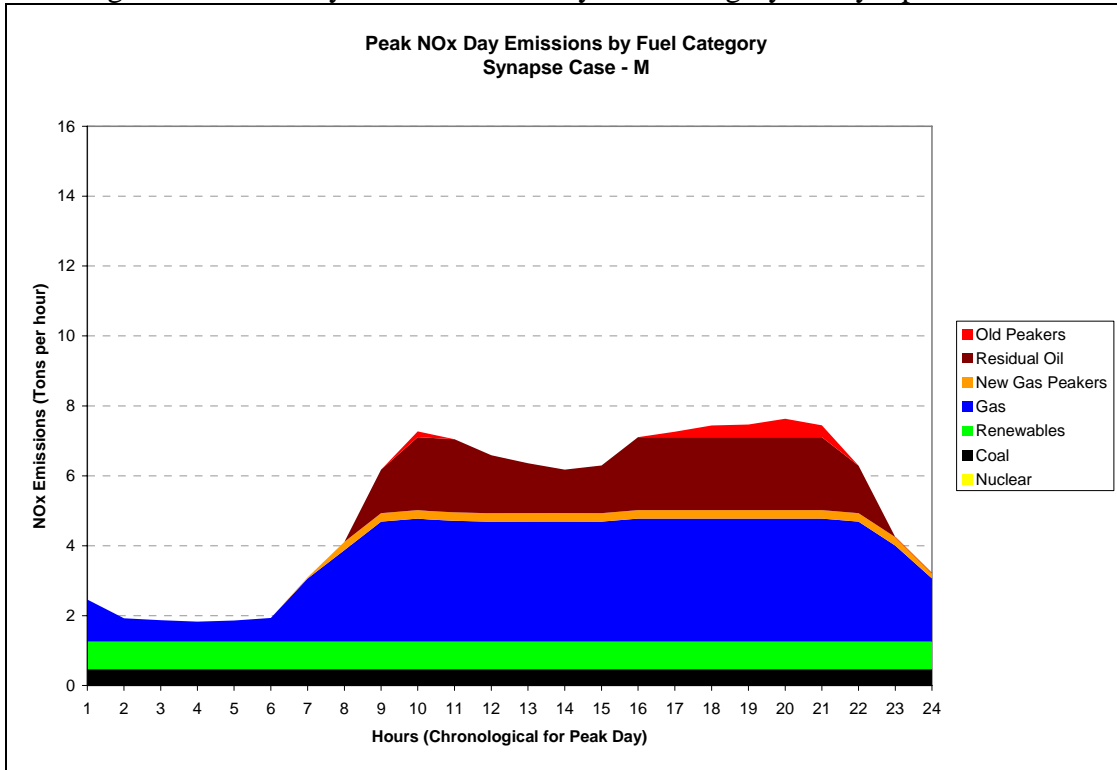


Figure 20: Summer Period NO<sub>x</sub> Emissions by Fuel Category for Synapse M Case

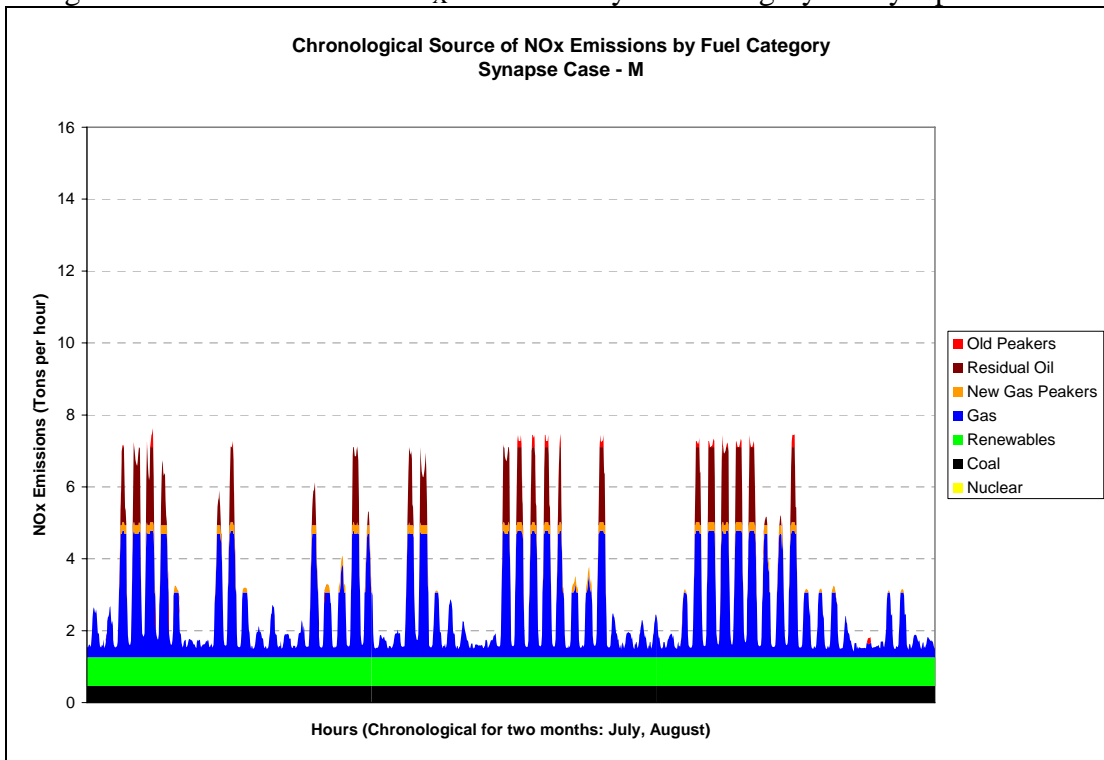


Figure 21: Annual NO<sub>x</sub> Emissions Duration by Fuel Category for Synapse M Case

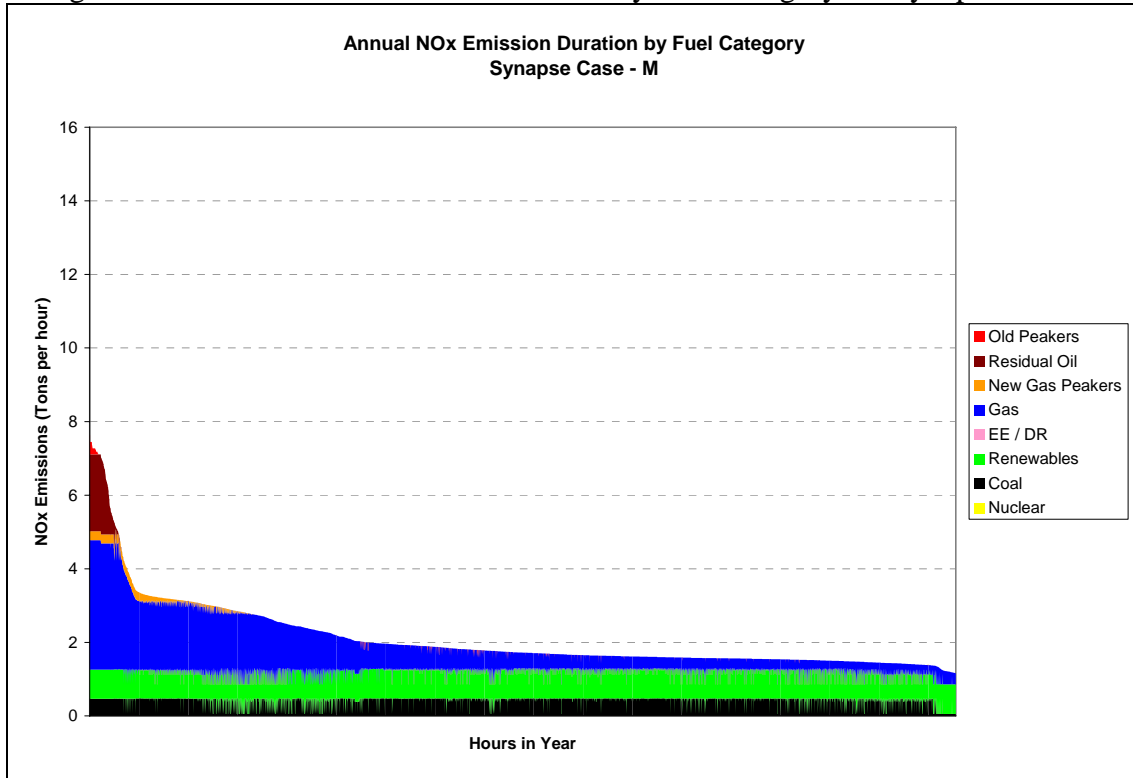


Figure 22: Peak Day NO<sub>x</sub> Emissions by Fuel Category for Synapse P Case

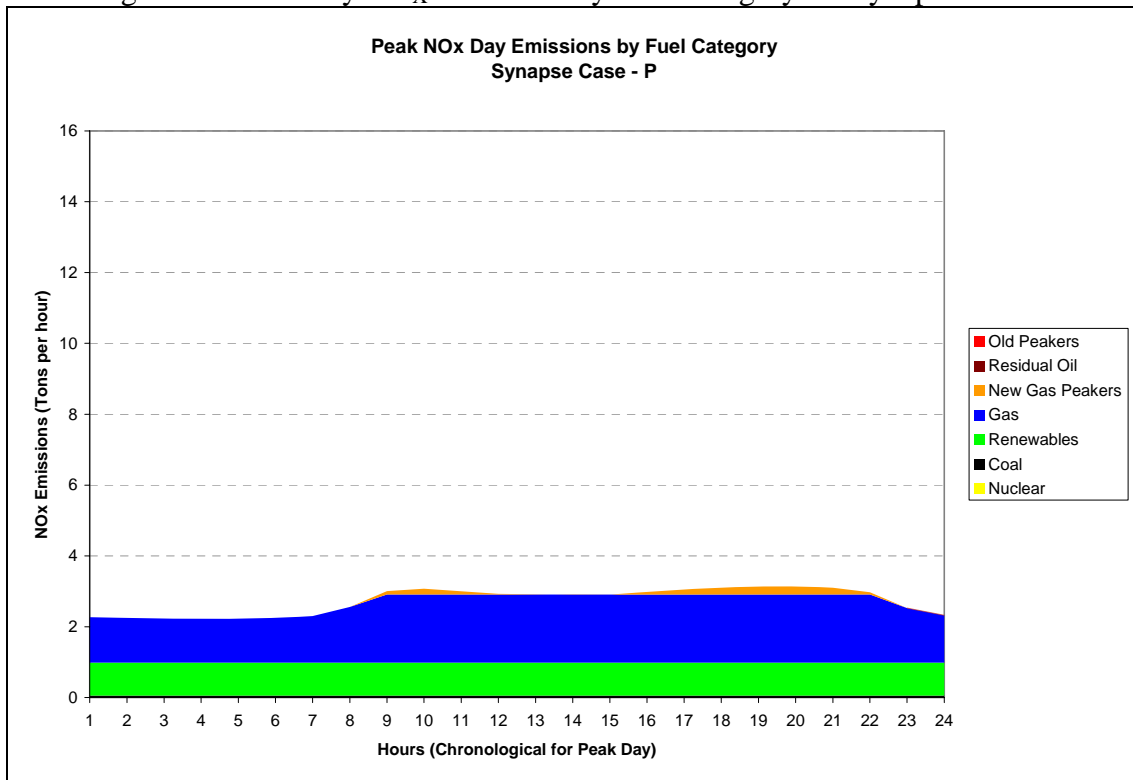


Figure 23: Summer Period NO<sub>x</sub> Emissions by Fuel Category for Synapse P Case

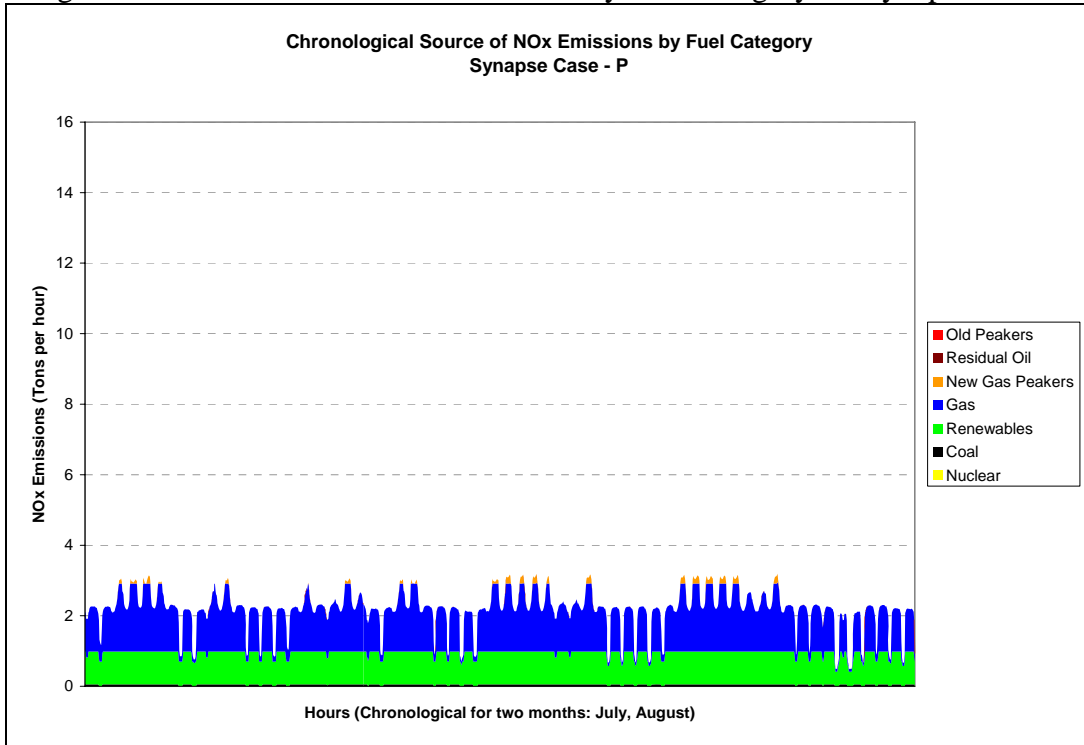


Figure 24: Annual NO<sub>x</sub> Emissions Duration by Fuel Category for Synapse P Case

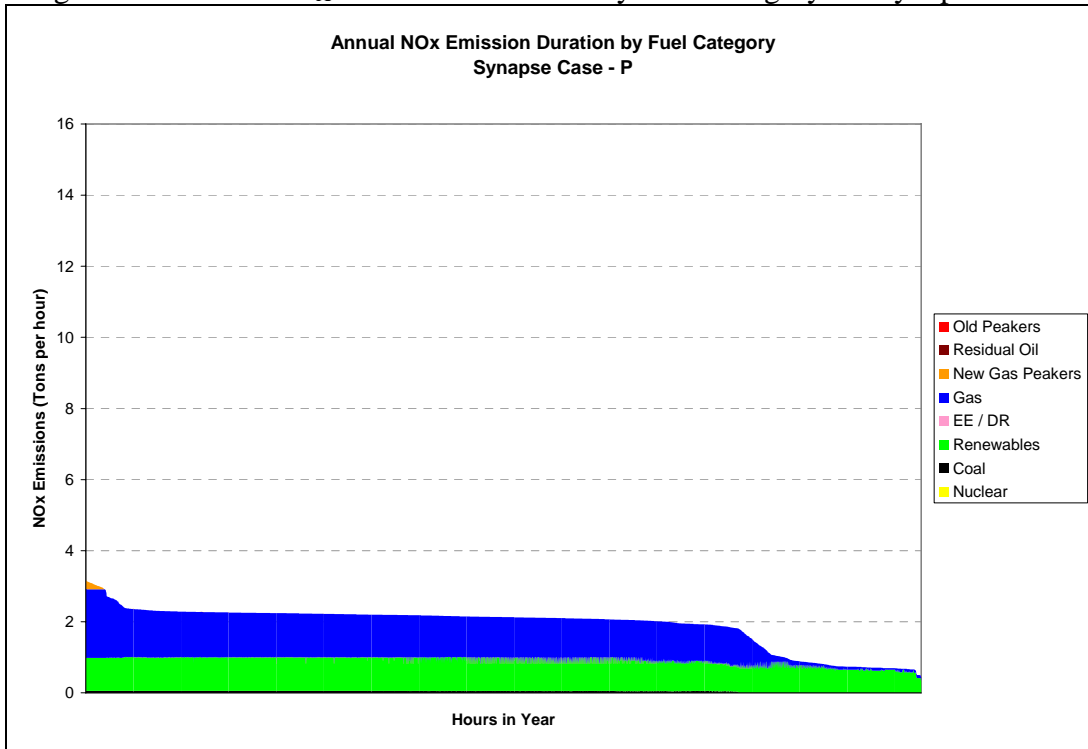


Figure 25: Annual Clearing Price Duration Curve for EE/DR Case

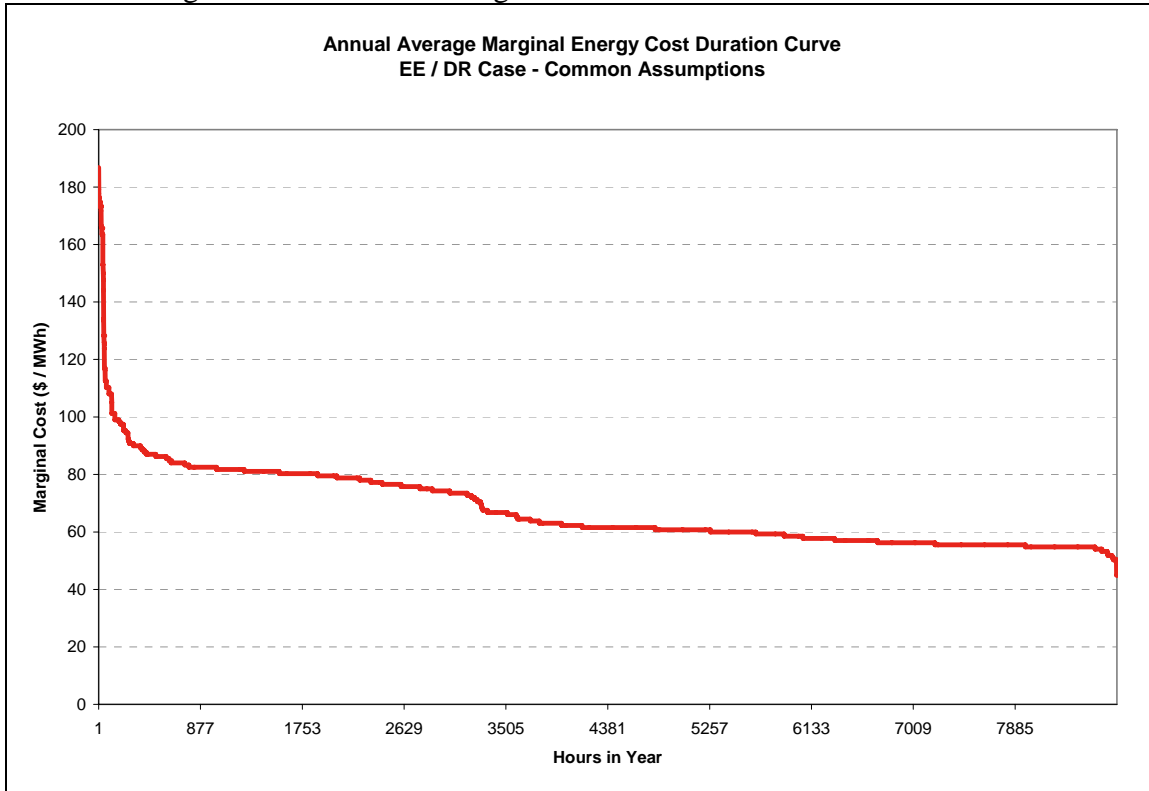


Figure 26: Annual Clearing Price Duration Curve for EE/DR with Retirements Case

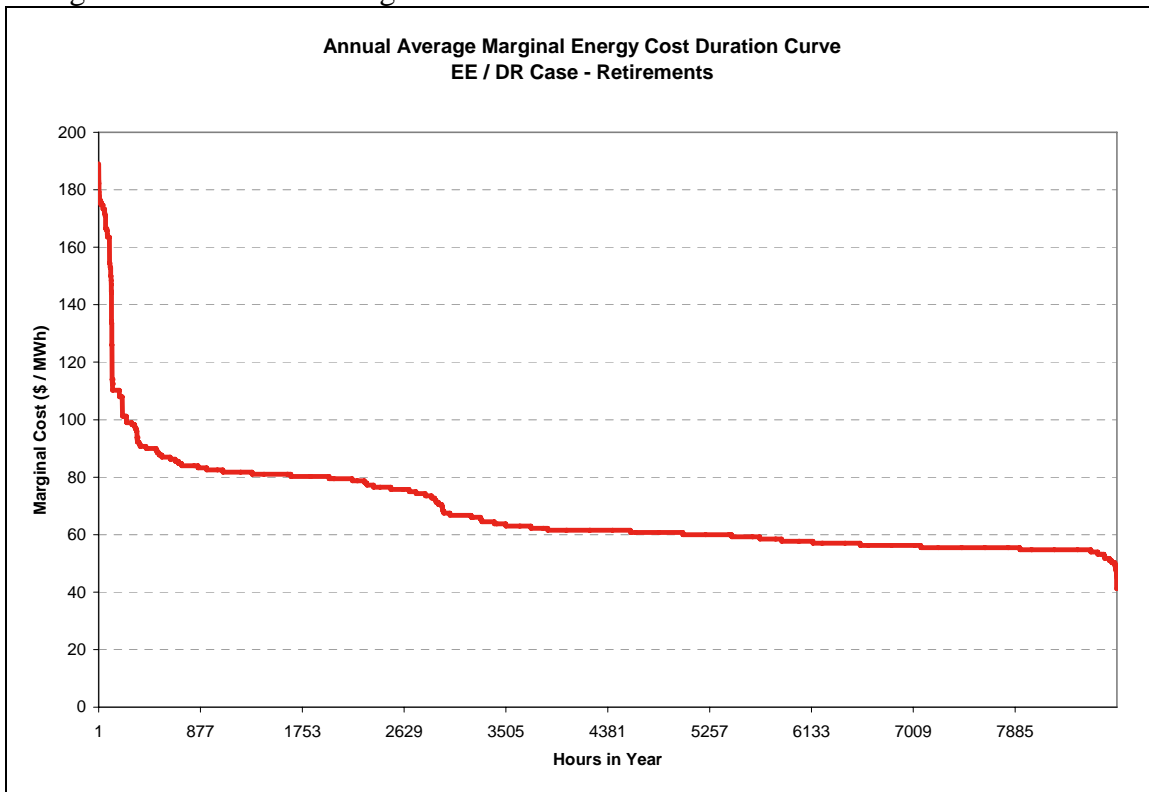


Figure 27: Annual Clearing Price Duration Curve for Synapse M Case

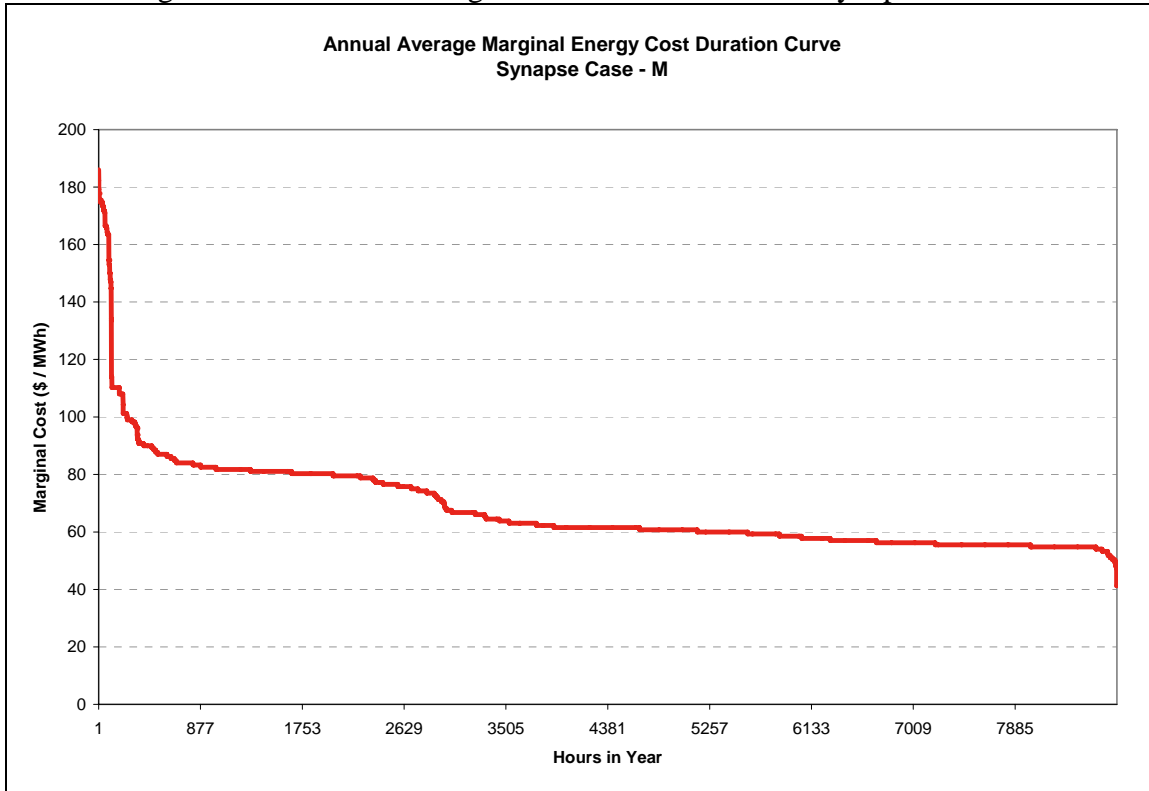


Figure 28: Annual Clearing Price Duration Curve for Synapse P Case

