First Draft
New England Electricity Scenario Analysis: Documentation of the Data-Extraction Spreadsheets

Prepared at the request of the
Scenario Analysis Stakeholder Group

System Planning
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Disclaimers

Although ISO New England (ISO) believes it has accurately portrayed and correctly configured the data contained within the Scenario Analysis spreadsheets, it makes no representation or warranty about the accuracy, reliability, or completeness of these data, the source data used, or the information contained in this guide. The ISO cannot be held responsible for any errors and omissions inherent in these spreadsheets. All users of these data agree that the ISO is not liable for the third-party use of or reliance on these data, for any data errors contained herein, or omissions from this guide.

The findings discussed herein depend on the assumptions identified in *New England Electricity Scenario Analysis* report and more thoroughly described in the April 30, 2007, Final Modeling Assumptions (available online at http://www.iso-ne.com/committees/comm_wkgrps/othr/sas/mtrls/apr302007/assumptions.pdf). There are no assurances that any of the specific assumptions made during the Scenario Analysis process about a particular resource or location will actually be encountered.

Table of Contents

List of Figures

List of Tables

Section 1
Introduction

This user's guide provides basic instructions on how to use several Microsoft Excel® spreadsheets to extract either the data that were input into the Scenario Analysis simulations or the results that flowed out of these simulations.[1] ISO New England (ISO) is providing these spreadsheets to regional stakeholders to facilitate their review of the results of the Scenario Analysis and allow stakeholders to manipulate the results, develop hypothesizes, and extrapolate to obtain their own results. Data tables and several types of graphic displays have been created to make the information presented clear and understandable.

The ISO expects that stakeholders who use these data and spreadsheets are familiar with the Scenario Analysis project and the use of Microsoft Excel®. These spreadsheets use macros to facilitate the extraction, formatting, and display of the data.

1.1 Available Spreadsheets

Seven different spreadsheets are presented for the following data elements:

- Hourly load, intermittent resource, or "negawatt" profiles for the various resource technologies
- Electric energy generated by fuel category
- Hourly emissions of nitrogen oxides (NO_X) by fuel category
- Marginal electric energy prices
- Simulation metrics and scenario technology operational statistics
- Template for new resource costs and revenues
- Template for conceptual New England electricity rates

Users should note that these spreadsheets are contained in relatively large files (ranging from less than 1 megabyte to 66 megabytes).

1.2 Case Identification and Data Display

Each of the 53 cases of the Scenario Analysis—for the common assumptions and the sensitivities—have been assigned a "Case ID" number, which is used in the spreadsheets to display the associated data and graphics. The "hourly load, resource, or negawatt" spreadsheet uses different identification numbers. The templates for new resource costs and revenues and for the conceptual electricity rate sensitivity spreadsheet do not reference specific scenarios and sensitivities. Selecting and displaying data for this spreadsheet is explained in Section 8.

[1] Additional information about the Scenario Analysis is available online at http://www.iso-ne.com/committees/comm_wkgrps/othr/sas/index.html.

To select a case and display the requested results, most of the spreadsheets use an indexing mechanism to select data. As shown in Figure 1-1, the value that appears to the right of "Case ID =>" is a case number index value. To update the Case ID number, a user can either type a new value into this field or click on the blue buttons. The "Decrement" button will decrease the Case ID by one value, while the "Increment" button will increase the "Case ID" by one value. The name of the data element selected will be displayed in the two cells below the Case ID label.

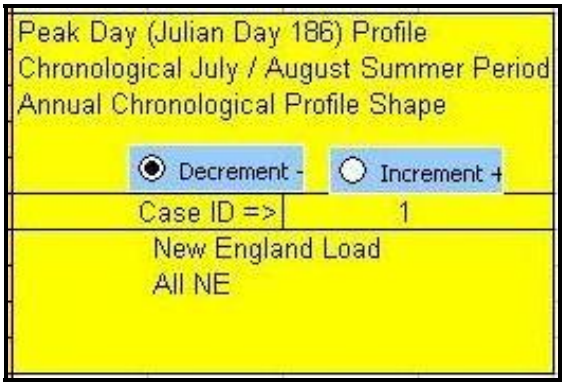


Figure 1-1: Example of the indexing mechanism.

1.3 Spreadsheet Tabs

Once a spreadsheet is opened, a number of tabs for different worksheets can be seen and accessed. These tabs have various data associated with them. The most important tabs for spreadsheet users are as follows:

- The "Read Me" tab provides access to this documentation.
- The "Welcome" tab provides access to the macros that control the data to be selected and displayed.
- The "Selected Data" tab contains the selected data that are displayed on the graphs.

The graphic displays are available under additional (appropriately labeled) tabs for each spreadsheet. Other tabs include the raw, unformatted data that can be manipulated using the user interface. The ISO did not document how to use the data on this and the other additional tabs because the user interface is designed to facilitate viewing of these data.

The templates for viewing and generating new resource cost and revenue data and conceptual electricity rates include the Read Me and Welcome tabs, but not Selected Data tabs.

Section 2
Hourly Load, Intermittent Resource, and "Negawatt" Profiles

2.1 Spreadsheet Name

Load_Shapes_Hour.xls (The size of this spreadsheet is approximately 8 megabytes.)

2.2 Purpose

This spreadsheet can be used to extract and display numerous hourly load or resource profiles that were used in the Scenario Analysis simulations. Each profile consists of 8,760 hourly values representing each hour of the year. The profiles include New England's hourly loads (in megawatts, MW) for all of New England. This spreadsheet also includes various load modifiers to represent intermittent resources, for example, hydro, wind, demand-response (DR), and energy-efficiency (EE) resources, that are not dispatched in the same manner as fully dispatchable generating resources. The values for the later two resources (DR and EE) are considered to be "negawatts," which represent load reduction.

Energy profiles can be extracted for intermittent resources, which represent the profiles used in the modeling for the common assumptions cases. Because an increased amount of scenario technology capacity was assumed for the retirement sensitivity case, this case shows more capacity producing more energy, which thus requires different profiles. Alternatively, separate profiles are needed for the sensitivity cases where energy efficiency and demand response decrease the amount of installed scenario technology capacity, therefore energy production.

The types of hourly data profiles that can be obtained are listed in Table 2-1. Several graphic displays of these data can be generated (see Section 2.5). The underlying data also can be accessed for further manipulation.

Table 2-1
Data Profiles Contained in the Scenario Analysis Spreadsheet

Profile	Common Assumption Profile Available?	With More EE/DR	With Retirements	Other Load Shapes
New England load profile (common to all cases)	Yes			
Hydro imports resource profile	Yes	Yes	Yes	Imports of 23 TWh
Energy efficiency (Scenario #2) "negawatt" profile	Yes	(a)	Yes	Double EE
Demand response (Scenario #2) "negawatt" profile	Yes	(a)	Yes	Double DR
Onshore wind resource profile	Yes	Yes	Yes	
Offshore wind resource profile	Yes	Yes	Yes	
Photovoltaic (PV) resource profile	Yes	Yes	Yes	

(a) Same as common-assumption profile

2.3 Spreadsheet Tabs

For hourly New England loads, hourly energy production from intermittent resources, and load reducing "negawatts," the Welcome tab provides access to the raw hourly data for each profile. The Graph Annual tab contains the graph for the selected profile for the entire year, and the Graph Summer tab contains the graph for the selected profile for the two summer months only. The Graph Peak Day tab contains the graph for the selected profile for the peak day only. The Selected Data tab contains the selected data that are displayed on the graphs.

2.4 Macro Interface

Each hourly profile has an identification number (Case ID; for this spreadsheet, a Load Shape ID). The different profiles can be selected by changing the Case ID value in cell H12 of the Welcome tab. This is shown in Figure 2-1 to the right of the Case ID arrow. By clicking on the Increment or Decrement buttons, the Case ID will increase or decrease appropriately.

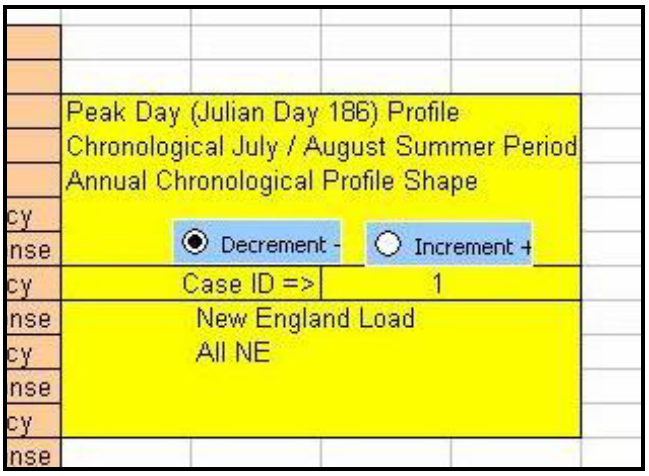


Figure 2-1: Portion of "Welcome" tab showing data-selection options.

Note: Case ID (Load Shape ID) #1 is selected, the "New England Load, All NE."

The Case IDs are listed in column **C** of the Welcome tab, labeled "Load Shape ID." These IDs are shown in Table 2-2 for each profile.

Table 2-2
Load Shape ID for Load and Resource Profiles

Load Shape ID	Load/Scenario/Sensitivity	Technology	Comment
1	New England load	All NE	Common to all cases
2	Hydro imports	Hydro imports	Hourly MW provided
3	Hydro imports with retirements	Hydro imports	Hourly MW provided
4	Hydro imports with EE/DR	Hydro imports	Hourly MW provided
5	Hydro imports with less energy	Hydro imports	Hourly MW provided
6	EE/DR (Scenario #2)	Energy efficiency	"Negawatt" resource profile
7	EE/DR (Scenario #2)	Demand response	"Negawatt" resource profile
8	EE/DR (Scenario #2 with retirements)	Energy efficiency	"Negawatt" resource profile
9	EE/DR (Scenario #2 with retirements)	Demand response	"Negawatt" resource profile
10	Double demand response	Energy efficiency	"Negawatt" resource profile
11	Double efficiency	Demand response	"Negawatt" resource profile
12	Renewables	Onshore Wind	Hourly MW provided
13	Renewables with EE/DR	Onshore Wind	Hourly MW provided
14	Renewables with retirements	Onshore Wind	Hourly MW provided
15	Renewables	Offshore Wind	Hourly MW provided
16	Renewables with EE/DR	Offshore Wind	Hourly MW provided
17	Renewables with retirements	Offshore Wind	Hourly MW provided
18	Renewables	PV	Hourly MW provided
19	Renewables with EE/DR	PV	Hourly MW provided
20	Renewables with retirements	PV	Hourly MW provided

2.5 Sample Graphs

As the user selects each Case ID, the spreadsheet automatically generates three preprogrammed graphs of the data, which can be accessed within other spreadsheet tabs. The following figures show the available types of graphs for this spreadsheet. The first graph, as shown in Figure 2-2, is an annual overview of the hourly load profiles, which is available at the Graph Annual tab. Because of the large amount of data on the graph, only a broad overview of the annual profile can be seen and very little detail can be discerned.

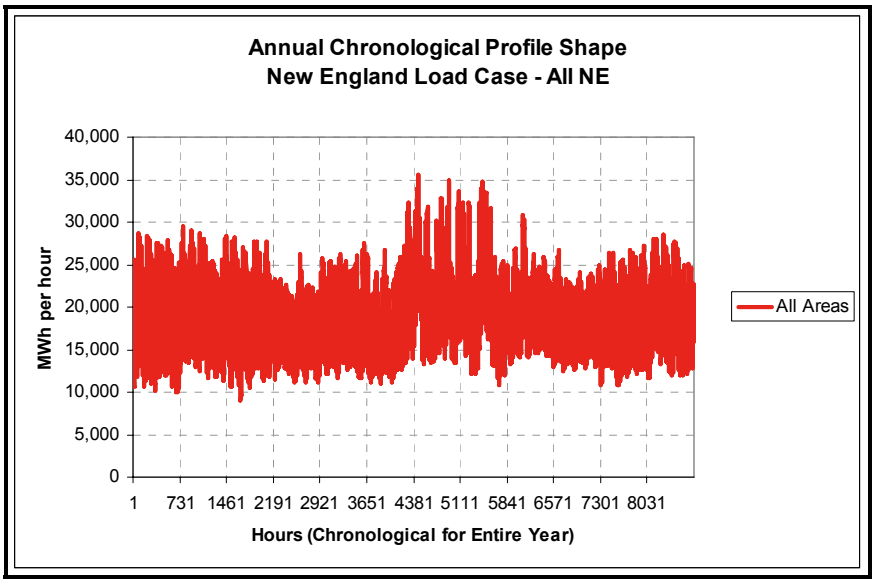


Figure 2-2: Sample chronological graph of hourly loads for entire year.

To compensate for the limitation on visible detail of the annual graph and more clearly depict the daily profiles, a shorter two-month period is used. Figure 2-3 shows the two-month summer-peak load period for July and August to facilitate the examination of a more critical period. This graph is available under the Graph Summer tab.

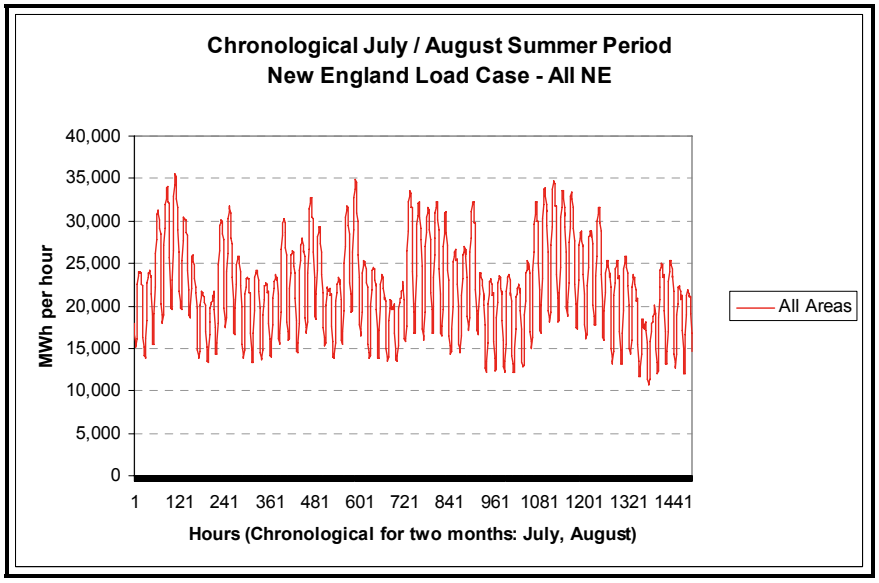


Figure 2-3: Sample chronological graph of hourly loads for the summer months, July and August.

To allow an even more detailed view of the load shape or load-shape modifier on the peak day, a single 24-hour period can be graphed, as shown in Figure 2-4 and available under the Graph Peak Day tab. For this spreadsheet, the peak day has been set to the Julian Day 186, which is the day with the highest peak load in the annual New England load profile used in the Scenario Analysis.

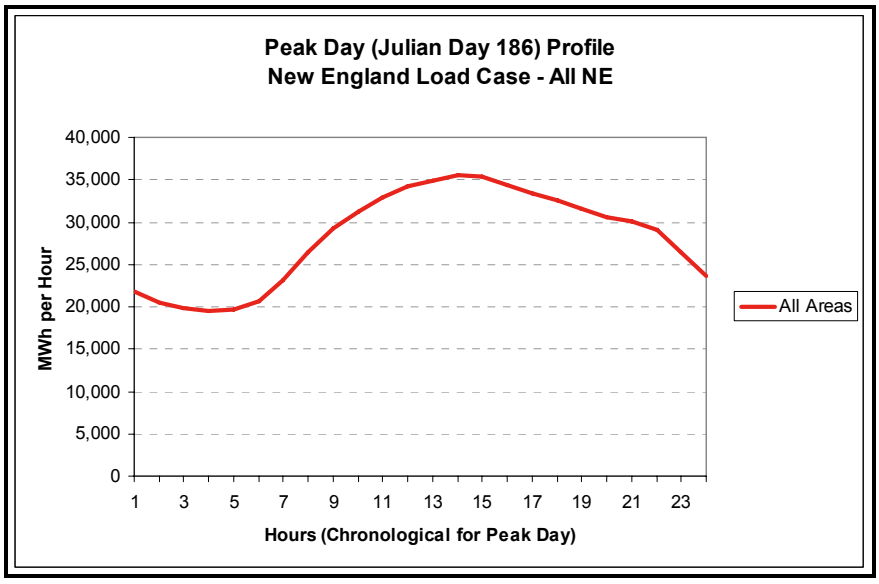
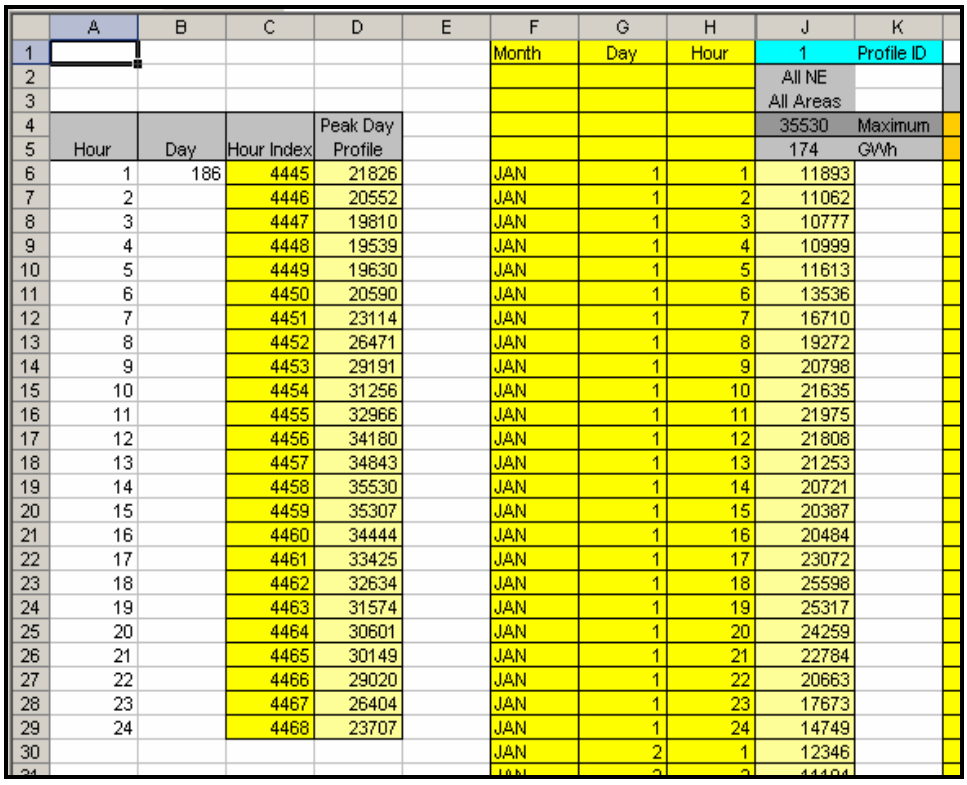


Figure 2-4: Sample chronological graph of hourly loads for the peak day (Julian Day 186).

2.6 Underlying Data

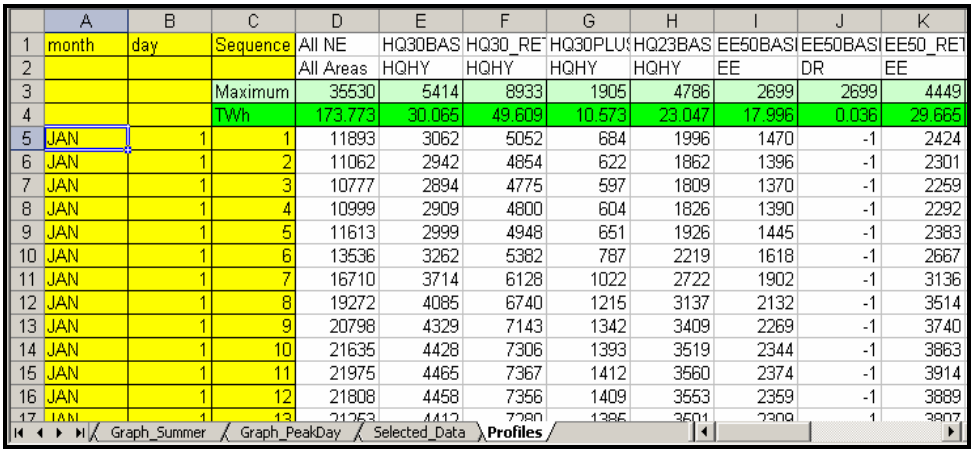
The underlying data for each graph can be viewed within the Selected Data tab. An example of the data within this tab is shown in Figure 2-5. The data in column **D**, "Peak Load Data," are the 24 hourly values for the peak day. The data in column **J**, labeled "All NE, All Areas" for the selected data, are the profiles' hourly values starting on January 1 at 1:00 a.m. and continuing down the column for 8,760 values until reaching the December 31 midnight value. The spreadsheet user can manually copy these data into a different spreadsheet for further analysis.



	A	B	C	D	E	F	G	H	J	K
1						Month	Day	Hour	1	Profile ID
2									All NE	
3									All Areas	
4				Peak Day					35530	Maximum
5	Hour	Day	Hour Index	Profile					174	GWh
6	1	186	4445	21826		JAN	1	1	11893	
7	2		4446	20552		JAN	1	2	11062	
8	3		4447	19810		JAN	1	3	10777	
9	4		4448	19539		JAN	1	4	10999	
10	5		4449	19630		JAN	1	5	11613	
11	6		4450	20590		JAN	1	6	13536	
12	7		4451	23114		JAN	1	7	16710	
13	8		4452	26471		JAN	1	8	19272	
14	9		4453	29191		JAN	1	9	20798	
15	10		4454	31256		JAN	1	10	21635	
16	11		4455	32966		JAN	1	11	21975	
17	12		4456	34180		JAN	1	12	21808	
18	13		4457	34843		JAN	1	13	21253	
19	14		4458	35530		JAN	1	14	20721	
20	15		4459	35307		JAN	1	15	20387	
21	16		4460	34444		JAN	1	16	20484	
22	17		4461	33425		JAN	1	17	23072	
23	18		4462	32634		JAN	1	18	25598	
24	19		4463	31574		JAN	1	19	25317	
25	20		4464	30601		JAN	1	20	24259	
26	21		4465	30149		JAN	1	21	22784	
27	22		4466	29020		JAN	1	22	20663	
28	23		4467	26404		JAN	1	23	17673	
29	24		4468	23707		JAN	1	24	14749	
30						JAN	2	1	12346	

Figure 2-5: "Selected_Data" sample tab—chronological graph of hourly loads for the peak day (Julian Day 186) (MW).

The values shown on the Selected Data tab are extracted from data contained on another worksheet tab, "Profiles." An example of the Profiles tab is shown in Figure 2-6. These data consist of all 8,760 hours values (in rows), and each of the profiles are ordered across the top (in consecutive columns). The ISO did not document how to use the data on this tab because the user interface is designed to facilitate viewing of these data.



	A	B	C	D	E	F	G	H	I	J	K
1	month	day	Sequence	All NE	HQ30BAS	HQ30_RE	HQ30PLU	HQ23BAS	EE50BASI	EE50BASI	EE50_RE
2				All Areas	HQHY	HQHY	HQHY	HQHY	EE	DR	EE
3			Maximum	35530	5414	8933	1905	4786	2699	2699	4449
4			TWh	173.773	30.065	49.609	10.573	23.047	17.996	0.036	29.665
5	JAN	1	1	11893	3062	5052	684	1996	1470	-1	2424
6	JAN	1	2	11062	2942	4854	622	1862	1396	-1	2301
7	JAN	1	3	10777	2894	4775	597	1809	1370	-1	2259
8	JAN	1	4	10999	2909	4800	604	1826	1390	-1	2292
9	JAN	1	5	11613	2999	4948	651	1926	1445	-1	2383
10	JAN	1	6	13536	3262	5382	787	2219	1618	-1	2667
11	JAN	1	7	16710	3714	6128	1022	2722	1902	-1	3136
12	JAN	1	8	19272	4085	6740	1215	3137	2132	-1	3514
13	JAN	1	9	20798	4329	7143	1342	3409	2269	-1	3740
14	JAN	1	10	21635	4428	7306	1393	3519	2344	-1	3863
15	JAN	1	11	21975	4465	7367	1412	3560	2374	-1	3914
16	JAN	1	12	21808	4458	7356	1409	3553	2359	-1	3889
17	JAN	1	13	21253	4412	7280	1386	3501	2309	1	3807

Graph_Summer | Graph_PeakDay | Selected_Data | Profiles

Figure 2-6: Hourly chronological values for the profiles used in the Scenario Analysis (MW).

Section 3
Energy Generated by Fuel Categories

3.1 Spreadsheet Name

FuelHour.xls (The size of this spreadsheet is approximately 66 megabytes.)

3.2 Purpose

This spreadsheet documents the amount of electric energy generated by resources from broad fuel categories across all hours of the year. The data for all of the scenarios and related sensitivities can be selected by specifying the case according to a numerical code shown in Table 3-1. Once the data are displayed, the underlying selected data can be accessed for further manipulation.

Table 3-1
Case ID Used to Select Specific Scenarios and Sensitivity Cases

		A	B	C	D	E	F	G	H	I	J	K
	Scenarios — incremental 8,000 MW All cases have the same 2,600 MW of resources reflecting proposals in the ISO queue as of 9/30/06.	Common Assumptions	Low Gas/Oil Fuel Prices	High Gas/Oil Fuel Prices	Replace 3,500 MW of the Scenario Technology with 1,750 MW of Energy Efficiency (EE) and 1,750 MW of Demand Response (DR)	Replace 2,700 MW of DR with 2,700 MW of EE	Replace 2,700 MW of EE with 2,700 MW of DR	Retire 3,500 MW and Replace with Scenario Technology	Low Carbon–Allowance Prices	High Carbon–Allowance Prices	For Coal with Carbon Sequestration	Decreased Imports of Low–Emission Resources (~7 TWh)
1	**Queue Mix —** combination of currently proposed resources; 5,400 MW blend reflecting the fuel mix exhibited recently by the market	1	15	8	22			29	43	36		
2	**Demand-side resources —** an additional 2,700 MW of DR and 2,700 MW of EE	2	16	9	23	52	51	30	44	37		
3	**Nuclear —** 5,400 MW	3	17	10	24			31	45	38		
4	**Advanced technology coal (IGCC) —** 5,400 MW without carbon sequestration	4	18	11	25			32	46	39	53	
5	**Natural gas (combined cycle) —** 5,400 MW	5	19	12	26			33	47	40		
6	**Renewables —** 5,400 MW, including a combo of on– and offshore wind, hydro, biomass, landfill gas, combined heat and power, fuel cells, photovoltaics; 1/8 each	6	20	13	27			34	48	41		
7	**Increased imports of hydro and other low–emission resources —** 30 TWh of imports	7	21	14	28			35	49	42		50

3.3 Spreadsheet Tabs

For this spreadsheet, the Read Me tab provides access to this documentation. The Welcome tab provides access to the macros that control the data to be extracted on the electric energy generated by various fuels. The Selected Data tab contains the raw data that will be displayed on the graphs identified below (Section 3.5) and accessible from the following tabs:

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- The Graph Duration tab contains the duration curve graph for the annual electric energy production by fuel category.

- The Graph Summer tab contains the graph for the chronological electric energy production by fuel category for July and August.
- The Graph Peak Day tab contains the graph for the electric energy production by fuel category for the peak day only.

3.4 Macro Interface

The user can select different profiles by changing the value in cell H12 of the Welcome tab. This is shown in Figure 3-1 to the right of the Case ID arrow. When the Increment or Decrement button is clicked, the duration curve for the annual electric energy production by fuel category is reset to zero and can be recreated by clicking on the "Create Annual Duration Curve" button, shown at the bottom of the yellow box.

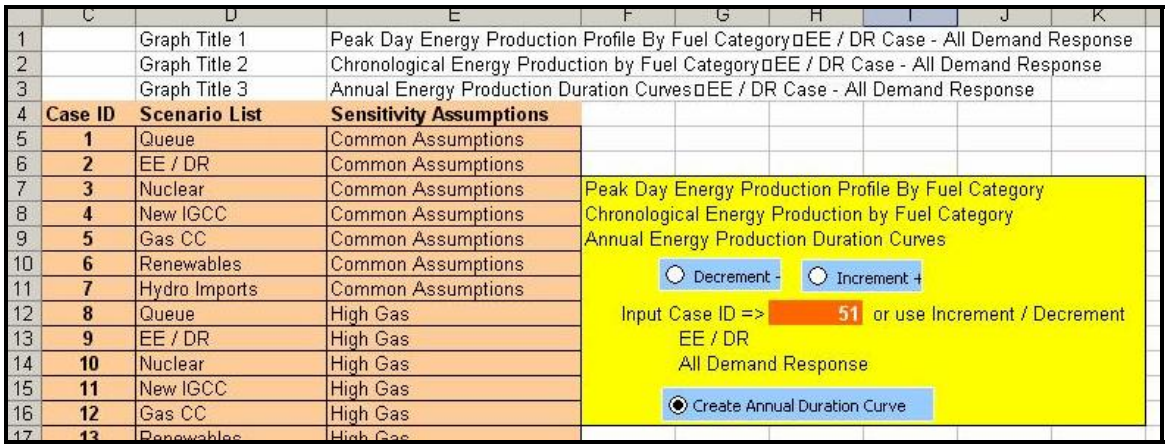


Figure 3-1: Portion of "Welcome" tab showing data-selection options.

3.5 Sample Graphs

The first of the three preprogrammed graphs for this spreadsheet, as shown in Figure 3-2 and available within the Graph Duration tab, is the duration curve for the electric energy produced annually by fuel category.

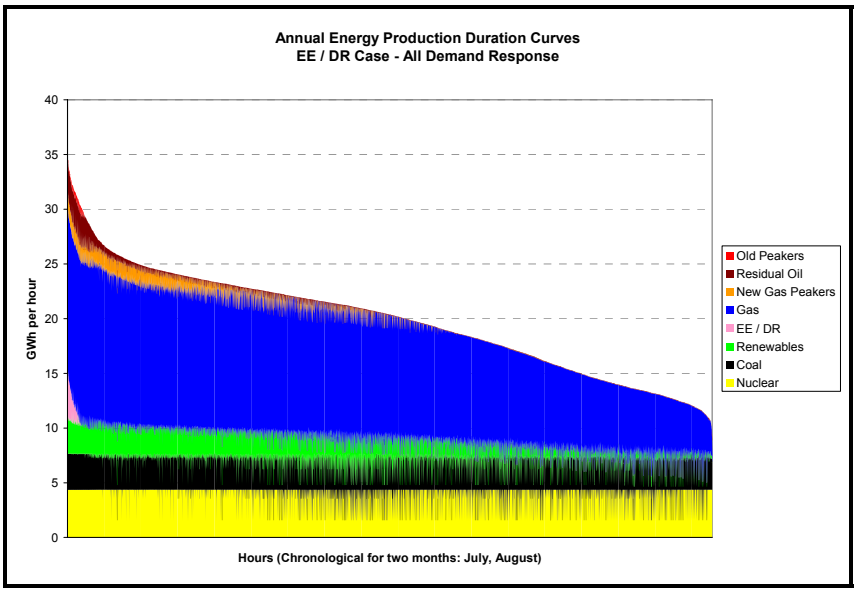


Figure 3-2: Sample duration curve of the electric energy produced by fuel category from hourly simulation results for the entire year.

To investigate the daily profiles, a shorter two-month period is used, which is available at the Graph Summer tab. Figure 3-3 shows the chronological energy production by fuel category for the two-month summer-peak load period for July and August to more easily examine a critical period for each profile.

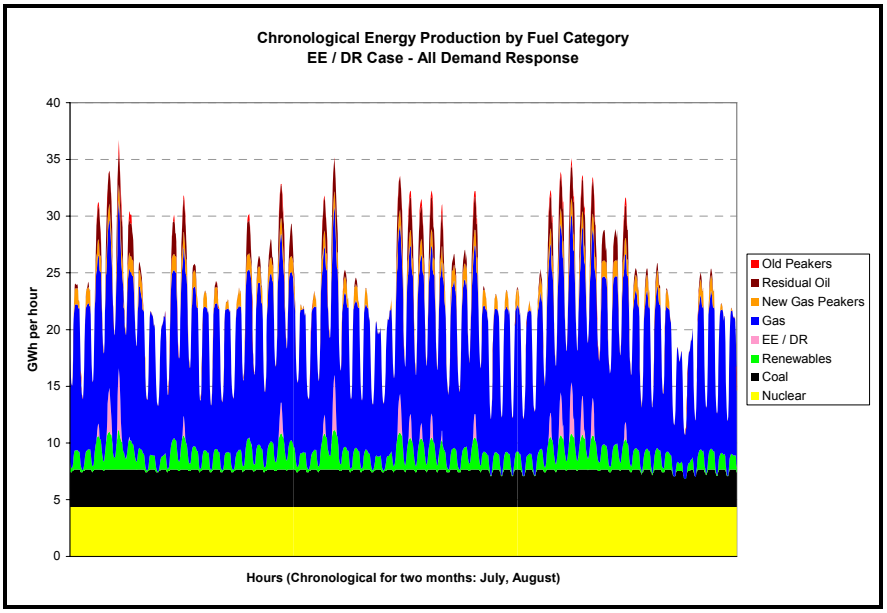


Figure 3-3: Sample chronological graph of hourly loads for the summer months, July and August.

To allow an even more detailed understanding of the electric energy production by fuel category for the peak-load day, a graph focusing on this day can be developed for each profile, as shown in Figure 3-4. This graph is available at the Graph Peak Day tab. For the Scenario Analysis, this day has been set to the Julian Day 186, which is the day with the highest peak load in the annual New England load profile.

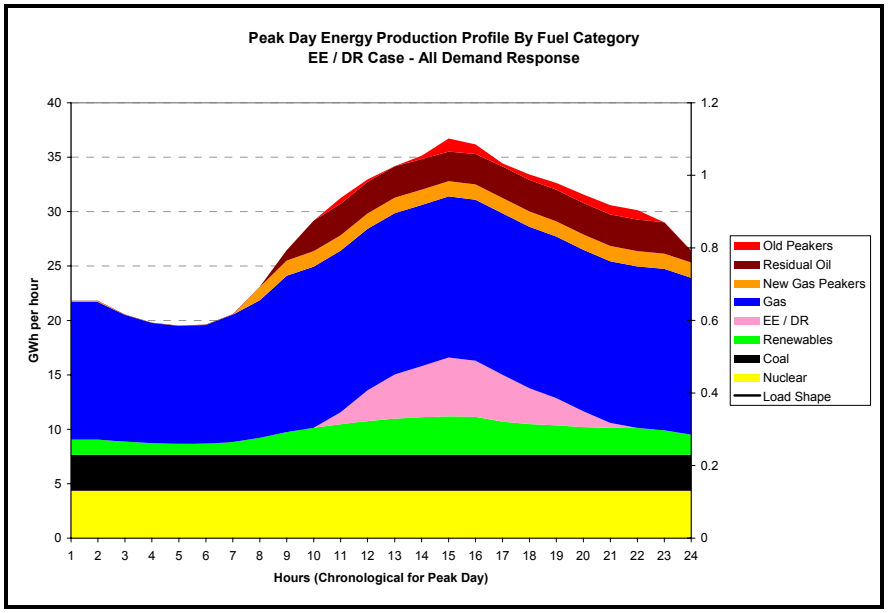
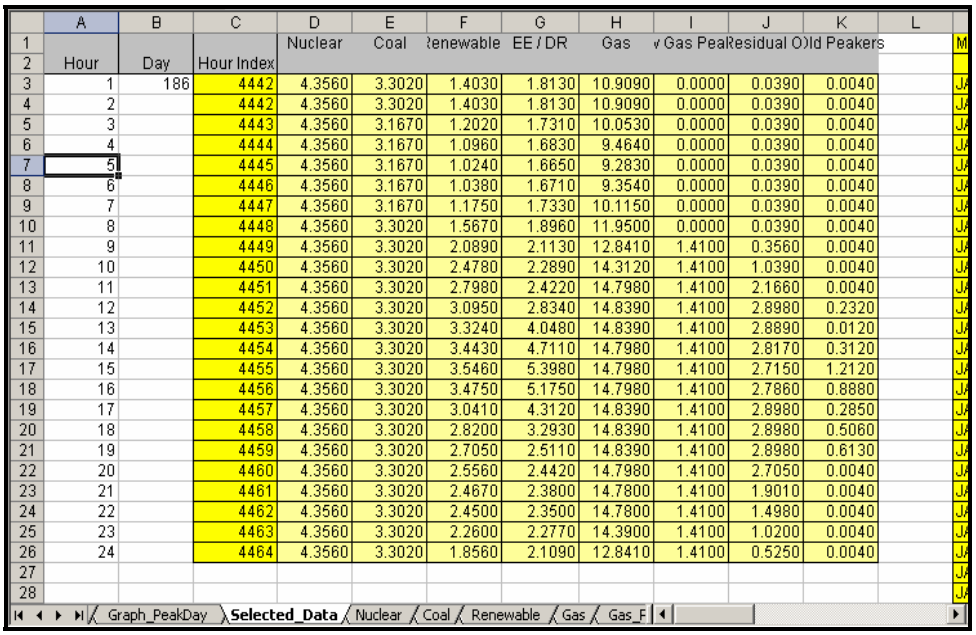


Figure 3-4: Sample chronological graph of hourly loads for the peak day (Julian Day 186).

3.6 Underlying Data

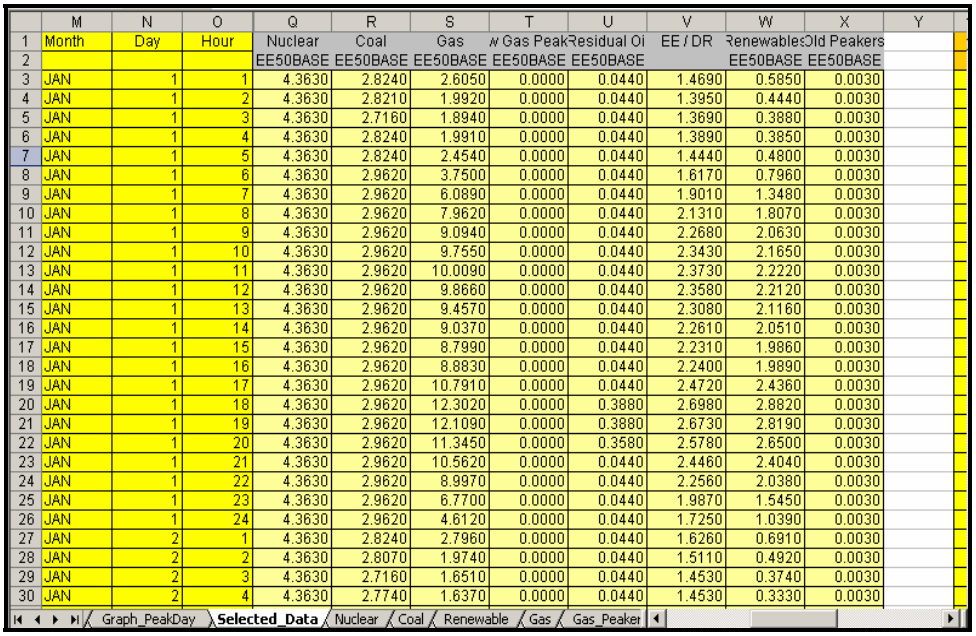
The underlying data for each graph can be seen on the Selected Data tab. Examples of the data within this tab are shown in Figure 3-5 and Figure 3-6. The data in columns **D** through **K** (on Figure 3-5) are the 24 hourly values for the peak day. The data in columns **Q** through **X** (on Figure 3-6) are the hourly values starting on January 1 at 1:00 a.m. and continuing down the columns for 8,760 values until reaching the December 31 midnight value. Spreadsheet users can manually copy these data into a different spreadsheet for further analysis.



	A	B	C	D	E	F	G	H	I	J	K	L
1				Nuclear	Coal	Renewable	EE / DR	Gas	w Gas Pea	Residual O	Old Peakers	
2	Hour	Day	Hour Index									
3	1	186	4442	4.3560	3.3020	1.4030	1.8130	10.9090	0.0000	0.0390	0.0040	
4	2		4442	4.3560	3.3020	1.4030	1.8130	10.9090	0.0000	0.0390	0.0040	
5	3		4443	4.3560	3.1670	1.2020	1.7310	10.0530	0.0000	0.0390	0.0040	
6	4		4444	4.3560	3.1670	1.0960	1.6830	9.4640	0.0000	0.0390	0.0040	
7	5		4445	4.3560	3.1670	1.0240	1.6650	9.2830	0.0000	0.0390	0.0040	
8	6		4446	4.3560	3.1670	1.0380	1.6710	9.3540	0.0000	0.0390	0.0040	
9	7		4447	4.3560	3.1670	1.1750	1.7330	10.1150	0.0000	0.0390	0.0040	
10	8		4448	4.3560	3.3020	1.5670	1.8960	11.9500	0.0000	0.0390	0.0040	
11	9		4449	4.3560	3.3020	2.0890	2.1130	12.8410	1.4100	0.3560	0.0040	
12	10		4450	4.3560	3.3020	2.4780	2.2890	14.3120	1.4100	1.0390	0.0040	
13	11		4451	4.3560	3.3020	2.7980	2.4220	14.7980	1.4100	2.1660	0.0040	
14	12		4452	4.3560	3.3020	3.0950	2.8340	14.8390	1.4100	2.8980	0.2320	
15	13		4453	4.3560	3.3020	3.3240	4.0480	14.8390	1.4100	2.8890	0.0120	
16	14		4454	4.3560	3.3020	3.4430	4.7110	14.7980	1.4100	2.8170	0.3120	
17	15		4455	4.3560	3.3020	3.5460	5.3980	14.7980	1.4100	2.7150	1.2120	
18	16		4456	4.3560	3.3020	3.4750	5.1750	14.7980	1.4100	2.7860	0.8880	
19	17		4457	4.3560	3.3020	3.0410	4.3120	14.8390	1.4100	2.8980	0.2850	
20	18		4458	4.3560	3.3020	2.8200	3.2930	14.8390	1.4100	2.8980	0.5060	
21	19		4459	4.3560	3.3020	2.7050	2.5110	14.8390	1.4100	2.8980	0.6130	
22	20		4460	4.3560	3.3020	2.5560	2.4420	14.7980	1.4100	2.7050	0.0040	
23	21		4461	4.3560	3.3020	2.4670	2.3800	14.7800	1.4100	1.9010	0.0040	
24	22		4462	4.3560	3.3020	2.4500	2.3500	14.7800	1.4100	1.4980	0.0040	
25	23		4463	4.3560	3.3020	2.2600	2.2770	14.3900	1.4100	1.0200	0.0040	
26	24		4464	4.3560	3.3020	1.8560	2.1090	12.8410	1.4100	0.5250	0.0040	
27												
28												

Graph_PeakDay | Selected_Data | Nuclear | Coal | Renewable | Gas | Gas_F

Figure 3-5: "Selected Data" tab showing hourly electric energy production by fuel category for the peak day (GWh per hour).



	M	N	O	Q	R	S	T	U	V	W	X	Y
1	Month	Day	Hour	Nuclear	Coal	Gas	w Gas Peak	Residual Oi	EE / DR	Renewables	Old Peakers	
2				EE50BASE	EE50BASE	EE50BASE	EE50BASE	EE50BASE		EE50BASE	EE50BASE	
3	JAN	1	1	4.3630	2.8240	2.6050	0.0000	0.0440	1.4690	0.5850	0.0030	
4	JAN	1	2	4.3630	2.8210	1.9920	0.0000	0.0440	1.3950	0.4440	0.0030	
5	JAN	1	3	4.3630	2.7160	1.8940	0.0000	0.0440	1.3690	0.3880	0.0030	
6	JAN	1	4	4.3630	2.8240	1.9910	0.0000	0.0440	1.3890	0.3850	0.0030	
7	JAN	1	5	4.3630	2.8240	2.4540	0.0000	0.0440	1.4440	0.4800	0.0030	
8	JAN	1	6	4.3630	2.9620	3.7500	0.0000	0.0440	1.6170	0.7960	0.0030	
9	JAN	1	7	4.3630	2.9620	6.0890	0.0000	0.0440	1.9010	1.3480	0.0030	
10	JAN	1	8	4.3630	2.9620	7.9620	0.0000	0.0440	2.1310	1.8070	0.0030	
11	JAN	1	9	4.3630	2.9620	9.0940	0.0000	0.0440	2.2680	2.0630	0.0030	
12	JAN	1	10	4.3630	2.9620	9.7550	0.0000	0.0440	2.3430	2.1650	0.0030	
13	JAN	1	11	4.3630	2.9620	10.0090	0.0000	0.0440	2.3730	2.2220	0.0030	
14	JAN	1	12	4.3630	2.9620	9.8660	0.0000	0.0440	2.3580	2.2120	0.0030	
15	JAN	1	13	4.3630	2.9620	9.4570	0.0000	0.0440	2.3080	2.1160	0.0030	
16	JAN	1	14	4.3630	2.9620	9.0370	0.0000	0.0440	2.2610	2.0510	0.0030	
17	JAN	1	15	4.3630	2.9620	8.7990	0.0000	0.0440	2.2310	1.9860	0.0030	
18	JAN	1	16	4.3630	2.9620	8.8830	0.0000	0.0440	2.2400	1.9890	0.0030	
19	JAN	1	17	4.3630	2.9620	10.7910	0.0000	0.0440	2.4720	2.4360	0.0030	
20	JAN	1	18	4.3630	2.9620	12.3020	0.0000	0.3880	2.6980	2.8820	0.0030	
21	JAN	1	19	4.3630	2.9620	12.1090	0.0000	0.3880	2.6730	2.8190	0.0030	
22	JAN	1	20	4.3630	2.9620	11.3450	0.0000	0.3580	2.5780	2.6500	0.0030	
23	JAN	1	21	4.3630	2.9620	10.5620	0.0000	0.0440	2.4460	2.4040	0.0030	
24	JAN	1	22	4.3630	2.9620	8.9970	0.0000	0.0440	2.2560	2.0380	0.0030	
25	JAN	1	23	4.3630	2.9620	6.7700	0.0000	0.0440	1.9870	1.5450	0.0030	
26	JAN	1	24	4.3630	2.9620	4.6120	0.0000	0.0440	1.7250	1.0390	0.0030	
27	JAN	2	1	4.3630	2.8240	2.7960	0.0000	0.0440	1.6260	0.6910	0.0030	
28	JAN	2	2	4.3630	2.8070	1.9740	0.0000	0.0440	1.5110	0.4920	0.0030	
29	JAN	2	3	4.3630	2.7160	1.6510	0.0000	0.0440	1.4530	0.3740	0.0030	
30	JAN	2	4	4.3630	2.7740	1.6370	0.0000	0.0440	1.4530	0.3330	0.0030	

Graph_PeakDay | Selected_Data | Nuclear | Coal | Renewable | Gas | Gas_Peaker

Figure 3-6: "Selected Data" tab showing hourly electric energy produced by fuel category for the entire year (GWh per hour).

The values shown on in these tables are extracted from data contained on other worksheet tabs for each of the following fuel categories:

- Nuclear (GWh)
- Coal (GWh)

- Gas (without the 'new' peakers) (GWh)
- Gas (only the 'new' peakers) (GWh)
- Residual oil (GWh)
- Energy efficiency and demand response (MW)
- Renewables (GWh)
- Distillate oil (GWh)

An example of the Renewables tab is shown in Figure 3-7. Theses data consist of all 8,760 hourly values (in rows), and each of the scenario and sensitivities are ordered across the top (in consecutive columns). The ISO did not document how to use the data on this and the other additional tabs because the user interface is designed to facilitate viewing of this data.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	month	day	Sequence	QUE_BAS	EE50BAS	NUKEBAS	IGCCBAS	NECCBAS	RENWBAS	HQ30BAS	QUE_FUH	EE50FUH	NUKEFUH	IGCCFUH	NE
2	JAN	1	1	1.527	2.054	0.539	0.583	0.583	4.629	3.646	1.527	2.054	0.539	0.583	
3	JAN	1	2	1.382	1.839	0.323	0.398	0.442	4.467	3.385	1.382	1.839	0.323	0.398	
4	JAN	1	3	1.316	1.757	0.267	0.327	0.386	4.359	3.281	1.316	1.757	0.217	0.291	
5	JAN	1	4	1.296	1.774	0.264	0.339	0.383	4.291	3.293	1.296	1.774	0.264	0.339	
6	JAN	1	5	1.364	1.924	0.434	0.436	0.478	4.281	3.478	1.364	1.924	0.434	0.478	
7	JAN	1	6	1.668	2.413	0.794	0.794	0.794	4.657	4.057	1.668	2.413	0.794	0.794	
8	JAN	1	7	2.213	3.249	1.346	1.346	1.346	5.249	5.061	2.213	3.249	1.346	1.346	
9	JAN	1	8	2.699	3.938	1.805	1.805	1.805	5.934	5.891	2.699	3.938	1.805	1.805	
10	JAN	1	9	2.954	4.331	2.061	2.061	2.061	6.460	6.391	2.954	4.331	2.061	2.061	
11	JAN	1	10	3.002	4.508	2.163	2.163	2.163	6.530	6.592	3.002	4.508	2.163	2.163	
12	JAN	1	11	3.044	4.595	2.220	2.220	2.220	6.633	6.686	3.044	4.595	2.220	2.220	
13	JAN	1	12	3.047	4.570	2.210	2.210	2.210	6.742	6.669	3.047	4.570	2.210	2.210	
14	JAN	1	13	2.924	4.424	2.114	2.114	2.114	6.518	6.527	2.924	4.424	2.114	2.114	
15	JAN	1	14	2.853	4.312	2.049	2.049	2.049	6.350	6.418	2.853	4.312	2.049	2.049	
16	JAN	1	15	2.791	4.217	1.984	1.984	1.984	6.165	6.333	2.791	4.217	1.984	1.984	
17	JAN	1	16	2.799	4.229	1.987	1.987	1.987	5.996	6.352	2.799	4.229	1.987	1.987	
18	JAN	1	17	3.243	4.908	2.434	2.434	2.434	6.236	7.145	3.243	4.908	2.434	2.434	
19	JAN	1	18	3.729	5.580	2.880	2.880	2.880	6.832	7.888	3.729	5.580	2.880	2.880	
20	JAN	1	19	3.655	5.492	2.817	2.817	2.817	6.720	7.739	3.655	5.492	2.817	2.817	
21	JAN	1	20	3.502	5.228	2.648	2.648	2.648	6.598	7.430	3.502	5.228	2.648	2.648	

Graph_PeakDay | Selected_Data | Nuclear | Coal | **Renewable** | Gas | Gas_Peakers | Residual | Dis

Figure 3-7: Hourly data values for aggregate renewables for all scenarios and sensitivity cases (GWh per hour).

Section 4
NO_X Produced by Fuel Categories

4.1 Spreadsheet Name

NO_XFuelHour.xls (The size of this spreadsheet is approximately 50 Megabytes)

4.2 Purpose

This spreadsheet documents the amount of electric energy generated by resources from broad fuel categories across all hours of the year. The data for all of the scenarios and related sensitivities can be selected by specifying the case according to a numerical code from Table 4-1. Once the data are displayed, the underlying selected data can be accessed for further manipulation.

Table 4-1
Case ID Numbers Used to Select Specific Scenario and Sensitivity Cases

		A	B	C	D	E	F	G	H	I	J	K
	Scenarios — incremental 8,000 MW All cases have the same 2,600 MW of resources reflecting proposals in the ISO queue as of 9/30/06.	Common Assumptions	Low Gas/Oil Fuel Prices	High Gas/Oil Fuel Prices	Replace 3,500 MW of the Scenario Technology with 1,750 MW of Energy Efficiency (EE) and 1,750 MW of Demand Response (DR)	Replace 2,700 MW of DR with 2,700 MW of EE	Replace 2,700 MW of EE with 2,700 MW of DR	Retire 3,500 MW and Replace with Scenario Technology	Low Carbon-Allowance Prices	High Carbon-Allowance Prices	For Coal with Carbon Sequestration	Decreased Imports of Low-Emission Resources (-7 TWh)
1	**Queue Mix —** combination of currently proposed resources; 5,400 MW blend reflecting the fuel mix exhibited recently by the market	1	15	8	22			29	43	36		
2	**Demand-side resources —** an additional 2,700 MW of DR and 2,700 MW of EE	2	16	9	23	52	51	30	44	37		
3	**Nuclear —** 5,400 MW	3	17	10	24			31	45	38		
4	**Advanced technology coal (IGCC) —** 5,400 MW without carbon sequestration	4	18	11	25			32	46	39	53	
5	**Natural gas (combined cycle) —** 5,400 MW	5	19	12	26			33	47	40		
6	**Renewables —** 5,400 MW, including a combo of on- and offshore wind, hydro, biomass, landfill gas, combined heat and power, fuel cells, photovoltaics; 1/8 each	6	20	13	27			34	48	41		
7	**Increased imports of hydro and other low-emission resources —** 30 TWh of imports	7	21	14	28			35	49	42		50

4.3 Spreadsheet Tabs

Once the spreadsheet is opened, a number of tabs associated with various data can be seen. The most important tabs are identified below:

- The Read Me tab provides access to this documentation.
- The Welcome tab provides access to the macros that control the data to be selected and displayed.
- The Selected Data tab contains the data that has been selected to be displayed on the graphs.

- The Graph Duration tab contains the graph for the annual NO_X emissions by fuel category duration curve.
- The Graph Summer tab contains the graph for the chronological NO_X emissions by fuel category for the two summer months of July and August.
- The Graph Peak Day tab contains the graph for the NO_X emissions by fuel category for the peak day only.

The other tabs include the raw, unformatted data that will be extracted using the user interface. The ISO did not document how to use the data on this and the other additional tabs because the user interface is designed to facilitate viewing of these data.

4.4 Macro Interface

Different profiles can be selected by changing the value in cell H12 of the Welcome tab. This is shown in Figure 4-1 to the right of the Case ID arrow. By clicking on the Increment or Decrement buttons, the Case ID will increase or decrease appropriately. When the Increment or Decrement button is clicked, the duration curve for the annual NOx emissions production by fuel category is reset to zero and can be recreated by clicking on the Create Annual Duration Curve button shown at the bottom of the yellow box in the figure.

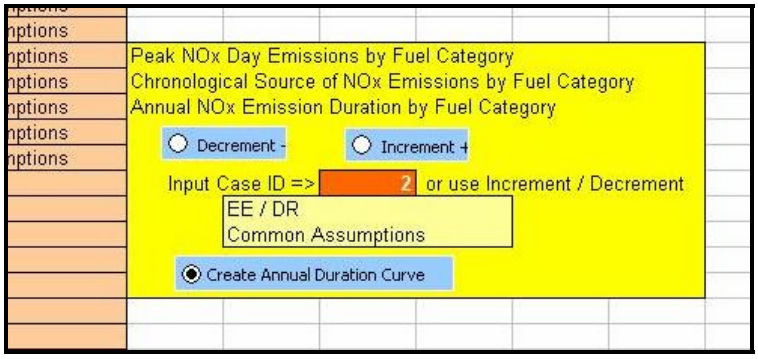


Figure 4-1: Portion of "Welcome" tab showing data-selection options.

4.5 Sample Graphs

Three preprogrammed formats for presenting these data are shown on the following graphs. The first graph, as shown in Figure 4-2, is the annual duration curve for the NO_X emissions produced by fuel category.

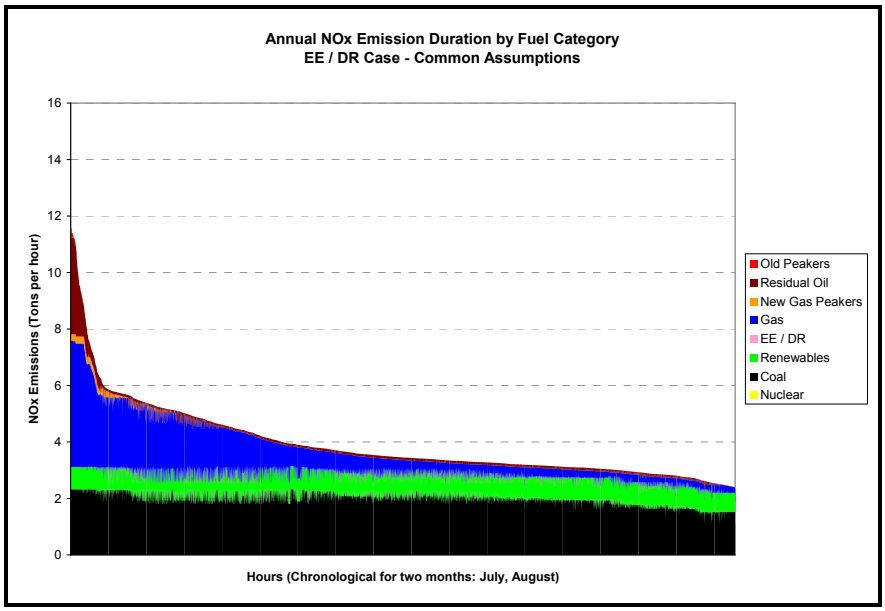


Figure 4-2: Sample duration curve for NO_X emissions produced by fuel category from hourly simulation results for the entire year.

Because an annual duration curve does not provide any chronological information, a two month period was selected to depict the daily cycles. Figure 4-3 shows the chronological NO_X emissions by fuel category for the two-month summer-peak load period for July and August.

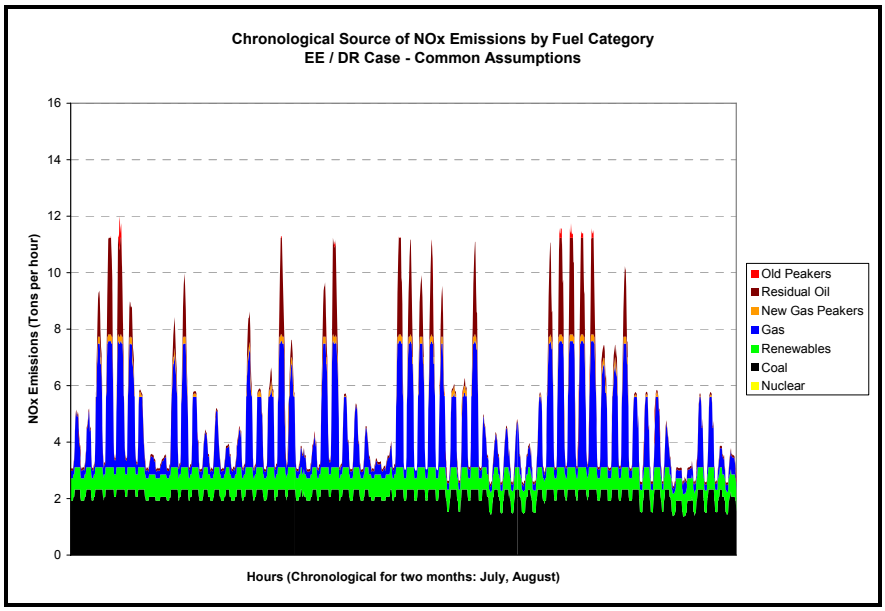


Figure 4-3: Sample chronological graph of hourly NO_X emissions produced during the summer months, July and August.

To allow an even more detailed understanding of the NO_X emission production by fuel category for the peak-load day, a graph focusing on this day can be developed (see Figure 4-4). For this

spreadsheet, the peak day has been automatically determined and the appropriate data selected. For the Scenario Analysis, this day is Julian Day 186.

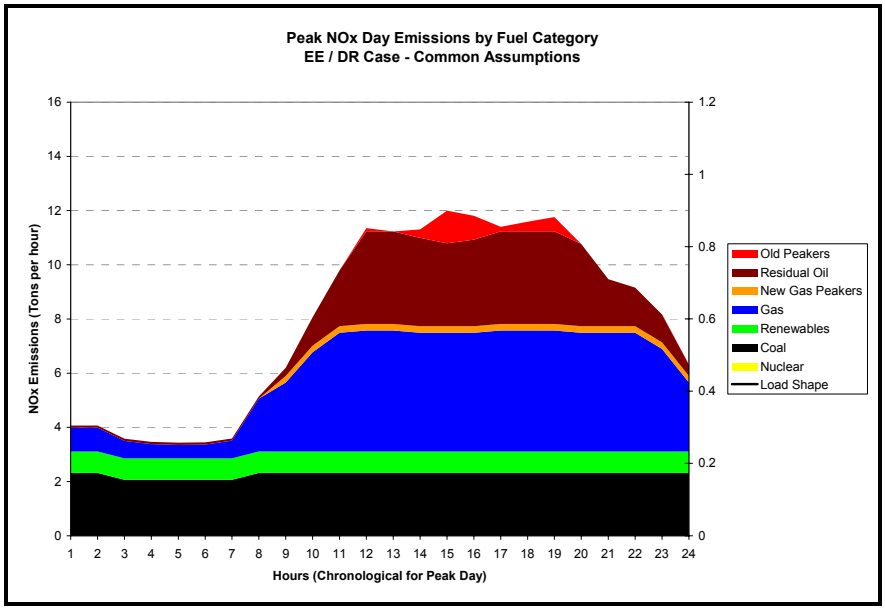
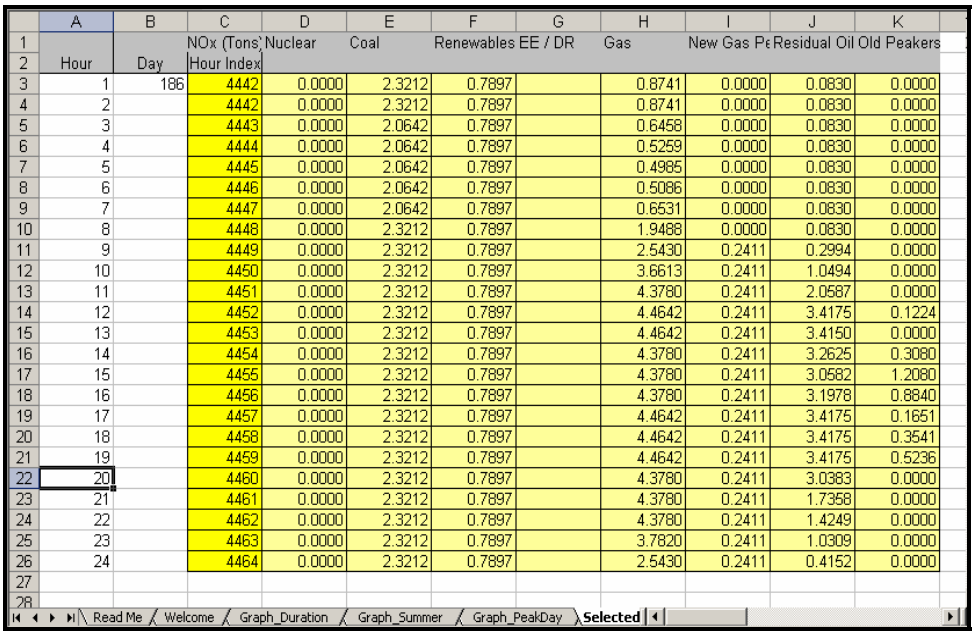


Figure 4-4: Sample chronological graph of NO_X emissions produced on the peak day (Julian Day 186).

4.6 Selected Data

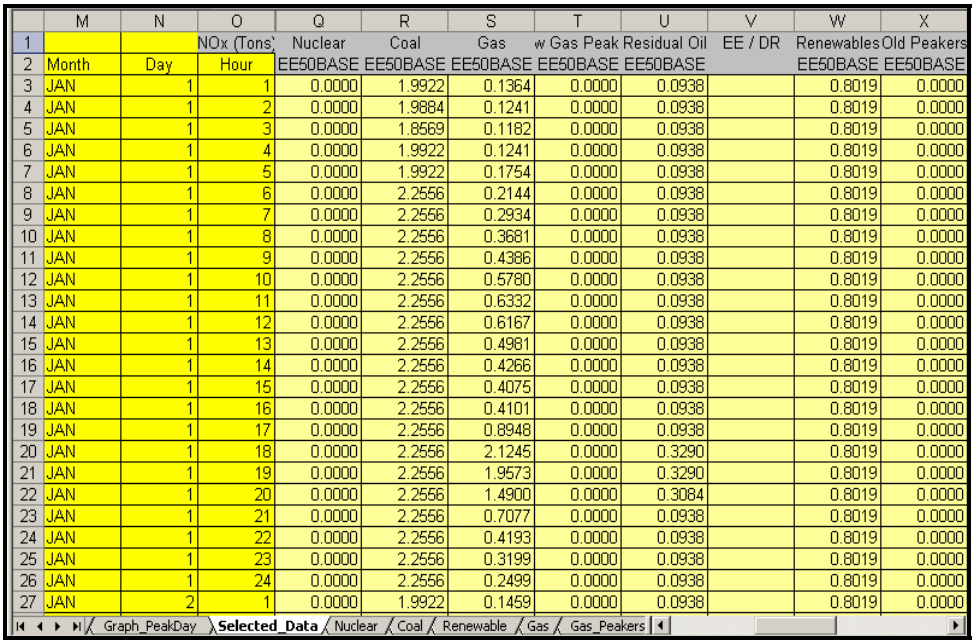
The selected data for each graph can be seen on the Selected Data tab. Examples of the data within this tab are shown in Figure 4-5 and Figure 4-6. The data in columns **D** through **K** are the 24 hourly values for the peak day. The data in columns **Q** through **X** are the hourly values starting on January 1 at 1:00 a.m. and continuing down the columns for 8,760 values until reaching the December 31 midnight value. Figure 4-7 shows the data sorted in descending order by the sum of the hourly NO_X emissions. This is the source of the data used in the annual duration graphs. Spreadsheet users can manually copy these data into a different spreadsheet for further analysis.



	A	B	C	D	E	F	G	H	I	J	K
1			NOx (Tons/	Nuclear	Coal	Renewables	EE / DR	Gas	New Gas Pe	Residual Oil	Old Peakers
2	Hour	Day	Hour Index								
3	1	186	4442	0.0000	2.3212	0.7897		0.8741	0.0000	0.0830	0.0000
4	2		4442	0.0000	2.3212	0.7897		0.8741	0.0000	0.0830	0.0000
5	3		4443	0.0000	2.0642	0.7897		0.6458	0.0000	0.0830	0.0000
6	4		4444	0.0000	2.0642	0.7897		0.5259	0.0000	0.0830	0.0000
7	5		4445	0.0000	2.0642	0.7897		0.4985	0.0000	0.0830	0.0000
8	6		4446	0.0000	2.0642	0.7897		0.5086	0.0000	0.0830	0.0000
9	7		4447	0.0000	2.0642	0.7897		0.6531	0.0000	0.0830	0.0000
10	8		4448	0.0000	2.3212	0.7897		1.9488	0.0000	0.0830	0.0000
11	9		4449	0.0000	2.3212	0.7897		2.5430	0.2411	0.2994	0.0000
12	10		4450	0.0000	2.3212	0.7897		3.6613	0.2411	1.0494	0.0000
13	11		4451	0.0000	2.3212	0.7897		4.3780	0.2411	2.0587	0.0000
14	12		4452	0.0000	2.3212	0.7897		4.4642	0.2411	3.4175	0.1224
15	13		4453	0.0000	2.3212	0.7897		4.4642	0.2411	3.4150	0.0000
16	14		4454	0.0000	2.3212	0.7897		4.3780	0.2411	3.2625	0.3080
17	15		4455	0.0000	2.3212	0.7897		4.3780	0.2411	3.0582	1.2080
18	16		4456	0.0000	2.3212	0.7897		4.3780	0.2411	3.1978	0.8840
19	17		4457	0.0000	2.3212	0.7897		4.4642	0.2411	3.4175	0.1651
20	18		4458	0.0000	2.3212	0.7897		4.4642	0.2411	3.4175	0.3541
21	19		4459	0.0000	2.3212	0.7897		4.4642	0.2411	3.4175	0.5236
22	20		4460	0.0000	2.3212	0.7897		4.3780	0.2411	3.0383	0.0000
23	21		4461	0.0000	2.3212	0.7897		4.3780	0.2411	1.7358	0.0000
24	22		4462	0.0000	2.3212	0.7897		4.3780	0.2411	1.4249	0.0000
25	23		4463	0.0000	2.3212	0.7897		3.7820	0.2411	1.0309	0.0000
26	24		4464	0.0000	2.3212	0.7897		2.5430	0.2411	0.4152	0.0000
27											
28											

Read Me | Welcome | Graph_Duration | Graph_Summer | Graph_PeakDay | **Selected**

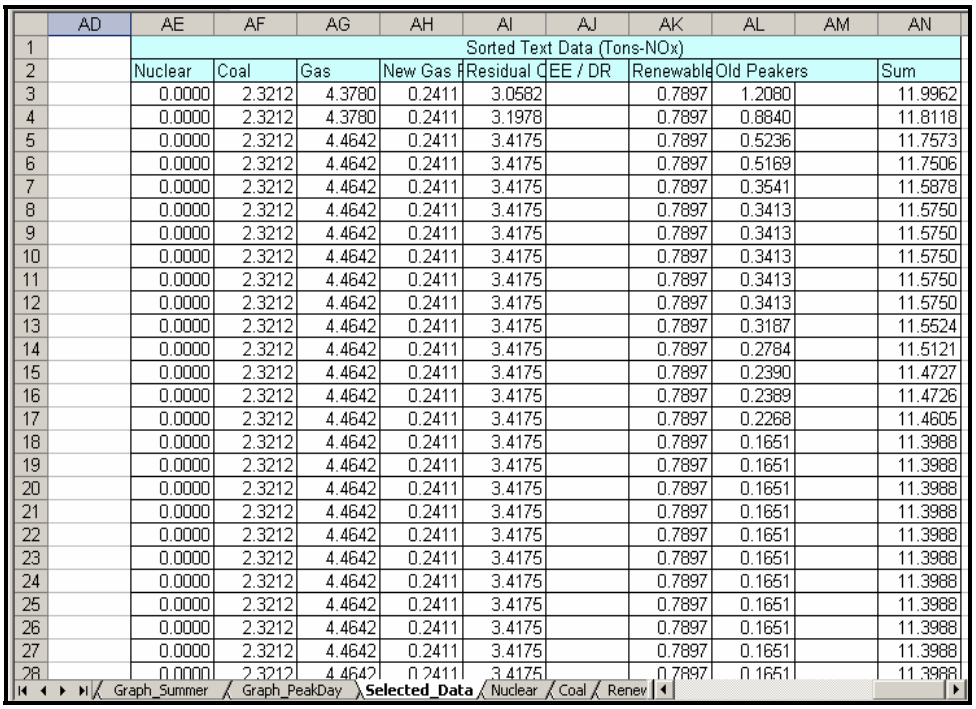
Figure 4-5: "Selected Data" tab showing hourly NO_X emissions produced by fuel category for the peak day (tons per hour).



	M	N	O	Q	R	S	T	U	V	W	X
1			NOx (Tons/	Nuclear	Coal	Gas	w Gas Peak	Residual Oil	EE / DR	Renewables	Old Peakers
2	Month	Day	Hour	EE50BASE	EE50BASE	EE50BASE	EE50BASE	EE50BASE		EE50BASE	EE50BASE
3	JAN	1	1	0.0000	1.9922	0.1364	0.0000	0.0938		0.8019	0.0000
4	JAN	1	2	0.0000	1.9884	0.1241	0.0000	0.0938		0.8019	0.0000
5	JAN	1	3	0.0000	1.8569	0.1182	0.0000	0.0938		0.8019	0.0000
6	JAN	1	4	0.0000	1.9922	0.1241	0.0000	0.0938		0.8019	0.0000
7	JAN	1	5	0.0000	1.9922	0.1754	0.0000	0.0938		0.8019	0.0000
8	JAN	1	6	0.0000	2.2556	0.2144	0.0000	0.0938		0.8019	0.0000
9	JAN	1	7	0.0000	2.2556	0.2934	0.0000	0.0938		0.8019	0.0000
10	JAN	1	8	0.0000	2.2556	0.3681	0.0000	0.0938		0.8019	0.0000
11	JAN	1	9	0.0000	2.2556	0.4386	0.0000	0.0938		0.8019	0.0000
12	JAN	1	10	0.0000	2.2556	0.5780	0.0000	0.0938		0.8019	0.0000
13	JAN	1	11	0.0000	2.2556	0.6332	0.0000	0.0938		0.8019	0.0000
14	JAN	1	12	0.0000	2.2556	0.6167	0.0000	0.0938		0.8019	0.0000
15	JAN	1	13	0.0000	2.2556	0.4981	0.0000	0.0938		0.8019	0.0000
16	JAN	1	14	0.0000	2.2556	0.4266	0.0000	0.0938		0.8019	0.0000
17	JAN	1	15	0.0000	2.2556	0.4075	0.0000	0.0938		0.8019	0.0000
18	JAN	1	16	0.0000	2.2556	0.4101	0.0000	0.0938		0.8019	0.0000
19	JAN	1	17	0.0000	2.2556	0.8948	0.0000	0.0938		0.8019	0.0000
20	JAN	1	18	0.0000	2.2556	2.1245	0.0000	0.3290		0.8019	0.0000
21	JAN	1	19	0.0000	2.2556	1.9573	0.0000	0.3290		0.8019	0.0000
22	JAN	1	20	0.0000	2.2556	1.4900	0.0000	0.3084		0.8019	0.0000
23	JAN	1	21	0.0000	2.2556	0.7077	0.0000	0.0938		0.8019	0.0000
24	JAN	1	22	0.0000	2.2556	0.4193	0.0000	0.0938		0.8019	0.0000
25	JAN	1	23	0.0000	2.2556	0.3199	0.0000	0.0938		0.8019	0.0000
26	JAN	1	24	0.0000	2.2556	0.2499	0.0000	0.0938		0.8019	0.0000
27	JAN	2	1	0.0000	1.9922	0.1459	0.0000	0.0938		0.8019	0.0000

Graph_PeakDay | **Selected_Data** | Nuclear | Coal | Renewable | Gas | Gas_Peakers

Figure 4-6: "Selected Data" tab showing hourly NO_X emissions produced by each fuel category for the entire year (tons per hour).



	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
1		Sorted Text Data (Tons-NOx)									
2		Nuclear	Coal	Gas	New Gas P	Residual C	EE / DR	Renewable	Old Peakers		Sum
3		0.0000	2.3212	4.3780	0.2411	3.0582		0.7897	1.2080		11.9962
4		0.0000	2.3212	4.3780	0.2411	3.1978		0.7897	0.8840		11.8118
5		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.5236		11.7573
6		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.5169		11.7506
7		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.3541		11.5878
8		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.3413		11.5750
9		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.3413		11.5750
10		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.3413		11.5750
11		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.3413		11.5750
12		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.3413		11.5750
13		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.3187		11.5524
14		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.2784		11.5121
15		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.2390		11.4727
16		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.2389		11.4726
17		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.2268		11.4605
18		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.1651		11.3988
19		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.1651		11.3988
20		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.1651		11.3988
21		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.1651		11.3988
22		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.1651		11.3988
23		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.1651		11.3988
24		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.1651		11.3988
25		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.1651		11.3988
26		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.1651		11.3988
27		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.1651		11.3988
28		0.0000	2.3212	4.4642	0.2411	3.4175		0.7897	0.1651		11.3988

Figure 4-7: "Selected Data" tab showing sorted hourly NO_X emissions produced by each fuel category for the entire year (tons per hour).

4.7 Underlying Data

The values shown on in these tables are extracted from data contained on other worksheet tabs for each of the fuel categories:

- Nuclear (tons)
- Coal (tons)
- Gas (without the 'new' peakers) (tons)
- Gas (only the 'new' peakers) (tons)
- Residual oil (tons)
- Energy efficiency/demand response (Since EE and DR do not emit NO_X, there is no tab for EE/DR.)
- Renewables (tons)
- Distillate oil (tons)

An example of the Renewables tab is shown in Figure 4-8. These data consist of all 8,760 hourly values (in rows), and each of the scenario and sensitivities are ordered across the top (in consecutive columns). The ISO did not document how to use the data on this and the other additional tabs because the user interface is designed to facilitate viewing of these data.

	A	B	C	D	E	F	G	H	I	J	K	L
1	month	day	Sequence	QUE_BAS	EE50BAS	NUKEBAS	IGCCBAS	NECCBAS	RENWBAS	HQ30BAS	QUE_FUH	EE50
2	JAN	1	1	0.8651	0.8019	0.6911	0.8019	0.8019	0.9438	0.8019	0.8651	0.8
3	JAN	1	2	0.8651	0.8019	0.6248	0.6911	0.8019	0.9438	0.8019	0.8651	0.8
4	JAN	1	3	0.8651	0.8019	0.6248	0.6718	0.8019	0.9438	0.8019	0.8651	0.8
5	JAN	1	4	0.8651	0.8019	0.6248	0.6911	0.8019	0.9438	0.8019	0.8651	0.8
6	JAN	1	5	0.8651	0.8019	0.6911	0.6911	0.8019	0.9438	0.8019	0.8651	0.8
7	JAN	1	6	0.8651	0.8019	0.8019	0.8019	0.8019	1.0101	0.8019	0.8651	0.8
8	JAN	1	7	0.8651	0.8019	0.8019	0.8019	0.8019	1.1208	0.8019	0.8651	0.8
9	JAN	1	8	0.8651	0.8019	0.8019	0.8019	0.8019	1.1208	0.8019	0.8651	0.8
10	JAN	1	9	0.8651	0.8019	0.8019	0.8019	0.8019	1.1208	0.8019	0.8651	0.8
11	JAN	1	10	0.8651	0.8019	0.8019	0.8019	0.8019	1.1208	0.8019	0.8651	0.8
12	JAN	1	11	0.8651	0.8019	0.8019	0.8019	0.8019	1.1208	0.8019	0.8651	0.8
13	JAN	1	12	0.8651	0.8019	0.8019	0.8019	0.8019	1.1208	0.8019	0.8651	0.8
14	JAN	1	13	0.8651	0.8019	0.8019	0.8019	0.8019	1.1208	0.8019	0.8651	0.8
15	JAN	1	14	0.8651	0.8019	0.8019	0.8019	0.8019	1.1208	0.8019	0.8651	0.8
16	JAN	1	15	0.8651	0.8019	0.8019	0.8019	0.8019	1.1208	0.8019	0.8651	0.8

Figure 4-8: Hourly data values for aggregate renewables for all scenarios and sensitivity cases (tons per hour).

Section 5
Hourly Average Cost

5.1 Spreadsheet Name

MarginalCostHour.xls (The size of this spreadsheet is approximately 6 megabytes.)

5.2 Purpose

This spreadsheet documents the hourly average cost of electric energy generated or consumed in each of the scenarios for all hours across the year. The data for all of the scenarios and related sensitivities can be selected by specifying the case according to a numerical code from Table 5-1 . Once the data are displayed, the selected data can be accessed for further manipulation.

Table 5-1
Case ID Numbers Used to Select Specific Scenario and Sensitivity Cases

	A	B	C	D	E	F	G	H	I	J	K
Scenarios — incremental 8,000 MW All cases have the same 2,600 MW of resources reflecting proposals in the ISO queue as of 9/30/06.	Common Assumptions	Low Gas/Oil Fuel Prices	High Gas/Oil Fuel Prices	Replace 3,500 MW of the Scenario Technology with 1,750 MW of Energy Efficiency (EE) and 1,750 MW of Demand Response (DR)	Replace 2,700 MW of DR with 2,700 MW of EE	Replace 2,700 MW of EE with 2,700 MW of DR	Retire 3,500 MW and Replace with Scenario Technology	Low Carbon-Allowance Prices	High Carbon-Allowance Prices	For Coal with Carbon Sequestration	Decreased Imports of Low-Emission Resources (~7 TWh)
1 **Queue Mix —** combination of currently proposed resources; 5,400 MW blend reflecting the fuel mix exhibited recently by the market	1	15	8	22			29	43	36		
2 **Demand-side resources —** an additional 2,700 MW of DR and 2,700 MW of EE	2	16	9	23	52	51	30	44	37		
3 **Nuclear —** 5,400 MW	3	17	10	24			31	45	38		
4 **Advanced technology coal (IGCC) —** 5,400 MW without carbon sequestration	4	18	11	25			32	46	39	53	
5 **Natural gas (combined cycle) —** 5,400 MW	5	19	12	26			33	47	40		
6 **Renewables —** 5,400 MW, including a combo of on- and offshore wind, hydro, biomass, landfill gas, combined heat and power, fuel cells, photovoltaics; 1/8 each	6	20	13	27			34	48	41		
7 **Increased imports of hydro and other low-emission resources —** 30 TWh of imports	7	21	14	28			35	49	42		50

5.3 Spreadsheet Tabs

Once the spreadsheet is opened, a number of tabs associated with various data can be seen. The most important tabs are identified below:

- The Read Me tab provides access to this documentation.
- The Welcome tab provides access to the macros that control the data to be selected and displayed.
- The Selected Data tab contains the data that has been selected to be displayed on the graphs.
- The Graph Duration tab contains the graph for the annual marginal cost duration curve.

- The Graph Summer tab contains the graph for the chronological marginal energy cost for the two summer months of July and August.
- The Graph Peak Day tab contains the graph for the marginal cost curve for the peak day only.

The other tab, Marginal Cost, includes the raw, unformatted data that will be extracted using the user interface. The ISO did not document how to use the data on this tab because the user interface is designed to facilitate viewing of these data.

5.4 Macro Interface

Average marginal price information for each of the scenarios and sensitivities can be selected by changing the value in cell H12 of the Welcome tab. This is shown in Figure 5-1 to the right of the Case ID arrow. By clicking on the Increment or Decrement buttons, the Case ID will increase or decrease appropriately. When the Increment or Decrement button is clicked, the duration curve for the annual electric energy production by fuel category is reset to zero and can be recreated by clicking on the Create Annual Duration Curve button shown at the bottom of the yellow box the figure.

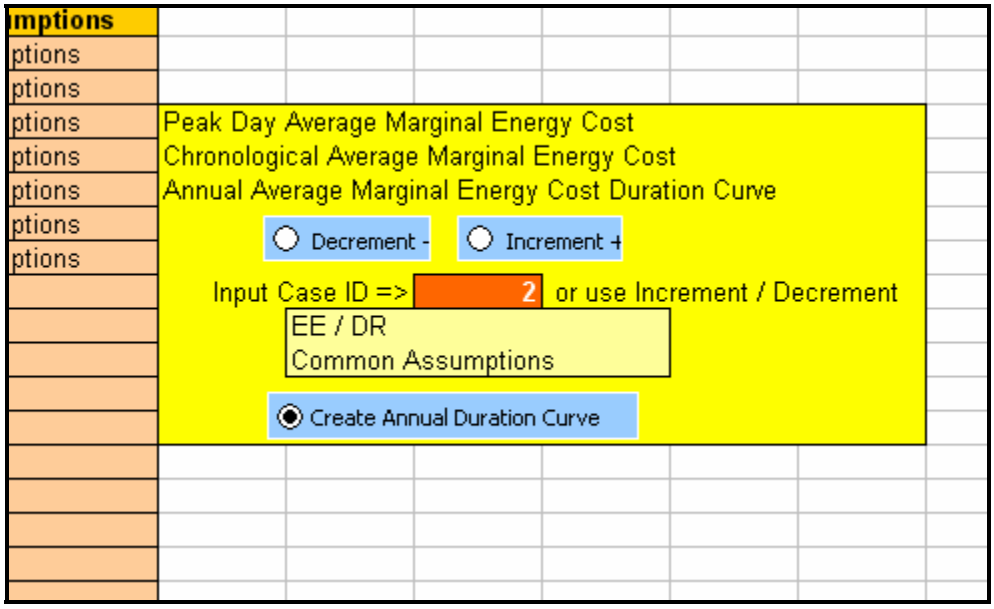


Figure 5-1: Portion of "Welcome" tab showing data selection options.

5.5 Sample Graphs

Three preprogrammed formats for presenting these data are shown on the following graphs. The first graph, as shown in Figure 5-2, is the average marginal cost duration curve for the electric energy produced.

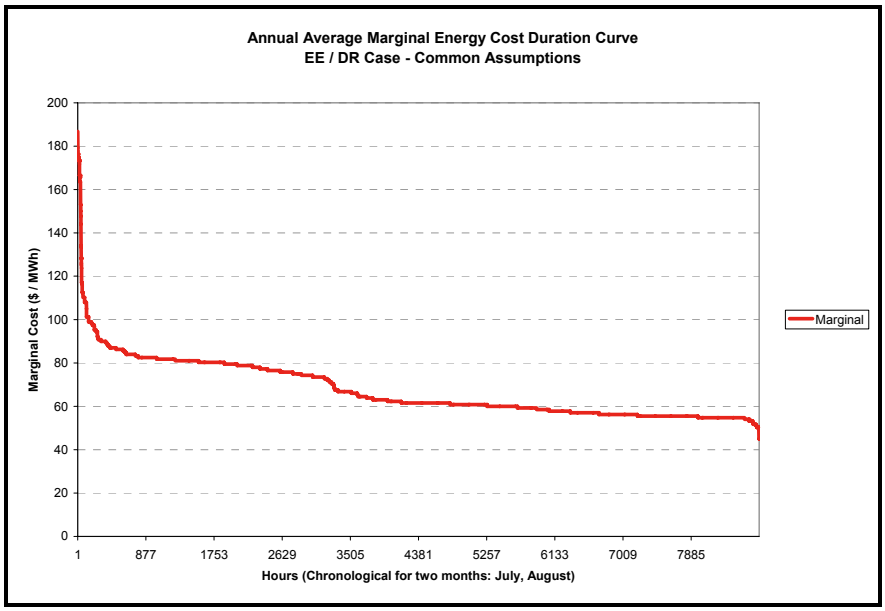


Figure 5-2: Sample duration curve for annual marginal energy cost from hourly simulation results.

To investigate the daily marginal energy cost profiles, a two-month period is shown in Figure 5-3. This graph shows the chronological marginal energy cost for the two-month summer-peak load period for July and August.

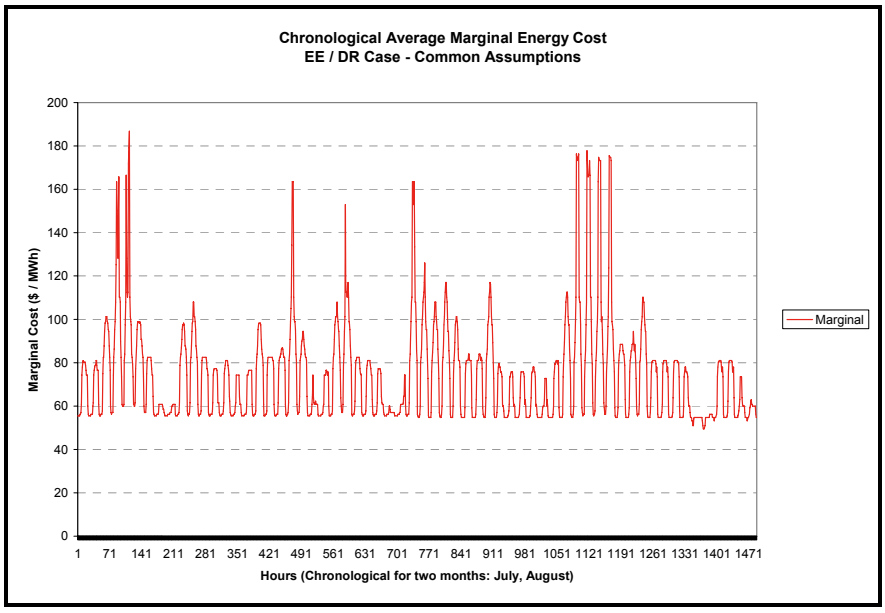


Figure 5-3: Sample chronological graph of hourly average marginal cost for the summer months, July and August.

To allow an even more detailed understanding of the average marginal electric energy cost for the peak-load day, a graph focusing on this day was developed, as shown in Figure 5-4. For this spreadsheet, the peak day is automatically selected and the appropriate data extracted. For the Scenario Analysis, this day is the Julian Day 186, which is the day with the highest peak load in the annual New England load profile.

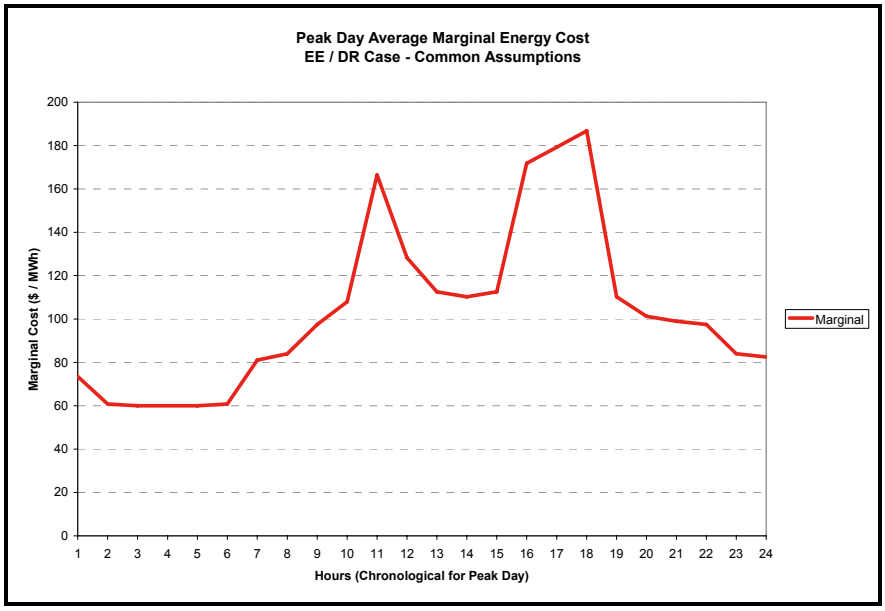


Figure 5-4: Sample chronological graph of hourly prices for the peak day (Julian Day 186).

5.6 Selected Data

The underlying data for each graph can be seen on the Selected Data tab. An example of the data within this tab is shown in Figure 5-5. The data in column **D** are the 24 hourly values for the peak day. The data in column **J** are the hourly values starting on January 1 at 1:00 a.m. and continuing down the columns for 8,760 values until reaching the December 31 midnight value. Spreadsheet users can manually copy these data into a different spreadsheet for further analysis.

	A	B	C	D	E	F	G	H	J
1			Hour	Marginal		Month	Day	Hour	2
2	Hour	Day	in Year	Cost					EE50BASE
3	1	186	4442	73.50		JAN	1	1	57.00
4	2		4443	60.75		JAN	1	2	53.25
5	3		4444	60.00		JAN	1	3	53.25
6	4		4445	60.00		JAN	1	4	53.25
7	5		4446	60.00		JAN	1	5	55.50
8	6		4447	60.75		JAN	1	6	61.50
9	7		4448	81.00		JAN	1	7	61.50
10	8		4449	84.00		JAN	1	8	61.50
11	9		4450	97.50		JAN	1	9	63.75
12	10		4451	108.00		JAN	1	10	66.00
13	11		4452	166.50		JAN	1	11	66.75
14	12		4453	128.25		JAN	1	12	66.00
15	13		4454	112.50		JAN	1	13	66.00
16	14		4455	110.25		JAN	1	14	63.00
17	15		4456	112.50		JAN	1	15	63.00
18	16		4457	171.75		JAN	1	16	63.00
19	17		4458	179.25		JAN	1	17	80.25
20	18		4459	186.75		JAN	1	18	86.25
21	19		4460	110.25		JAN	1	19	83.25
22	20		4461	101.25		JAN	1	20	81.75
23	21		4462	99.00		JAN	1	21	70.50
24	22		4463	97.50		JAN	1	22	63.00
25	23		4464	84.00		JAN	1	23	61.50
26	24		4465	82.50		JAN	1	24	61.50
27						JAN	2	1	57.00
28						JAN	2	2	53.25
29						JAN	2	3	53.25

Figure 5-5: "Selected Data" tab showing hourly average marginal cost for electric energy for the peak day ($/MWh).

Section 6
Scenario-Specific Metrics and Expansion Technology Data

6.1 Spreadsheet Name

SA_Scenario_TechnologiesV1.xls (The size of this spreadsheet is less than 1 megabyte.)

6.2 Purpose

This spreadsheet documents the aggregate annual metrics for the each of the scenarios and sensitivities for the entire year. The annual data for all the scenarios and related sensitivities can be selected by specifying the case according to the numerical codes shown in Table 6-1. Once the data are displayed, the selected data can be accessed for further manipulation.

Table 6-1
Case ID Numbers Used to Select Specific Scenario and Sensitivity Cases

		A	B	C	D	E	F	G	H	I	J	K
	Scenarios — incremental 8,000 MW All cases have the same 2,600 MW of resources reflecting proposals in the ISO queue as of 9/30/06.	Common Assumptions	Low Gas/Oil Fuel Prices	High Gas/Oil Fuel Prices	Replace 3,500 MW of the Scenario Technology with 1,750 MW of Energy Efficiency (EE) and 1,750 MW of Demand Response (DR)	Replace 2,700 MW of DR with 2,700 MW of EE	Replace 2,700 MW of EE with 2,700 MW of DR	Retire 3,500 MW and Replace with Scenario Technology	Low Carbon-Allowance Prices	High Carbon-Allowance Prices	For Coal with Carbon Sequestration	Decreased Imports of Low-Emission Resources (~7 TWh)
1	**Queue Mix —** combination of currently proposed resources; 5,400 MW blend reflecting the fuel mix exhibited recently by the market	1	15	8	22			29	43	36		
2	**Demand-side resources —** an additional 2,700 MW of DR and 2,700 MW of EE	2	16	9	23	52	51	30	44	37		
3	**Nuclear —** 5,400 MW	3	17	10	24			31	45	38		
4	**Advanced technology coal (IGCC) —** 5,400 MW without carbon sequestration	4	18	11	25			32	46	39	53	
5	**Natural gas (combined cycle) —** 5,400 MW	5	19	12	26			33	47	40		
6	**Renewables —** 5,400 MW, including a combo of on- and offshore wind, hydro, biomass, landfill gas, combined heat and power, fuel cells, photovoltaics; 1/8 each	6	20	13	27			34	48	41		
7	**Increased imports of hydro and other low-emission resources —** 30 TWh of imports	7	21	14	28			35	49	42		50

6.3 Spreadsheet Tabs

Once the spreadsheet is opened, a number of tabs associated with various data can be seen. The two most important tabs are identified below:

- The Read Me tab provides access to this documentation.
- The Welcome tab provides access to the macros that control the data to be selected and displayed.

Another tab, Key Results, includes the raw, unformatted data that will be extracted using the user interface. The ISO did not document how to use the data on this and the other additional tabs because the user interface is designed to facilitate viewing of these data.

6.4 Macro Interface

The metrics for energy production (GWh), net energy market revenues (million $), total nameplate capacity (MW), total capital investment (million $) and total annual FCM revenues ($ million/yr) can be extracted for each of the scenarios and sensitivities. Additionally, annual aggregate metrics for load-serving entity expense; production cost; NO_X, SO_2, and CO_2 emissions; and average marginal cost are extracted to this tab. Metrics for each of the scenarios and sensitivities can be selected by changing the value in cell I7 of the Welcome tab. This is shown in Figure 6-1 to the right of the Case ID arrow. By clicking on the Increment or Decrement buttons, the Case ID will increase or decrease appropriately.

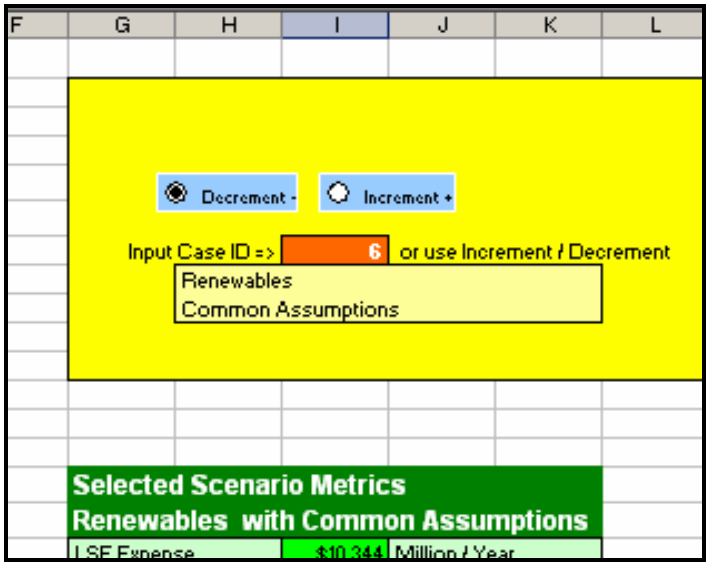


Figure 6-1: Portion of Welcome tab showing data selection options.

6.5 Scenario and Sensitivity Metric Extraction

One of two preprogrammed formats is available for presenting scenario and sensitivity-specific data. Figure 6-2 shows the annual simulation metrics for load-serving entity expense; production cost; NO_X, SO_2, and CO_2 emissions; and average marginal energy cost.

Selected Scenario Metrics Renewables with Common Assumptions		
LSE Expense	$10,344	Million / Year
Prd Cost	$5,569	Million / Year
Avg LMP	$59.52	$ / MWh
SO2	62	Thousand Tons / Year
NOx	38	Thousand Tons / Year
CO2	66	Million Tons / Year
Top Ten Days Nox	1,748	Tons / 10 days

Figure 6-2: Sample of annual simulation metrics.

6.6 Technology Data

The second of the two preprogrammed formats summarizes selected scenario technology metrics. Figure 6-3 shows the simulation-based metrics for each of the scenario technologies.

	B	C	D	E	F	G	H
1	ISO Scenario Analysis: Scenario Specific Data Extraction Tool						
2							
3		Select Scenario in box to the right					
4		Scenario Selected ==> Renewables with Common Assumptions					
5							
6	Category	Scenario Technology	Units	Data			
7	Energy	Sm Hydro (GWh)	GWh	3,759			
8		CHP (GWh)	GWh	5,277			
9		Biomass (GWh)	GWh	5,321			
10		Fuel Cells (GWh)	GWh	5,311			
11		LFG (GWh)	GWh	5,232			
12		PV (GWh)	GWh	2,321			
13		Onshore (GWh)	GWh	10,795			
14		Offshore (GWh)	GWh	9,268			
15		Total Energy From Scenario Resources	GWh	47,284			
16							
17	Nameplate MW	Sm Hydro (MW)	MW	675			
18		CHP (MW)	MW	675			
19		Biomass (MW)	MW	675			
20		Fuel Cells (MW)	MW	675			
21		LFG (MW)	MW	675			
22		PV (MW)	MW	1,715			
23		Onshore (MW)	MW	3,870			
24		Offshore (MW)	MW	2,885			
25		Total Nameplate Capacity (MW)	MW	11,845			
26							
27	Installed	Sm Hydro ($/kW-nameplate)	$ / kW	3,000			
28	Capital	CHP ($/kW-nameplate)	$ / kW	1,000			
29	Cost	Biomass ($/kW-nameplate)	$ / kW	2,500			
30		Fuel Cells ($/kW-nameplate)	$ / kW	3,500			
31		LFG ($/kW-nameplate)	$ / kW	2,000			
32		PV ($/kW-nameplate)	$ / kW	4,000			
33		Onshore ($/kW-nameplate)	$ / kW	1,500			
34		Offshore ($/kW-nameplate)	$ / kW	2,000			
35		Total Investment ($ Million)	$ Million	26,534			
36						Annual Net Energy Revenues	
37	Net Energy	Sm Hydro ($ Million)	$ Million / yr	222	$ / kW-yr	329	
38	Market	CHP ($ Million)	$ Million / yr	-75	$ / kW-yr	-111	
39	Revennues	Biomass ($ Million)	$ Million / yr	138	$ / kW-yr	205	
40		Fuel Cells ($ Million)	$ Million / yr	-8	$ / kW-yr	-11	
41		LFG ($ Million)	$ Million / yr	114	$ / kW-yr	169	
42		PV ($ Million)	$ Million / yr	143	$ / kW-yr	83	
43		Onshore ($ Million)	$ Million / yr	607	$ / kW-yr	157	
44		Offshore ($ Million)	$ Million / yr	526	$ / kW-yr	182	
45		Total Net Energy Market Revenues From Scenario Technologies	$ Million / yr	1,667	$ / kW-yr	141	
46							
47	MWs	Sm Hydro (Qualified MW)	MW	675			
48	Qualified	CHP (Qualified MW)	MW	675			
49	For FCM	Biomass (Qualified MW)	MW	675			
50	Payments	Fuel Cells (Qualified MW)	MW	675			
51		LFG (Qualified MW)	MW	675			
52		PV (Qualified MW)	MW	675			
53		Onshore (Qualified MW)	MW	675			
54		Offshore (Qualified MW)	MW	675			
55		Total Qualified Capacity (MW)	MW	5,400			

Weighted average based on nameplate ratings

Figure 6-3: "Welcome" tab showing key metrics for the scenario technologies considered.

Section 7
New Resource Economics Spreadsheet

7.1 Spreadsheet Name

NewResourceEconomics.xls (The size of this spreadsheet is less than 1 megabyte.)

7.2 Purpose

This spreadsheet is in the form of a template and summarizes the costs and revenues associated with the new resources assumed in the various scenarios. It provides an example calculation and allows the user to perform a parallel calculation while adjusting a number of key variables. Values that the user can adjust are highlighted in yellow on the template. The primary focus of this evaluation is expressed in terms of $/kW-year. Negative results indicate that the scenario technology may require additional revenue streams to be viable. Positive results indicate that the resource may be viable based on the assumptions underlying the analysis.

7.3 Spreadsheet Tabs

Once this spreadsheet is opened, two tabs can be seen are as follows:

- The Read Me tab, which provides access to this documentation
- The Welcome tab, which provides access to the template for analysis

7.4 Template Overview

Figure 7-1 shows the template used to analyze the economics of a new resource. The top three sections of the template provide data on revenue sources: capacity market revenues, energy market revenues, and other potential revenues. The fourth section provides data on the expenses related to capital costs. The fifth section summarizes the following four elements:

- **Capacity market revenues—**the revenues that a resource will be expected to receive in the capacity market. While these revenues are typically referred to in terms of $/kW-month, this template works in terms of $/kW-year and applies the appropriate conversion.
- **Net energy market revenues—**the revenue stream that is anticipated to result from the sale of electric energy in the wholesale energy markets, minus the cost of fuel and other variable costs used to produce the energy. This value can be obtained from Column **G** on the Welcome tab of the SA_Scenario_TechnologiesV1.xls spreadsheet (see Section 6).
- **Other potential revenues—**revenues assumed to be generated by other revenue sources including, but not limited to, ancillary services.
- **Capacity costs—**costs based on the assumed capital cost of a resource in terms of $/kW installed. These costs are then multiplied by the Annual Revenue Requirement Rate to get the annual cost that must be compared to the previously discussed revenue streams to evaluate the viability of the new resource.

	A	B	C	D	E
1	**ISO Scenario Analysis User Spreadsheet: A Conceptual Version**				
2	**New Resource Economics expressed in terms of $/kW-year**				
3					
4	Customize this spreadsheet by entering data in the fields highlighted in yellow below.				
5					
6				**ISO SA Data Common Assumptions Scenario 6 - Small Hydro**	**User Data**
7	**Line No.**	**Revenue/Cost Item**	**Units**		
8		**Capacity Market Revenues**			
9	1	Assumed range of monthly capacity payments (collar values from settlement agreement)	$/kW-mo	4.5	10.5
10	2	**Annual capacity payments (line 1 x 12 months)**	**$/kW-yr**	**54**	**126**
11		**Energy Market Revenues**			
12	3	**Net Energy Revenues [from SA_Scenario Technology.xls spreadsheet Welcome tab, Column G; gross annual energy revenues minus fuel costs minus variable O&M]**	**$/kW-yr**	**329**	**300**
13		**Other Potential Revenues**			
14	4	Estimated Ancillary Services (assume a percentage of energy revenues)	$/kW-yr	7	7
15	5	Assumed Public Policy Incentives: RECs, Tax incentives, Subsidies	$/kW-yr	0	0
16	6	**Total Other Potential Revenues**	**$/kW-yr**	**7**	**7**
17		**Capacity Costs**			
18	8	Resource Capital Cost	$/kW	3,000	2,300
19	9	Annual Revenue Requirement Rate	%	15	18
20	10	**Annual Revenue Requirements (ARR) (line 3 x line 4)**	**$/kW-yr**	**450**	**414**
21		**Summary of Revenue/Cost Calculations**			
22	11	**Capacity Market Revenues**	**$/kW-yr**	**54**	**126**
23	12	**Energy Market Revenues**	**$/kW-yr**	**329**	**300**
24	13	**Other Potential Revenues**	**$/kW-yr**	**7**	**7**
25	14	**Capacity Costs**	**$/kW-yr**	**-450**	**-414**
26	15	**New Resource Economics (Based on Assumptions)**	**$/kW-yr**	**-60**	**19**

Figure 7-1: The "Welcome" tab illustrates the template for the economic analysis of new resources.

Section 8
Conceptual Electricity Rate Sensitivity Spreadsheet

8.1 Spreadsheet Name

ConceptualElectricityRate.xls (The size of this spreadsheet is less than 1 megabyte.)

8.2 Purpose

This spreadsheet is in the form of a template. The purpose of this template is to provide a way to assess the potential impact of each scenario on electricity rates. It provides an example calculation and allows the user to perform a parallel analysis while adjusting a number of key variables. Values that the user can adjust are highlighted in yellow on the template.

The calculation is done by first compiling costs associated with energy, capacity, and ancillary services to reflect the resource supply costs. The transmission and distribution costs are then estimated to reflect the cost of energy delivery.

This spreadsheet is designed to work in terms of millions of dollars. The total cost is estimated in terms of millions of dollars, which is then divided by the amount of energy sold to estimate the rate impact. Because the energy efficiency scenario may be viewed as selling fewer kilowatt-hours (kWh) to customers, the spreadsheet includes provisions to calculate the average rate based on the fewer kWhs.

8.3 Spreadsheet Tabs

Once the spreadsheet is opened, two tabs can be seen:

- The Read Me tab, which provides access to this documentation
- The Welcome tab, which provides access to the template for analysis

8.4 Template Overview

Figure 8-1 through Figure 8-4 show the template used to estimate the total electricity rates for New England. Most of the values are self-explanatory.

Figure 8-1 shows the energy supply cost development section. The average wholesale electric energy cost can be obtained from Column **I** on the Welcome tab of the SA_Scenario_TechnologiesV1.xls spreadsheet. (see Section 6).

Figure 8-2 shows the development of the transmission and distribution costs. The transmission costs and distribution offsets for each scenario can be extracted from the materials presented during the plenary sessions of the Scenario Analysis.[2]

Figure 8-3 summarizes these components in terms of millions of dollars per year, while Figure 8-4 summarizes these components in terms of cents per kWh.

	A	B	C	D	E
1	**ISO Scenario Analysis User Spreadsheet: A Conceptual Version**				
2	**Total Cost for Providing Electricity:**				
3					
4	Customize this spreadsheet by entering data in the fields highlighted in yellow below.				
5					
6				**ISO SA Data Common Assumptions**	**User Data**
7	**Line No.**	**Revenue/Cost Item**	**Units**	**Scenario 2 - EE / DR**	
8		**Energy, Capacity and Ancillary Services Costs**			
9	1	System Energy Needs (w/o Energy Efficiency Reductions)	GWh	174,000	174,000
10	2	Energy Efficiency Reductions	GWh	0	36,000
11	3	Net System Energy	GWh	174,000	138,000
12					
13	4	Installed Capacity	MW Installed	39,000	39,000
14	5	Capacity Market Payments per month (Assume [0.6 to 1.4 x CONE (7.5)])	$/kW-mo	10.5	10.5
15	6	**Assumed Annual Capacity Market Payments**	**$ Million / yr**	**4,914**	**4,914**
16					
17	7	Annual Wholesale Energy Expenses (average energy clearing price from simulation)	$/MWh	70.40	70.40
18	8	**Annual Energy Market Expense**	**$ Million / yr**	**12,250**	**9,715**
19					
20	9	Ancilliary Percenatge Rate (Typical Low = 1%, High =2%)	%	1.0%	1.0%
21	10	**Assumed Ancillary Services (line 20 x line 21)**	**$ Million / yr**	**122**	**97**
22					
23	11	**Total Annual Energy, Capacity, and Ancillary Services Payment (lines 6 +8 + 10)**	**$ Million / yr**	**17,286**	**14,726**
24		**Transmission and Distribution Costs**			

Figure 8-1: "Welcome" tab showing the resource supply cost components.

24		**Transmission and Distribution Costs**			
25	12	Base Transmission Rate [6.40 from the Whitepaper; $2.98 is the current rate]	$/MWh	6.4	na
26	13	**Base Transmission Revenue Requirements**	**$ Million / yr**	**1,114**	**1,114**
27					
28	14	RSP06 Transmission Expansion Installed Costs	$ Million Cap	5,000	5,000
29	15	Offsets to Transmission Expansion Installed Costs	$ Million Cap	0	0
30	16	RSP06 Transmission Expansion Installed Costs	$ Million Cap	5,000	5,000
31	17	Annual Revenue Requirement Rate (typically between 18% and 22%)	%	22%	22%
32	18	**RSP Incremental Expansion Costs (at 22%)**	**$ Million / yr**	**1,100**	**1,100**
33					
34	19	SA New Transmission and ROW Costs (from SA Final Assumptions Presentation)	$ Million Cap	0	0
35	20	Other Transmission Expansion Costs (Land, etc.)	$ Million Cap	0	0
36	21	Total SA Transmission Expansion Costs (lines 19 + 20)	$ Million Cap	0	0
37	22	Annual Payment Rate for Transmission Investment	%	18%	18%
38	23	**SA Incremental Transmission Expense**	**$ Million / yr**	**0**	**0**
39					
40	24	Distribution Expenses ($68.90/MWh from ISO Electricity White Paper 2006)	$/MWh	68.9	na
41	25	Distribution Expenses	$ Million / yr	11,989	11,989
42	26	Distribution System Investment Savings (Can use assumed SA Distribution Costs/Savings $100M-$325M)	$ Million Cap	325	325
43	27	Assumed Range of Annual Revenue Requirement for Distribution Investment	%	18%	18%
44	28	Annual Distribution System Savings (line 26 x line 27)	$ Million / yr	59	59
45	29	**Annual Distribution System Expense**	**$ Million / yr**	**11,930**	**11,930**
46					
47	30	**Total Transmission and Distribution Expenses (lines 13 +18 + 23 - 29)**	**$ Million / yr**	**14,144**	**14,144**

Figure 8-2: "Welcome" tab showing the transmission and distribution cost components.

[2] The materials presented at the Scenario Analysis plenary sessions are available online at http://www.iso-ne.com/committees/comm_wkgrps/othr/sas/index.html.
Specifically, the range of transmission costs necessary for each scenario can be found online at http://www.iso-ne.com/committees/comm_wkgrps/othr/sas/mtrls/may212007/final_sa_modeling_assumptions.pdf, slides 40-41 Distribution system savings can be obtained from this same presentation from slide 46.

48		Summary of Revenue/Cost Calculations			
49	31	Total Annual Energy Expense	$ Million / yr	12,250	9,715
50	32	Total Ancillary Services Expense	$ Million / yr	122	97
51	33	Total Annual Capacity Expense	$ Million / yr	4,914	4,914
52	34	Total New England Transmission Expense	$ Million / yr	2,214	2,214
53	35	Total New England Distribution Expense	$ Million / yr	11,930	11,930
54	36	Total Electricity Expense	$ Million / yr	31430	28870

Figure 8-3: "Welcome" tab showing the cost components expressed in $ million/year.

55		Average Electricity Rate Summary			
56	37	Average Energy Rate Component	cents/KWh	7.040	7.040
57	38	Average Ancillary Services Rate Component	cents/KWh	0.070	0.070
58	39	Average Capacity Rate Component	cents/KWh	2.824	3.561
59	40	Average Transmission Rate Component	cents/KWh	1.272	1.604
60	41	Average Distribution Rate Component	cents/KWh	6.856	8.645
61	42	Average Total Electricity Rate	cents/KWh	18.063	20.920

Figure 8-4: "Welcome" tab showing the cost components expressed in cents/kWh.