Chapter 7

Summary of Simulation Models used in PRL Program Evaluation

In order to develop a quantitative measurement of the effect of the NYISO's PRL programs on New York State electricity markets for the summer of 2001, it was necessary to simulate PRL program benefits based on estimated short-run electricity market supply functions and participant response elasticities. Specifically, the simulation model would identify the effects of the PRL programs on the Day-Ahead and Real-Time LBMPs, changes in average prices and price volatility, calculated collateral system benefits, and any change in load reduction due to a change in the minimum payment level. Figure 7.1 outlines the general framework for such a simulation model.

The statistical software package, SAS, was used for all of the econometric modeling of the short-run supply and demand functions, as well as for the choice modeling performed on the survey response data. Since all the data that would be required of a simulation model already resided in SAS datasets, it was most efficient to develop the simulation model in SAS as well.

An aggressive functional specification was created to ensure every possible aspect of the PRL programs would be simulated. Supply and demand relationships were jointly incorporated into the specification as was the ability to choose between a historical simulation, based on actual EDRP events or DADRP scheduled load, or a hypothetical simulation, based on load curtailment information supplied by the user.

Two prototype models were developed from this functional specification, one contains the supply relationship and other contains the demand system. These two models

were used successfully to simulate PRL program effects on the two New York State

electricity markets. The results of these simulations are discussed extensively in Chapters

1 and 2 of this report. Specifically, the market effects due to participation in EDRP or

DADRP are reported for the Emergency Demand Response Program in Tables 1.13, 1.14,

1,15 and Appendix 1C, while the results of the Day-Ahead program's simulations are

provided in Tables 1.16, 1.17, 1,18 and Appendix 1D. Neenan Associates also simulated

the effect a change in the minimum guaranteed payment rate would have on program

participants load reduction based on estimated response elasticities. These results are

provided in Tables 2.11, 2.13, and 2.15.

Documentation for Supply Flexibility PRL Simulation Models

EDRP Simulation Model

User-Defined Parameters: In order to make this simulation model as flexible and efficient
as possible, there are several initial parameters the user can define.

> **Zone**: This parameter is used by the model to determine which NYISO Pricing
> Zone or "super-zone" is to be simulated. Valid zones are: **6**=Capital, **10**=New
> York City, **11**=Long Island, **12**=Western New York "super-zone", and
> **13**=Hudson River "super-zone".

> **Get_Data**: This parameter is used to speed up the processing time for the model.
> The first time the model is run, all the NYISO price and load data must be
> retrieved from a permanent dataset and placed into a temporary one for processing
> by the program. Once this is done and so long as the temporary dataset is not
> tampered with, the SAS program can continue to use the temporary dataset
> without needing to retrieve the same external data all over again. Thus, the first
> time through this model, this parameter should have a value of **'Y'**. Afterwards, a

value of **'N'** is sufficient since the program will use the same dataset sitting out in temporary library each time it is run.

NYSERDA: This parameter indicates if participants in NYSERDA's PONs are to be simulated only. If so, a value of **'Y'** must be used. Otherwise, a value of **'N'** tells the program to simulate all EDRP participants, not just those who were in a NYSERDA PON.

Export: Exporting the results of the simulation model is controlled by this parameter. A value of **'Y'** generates two Excel spreadsheets; one with overall results of the simulation model and the other with statistics on the change in prices associated with hedge contracts. A value of **'N'** causes the program to pass over these export statements.

Program: This parameter's value should never change. Since an EDRP simulation is being run, a value of **2** should be shown.

SAS Code

If the **Get_Data** parameter has a **'Y'** value then the program retrieves NYISO Price and Load data for weekdays during the month of August 2001 from a permanent SAS dataset and places it into a temporary dataset, NYISO_DATA.

The next data step retrieves the estimated supply flexibility model for the user-indicated **Zone** and **Program** and generates individual observations for each hour an EDRP event was called.

The load/price data and the estimated flexibility model data are then merged together by date-time stamp.

The next data step uses the load and price data to calculate all the different variables used in the estimated supply flexibility model. Since each model is different, the program figures out what the zonal supply model requires, in terms of data, and then plugs in the necessary data elements to create the indicated variables. The resulting

dataset includes, in part, the final estimated model coefficients and the calculated variables that are associated with each model coefficient.

Hourly EDRP Performance data is retrieved next, as it will be needed for simulation purposes in the next data step of the program. Separate permanent datasets were created for all EDRP participants and those EDRP participants who also took part in a NYSERDA PON. Depending upon the value in the **NYSERDA** parameter, the associated dataset is retrieved.

The calculated variables associated with the estimated short-run supply curve and the EDRP performance data are now merged together in order to perform the actual simulation. The segment of the electricity supply curve the market sees during each hour an EDRP event was called is created. This calculated supply curve is then used to determine what the market-clearing price would have been had the amount of EDRP curtailed load not been achieved. An arc-flexibility is calculated based on the percentage reduction in load and percentage increase in price, as are the associated program costs and collateral benefits.

The new market-clearing LBMPs, as calculated in the previous data step, are saved into a permanent dataset for further evaluation.

A quick summary of the program costs and market bill savings are calculated and shown to the user.

If the user has opted to **Export** the simulation results, an Excel spreadsheet detailing these results is created. As a means of identifying the long-term benefits of EDRP, the effect of EDRP on the market-clearing price for the hours of 6 AM through 9 PM over the entire month of August are calculated - a traditional time period covered under a standard hedge contract. These results are also exported to Excel. If NYSERDA participants have been simulated, all results are exported under a different naming convention than the overall simulation of EDRP participants.

DADRP Simulation Model

User-Defined Parameters: In order to make this simulation model as flexible and efficient as possible, there are several initial parameters the user can define.

Model_Zone: This parameter determines which estimated supply flexibility model is to be used in the simulation model. Valid zones are: **6**=Capital, **10**=New York City, **11**=Long Island, **12**=Western New York "super-zone", and **13**=Hudson River "super-zone".

Simulation: Two different types of simulations can be performed in this program: a value of **1** uses the actual scheduled DADRP bids and assumes 100% compliance with the scheduled load reduction, a value of **2** uses instead a user-defined level of load reduction as indicated in the parameter **Reduction**.

Reduction: This parameter will only be used if **Simulation** has a value of **2**. If this is the case, the simulation model will use the value placed here as the level of load reduction to be simulated.

Get_Data: This parameter is used to speed up the processing time for the model. The first time the model is run, all the NYISO price and load data must be retrieved from a permanent dataset and placed into a temporary one for processing by the program. Once this is done and so long as the temporary dataset is not tampered with, the SAS program can continue to use the temporary dataset without needing to retrieve the same external data all over again. Thus, the first time through this model, this parameter should have a value of **'Y'**. Afterwards, a value of **'N'** is sufficient since the program will use the same dataset sitting out in temporary library each time it is run.

Output: Exporting the results of the simulation model is controlled by this parameter. A value of **'Y'** generates 2 Excel spreadsheets with overall results of the simulation model and statistics on the actual and simulated prices. A value of **'N'** causes the program to pass over these export statements.

Program: This parameter's value should never change. Since a DADRP simulation is being run, a value of **1** should be shown.

SAS Code

If the **Get_Data** parameter has a **'Y'** value then the program retrieves NYISO Price and Load data for the months of July and August 2001 from a permanent SAS dataset and places it into a temporary dataset, NYISO_DATA.

SAS then assigns the actual **Zone** whose load and price data will be used for simulation purposes. Since "super-zones" were used to model the electricity markets in both Western NY and the Hudson River area, it was felt that load and price data for the actual zone where the DADRP bids were scheduled should be used in the simulation model for more accurate results. Thus, the **Model_Zone** parameter cannot be used alone; instead it must be used in tandem with this derived parameter, **Zone**.

The next data step retrieves the estimated supply flexibility model for the user-defined **Model_Zone** and **Program** and generates individual observations for each hour and date DADRP was active for the summer of 2001.

The load/price data and the estimated flexibility model data are then merged together by date-time stamp.

The next data step uses the load and price data to calculate all the different variables used in the estimated supply flexibility model. Since each model is different, the program figures out what the zonal supply model requires, in terms of data, and then plugs in the necessary data elements to create the indicated variables. The resulting dataset includes, in part, the final estimated model coefficients and the calculated variables that are associated with each model coefficient.

If the parameter **Simulation** has a value of **1**, then actual DADRP schedules are retrieved, as they will be needed for simulation purposes in the next step of the program. Otherwise, the level of load reduction as indicated in the parameter **Reduction** is used for every hour and date of the period being simulated.

The calculated variables associated with the short-run supply curve and the DADRP level of load reduction data are now merged together in order to do the actual simulation. The segment of the electricity supply curve the market sees during each hour any DADRP load reduction is present. This calculated supply curve is then used to

determine what the market-clearing price would have been had the amount of DADRP curtailed load not been achieved. An arc-flexibility is calculated based on the percentage reduction in load and percentage increase in price, as are the associated program costs and collateral benefits.

The new market-clearing LBMPs, as calculated in the previous data step, are saved into a permanent dataset for further evaluation.

A quick summary of the program costs and collateral benefits are calculated and shown to the user.

If the user has opted to **Output** the simulation results, an Excel spreadsheet detailing these results is created. As a means of identifying the long-term benefits of DADRP, the effect of the load reductions on the market-clearing price for the hours of 6 AM through 9 PM over the months of July and August are calculated - a traditional time period covered under a standard hedge contract. These results are also exported to Excel.
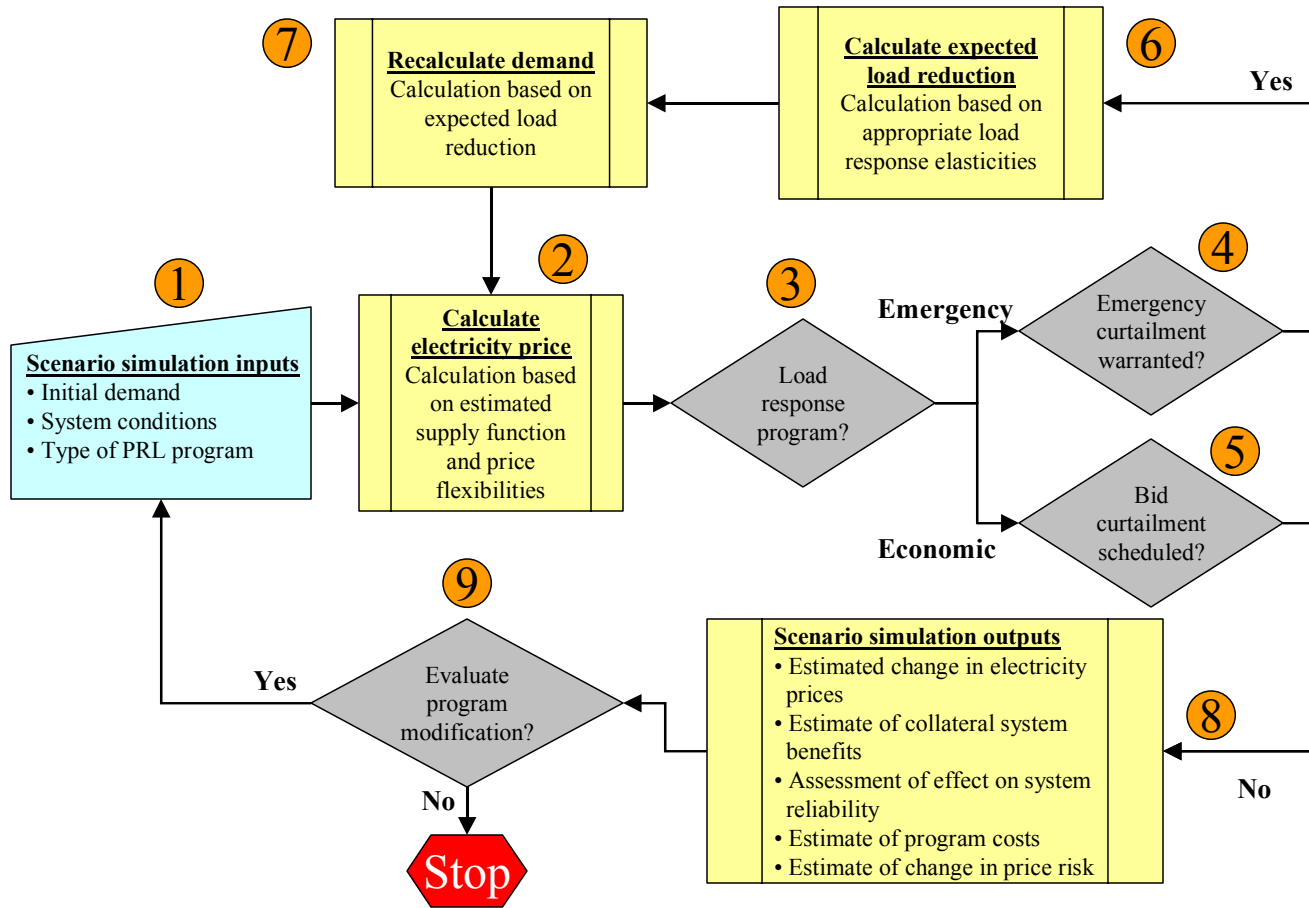
Figure 7.1 – Flowchart for PRL Simulation Model

Figure 7.2: Functional Specification for PRL Simulation

Import Simulation Parms

Get Zonal Supply and Demand Models

Read ISO Load/Gen and PRL Bid Data by Hour only for Zone Parm indicated

EDRP or DADRP

No — Use Nominated PRL Parm

EDRP — Calibrate Emergency Response using Estimated Demand Elasticity and CBL Parms

Calculate amount of Emergency PRL

Yes

DADRP

Use PRL Bid Price/Quantity Parms — No

Use Estimated Demand Elasticity

Yes — Calibrate Demand Curve using Background Rate and CBL Parms

No — Calculate PRL Bid Quantities using Background Rate, CBL, Strike Prices, and Elasticity Parms

Yes

Calculate amount of PRL to be scheduled

Recalibrate Supply Model Intercept w/ Load = L_{old}

Calculate $LBMP_{new}$ w/ (Load - PRL) = L_{new} from Supply Model

Calculate $LBMP_{old}$ w/ Load = L_{old} from Supply Model

EDRP or DADRP

DADRP — Load = FBL, LBMP = DAM LBMP, PRL Rate = Tariff Rate

EDRP — Load = Real-Time Load, LBMP = Real-Time LBMP, PRL Rate = 0 if Event, 999,999 if No Event

LBMP > PRL Rate

Hypothetical

True

False

History or Hypothetical

History

PRL used — Yes / No

L_{old} = Load, L_{new} = Load, $LBMP_{old}$ = LBMP, $LBMP_{new}$ = LBMP

PRL Factor used — Yes / No

Rescale PRL with PRL Factor

Recalibrate Supply Model Intercept w/ (Load - PRL) = L_{old}

Calculate $LBMP_{new}$ w/ Load = L_{new} from Supply

Calculate $LBMP_{old}$ w/ (Load - PRL)= L_{old} from Supply Model

Benefits Calculator:
Cost=(L_{old} - L_{new}) * $LBMP_{old}$
Benefit= ($LBMP_{old}$–$LBMP_{new}$)*L_{new}
Penalty= Benefit * Penalty Factor
Price Delta = ($LBMP_{old}$–$LBMP_{new}$)

Keep Date, Hour, Zone, Cost, Benefit, Price Delta, $LBMP_{old}$, $LBMP_{new}$, L_{old}, L_{new}

More hourly data to be read for Zone — Yes / No

Create output file and report summarizing Simulation results showing net costs, benefits and price risk