Day-Ahead Forecast Performance Report - 2008

October 23, 2008

Public

Table of Contents

Summary

In its first three months (July to September 2008) of operation the IESO day-ahead price forecast model provided enough benefits to cover eighty per cent of the cost of operating the model for a two–year period. In a previous analysis the IESO estimated the cost of operating the model over a two-year period at $80,000.[1] In this report the IESO calculated the potential benefits of improved day-ahead price forecasts at $61,000. This means that the benefits, in *only the first three months of operation*, have covered eighty per cent of the estimated cost of operation. The benefits come from improved forecasting performance under the assumption that a consumer would use the day-ahead price forecasts instead of the day-ahead pre-dispatch price signal. The model's performance was much better than the IESO day-ahead pre-dispatch price and it did as well as the IESO's 3-hour ahead pre-dispatch price signal.

[1] See http://www.ieso.ca/imoweb/pubs/consult/se58/se58-20080401-IESO_Position_Paper_Price_Forecast.pdf

Performance of the IESO Day Ahead Price Forecast Model

This report provides detailed statistics on the performance of the IESO day-ahead price forecast model for the period July 1, 2008 to September 30, 2008. The key metrics that were used to evaluate model performance indicate that the day-ahead price forecast model has performed very well over the evaluation period. Detailed results appear in the Tables and Charts on pages 5 to 15. Appendix A provides details on the Efficiency Score Metric and Appendix B describes how the estimated benefits were calculated. A description of the key metrics used in the report is provided first[2].

Average Error

This metric calculates the arithmetic average of the difference between the forecast price and the actual price over the study period. Since large positive errors cancel large negative errors, this metric can only be used as a rough guide to evaluate forecast accuracy. On the other hand the sign on the metric does convey information about the bias in the model. Given that the price difference is defined as the price forecast minus the actual price, a positive average error indicates that the model tends to over-forecast the actual price. Conversely a negative average error indicates that the model tends to under-forecast the actual price. Table 1, Table 4 and Chart 1 provide information on this metric for the period July to September 2008.

Absolute Price Difference

This metric calculates the average absolute difference between the price forecast and the actual price. The absolute value of the difference between two numbers provides information on how far apart the two numbers are without accounting for the sign on that difference. For example the price difference could be negative $5; the absolute value will be $5 and not negative $5. The advantage of this approach is that large negative errors will not cancel out large positive errors. Therefore a large absolute value for the price difference indicates poor forecast performance since the forecast is far from the actual price (either well above it or well below it). A small value for this metric is preferred to a large value because

[2] In the evaluations, all negative prices are excluded. This approach provides a common platform that allows meaningful comparative assessments.

it indicates the forecasted price is close to the actual price. Table 2, Table 5 and Chart 5 provide information on this metric for the period July to September 2008.

Mean Absolute Percentage Error (MAPE)

This metric calculates the absolute price difference in each hour as a percentage of the actual price and it averages this value for the evaluation period. It provides a good measure of the forecast accuracy of the model. A low value is preferred to a high value. Table 3, Table 6 and Chart 3 provide information on this metric for the period July to September 2008.

Efficiency Score

The Efficiency Score calculates the number of hours in which the day-ahead price forecast would have led the user to make an inefficient decision[3]. A model with a high score indicates that more inefficient decisions are likely if that model is used to make decisions. As a result a low score is preferred to a high score. Appendix A provides details on the Efficiency Score Metric.

Appendix B describes how the benefits from the IESO day ahead forecast were calculated.

[3] See Appendix A for a detailed discussion of this metric.

Table 1 Average Error

	Peak	Off-peak	All
New York	-$2.20	$3.57	-$0.38
Michigan	$4.35	-$1.92	$2.38
IESO Day Ahead Pre-Dispatch	-$8.06	-$0.35	-$5.63
IESO Day Ahead Price Forecast	-$6.48	$1.77	-$3.88

Note that New York in the Table refers to the New York day-ahead reference hub price. Michigan refers to the Michigan day-ahead reference hub price.

The average error is the difference between the day-ahead price and the actual price. A large price difference, either positive or negative, indicates poor model performance. Over the period July to September 2008, the day-ahead price forecast resulted in a smaller average error than the day ahead pre-dispatch price signal. Both the pre-dispatch price signal and the price forecast underestimated the actual electricity price meaning that the actual Hourly Ontario Energy Price (HOEP) was, on average, higher than forecasted.

Table 2 Average Absolute Error

	Peak	Off-peak	All
New York	$18.28	$19.64	$18.65
Michigan	$23.75	$8.00	$18.79
IESO Day Ahead Pre-Dispatch	$19.73	$11.10	$17.01
IESO Day Ahead Price Forecast	$15.68	$9.61	$13.77

Note that New York in the Table refers to the New York day-ahead reference hub price. Michigan refers to the Michigan day-ahead reference hub price.

The average absolute error is the average of the absolute value of the difference between the day-ahead price and the actual price. The smaller the difference the better the model performance. Over the period July to September 2008, the day-ahead price forecast resulted in a smaller average absolute error than the day ahead pre-dispatch price signal. This means the day-ahead price forecast provided more accurate price forecasts than the day-ahead pre-dispatch price signal.

Table 3 Mean Absolute Percentage Error

	Peak	Off-peak	All
New York	28%	81%	44%
Michigan	38%	40%	39%
IESO Day Ahead Pre-Dispatch	38%	129%	67%
IESO Day Ahead Price Forecast	26%	101%	49%
IESO 3-Hour Ahead 3 Pre-Dispatch	22%	101%	48%
IESO 2-Hour Ahead Pre-Dispatch	23%	102%	49%
IESO 1-Hour Ahead Pre-Dispatch	22%	105%	49%

Note that New York in the Table refers to the New York day-ahead reference hub price. Michigan refers to the Michigan day-ahead reference hub price.

The mean absolute percentage error (MAPE) provides information on the average absolute error as a ratio of the actual price. The smaller the MAPE, the better the model performance. Over the period July to September 2008, the MAPE for the day-ahead price forecast was smaller than the MAPE for the day ahead pre-dispatch price signal. This means the day-ahead price forecast provided more accurate price forecasts than the day-ahead price signal.

Table 4 Average Error by Group of Hours

Hours	IESO Day-Ahead Forecast	IESO Day-Ahead pre-dispatch
1-4	$3.44	-$0.31
5-8	$1.30	$4.37
9-12	-$1.87	-$6.16
13-16	-$6.69	-$10.39
18-21	-$11.17	-$12.46
21-24	-$5.73	-$6.08

This table provides a smoother comparison of the average error across group of hours. Over the period July to September 2008, the day ahead price forecast error was smaller than the day ahead pre-dispatch price signal error in all but the first group of hours (hours 1 to 4).

Table 5 Average Absolute Error by Group of Hours

Hours	IESO Day-Ahead Forecast	IESO Day-Ahead pre-dispatch
1-4	$10.27	$10.22
5-8	$8.76	$10.01
9-12	$16.51	$19.10
13-16	$17.13	$22.58
18-21	$18.65	$23.27
21-24	$10.55	$14.52

This table provides a smoother comparison of the average absolute error across groups of hours. Over the period July to September 2008, the day-ahead price forecast absolute error was smaller than the day ahead pre-dispatch price signal error in all but the first group of hours (hours 1 to 4). This means the day-ahead price forecast provided more accurate forecasts than the day ahead pre-dispatch price signal in all but the first group of hours.

Table 6 Mean Absolute Percentage Error by Group of Hours

Hours	IESO Day-Ahead Forecast	IESO Day-Ahead pre-dispatch
1-4	132%	116%
5-8	65%	51%
9-12	30%	33%
13-16	22%	38%
18-21	23%	43%
21-24	37%	118%

This table provides a smoother comparison of the mean absolute percentage error (MAPE) across groups of hours. Over the period July to September 2008, the day ahead price forecast MAPE was smaller than the day ahead pre-dispatch price signal MAPE in all but the first group of hours (hours 1 to 4). This means the day-ahead price forecast provided more accurate forecasts than the day ahead pre-dispatch price signal in all but the first group of hours.

Table 7 Efficiency Score- Incentive to Avoid Consumption

	IESO Day-ahead price forecast is above or equal to $100 and HOEP is less than $X	IESO Day Ahead pre-dispatch price is above or equal to $100 and HOEP is less than $X
X<$50	2	2
X<$65	3	5
X<$75	8	19
Score	**13**	**26**

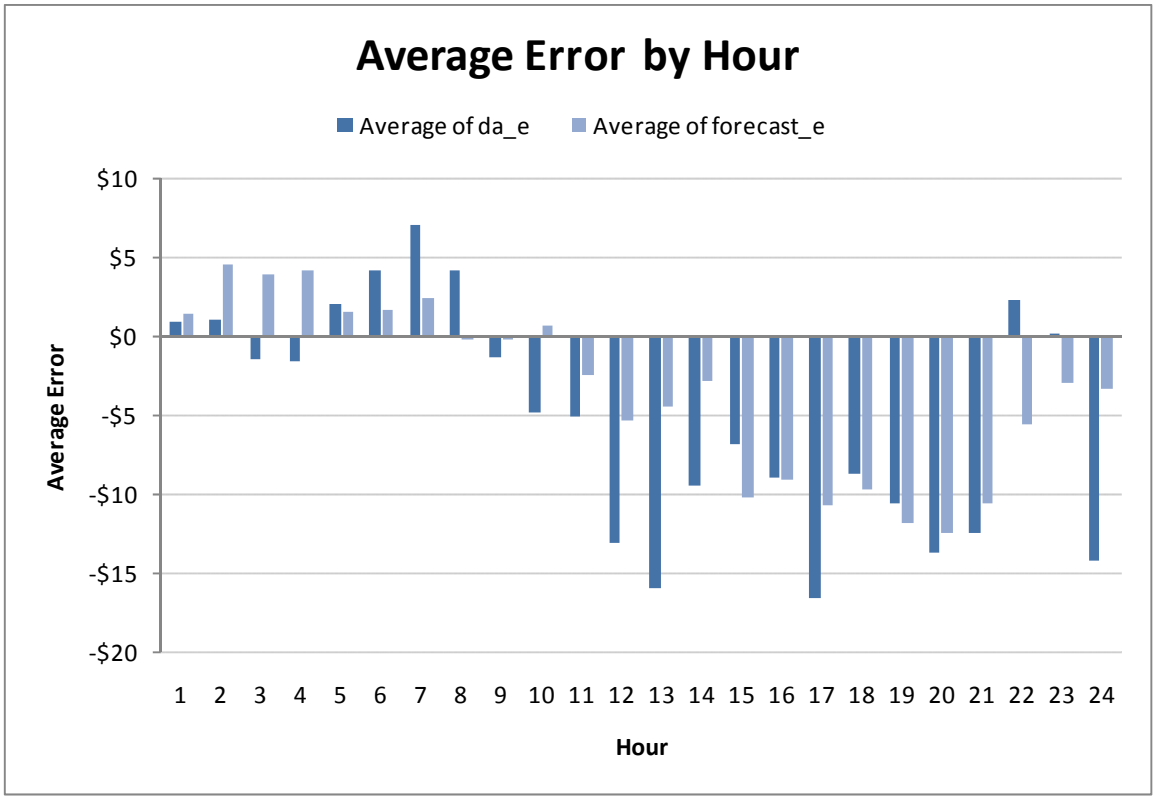
The efficiency score provides a measure of the inefficient consumption decisions induced by using the day ahead pre-dispatch price signal compared to using the day-ahead price forecasts. Over the period July to September 2008, the use of the day-ahead price forecast would have reduced the number of inefficient decisions by half. For example, in the case of a consumer with a willingness to pay up to $75 for electricity, there were 19 hours where the day ahead pre-dispatch price signal would have led the consumer to avoid electricity consumption, when in fact, it would have been efficient to consume the electricity. In contrast there were only 8 hours where this inefficient decision would have occurred, had the consumer used the day-ahead price forecast.

Table 8 Efficiency Score- Incentive to Increase Consumption

	IESO Day-ahead price forecast is less than or equal to $X and HOEP is greater than $100	IESO Day Ahead pre-dispatch price is less than or equal to $X and HOEP is greater than $100
X=$50	5	27
X=$65	20	40
X=$75	41	50
Score	**66**	**117**

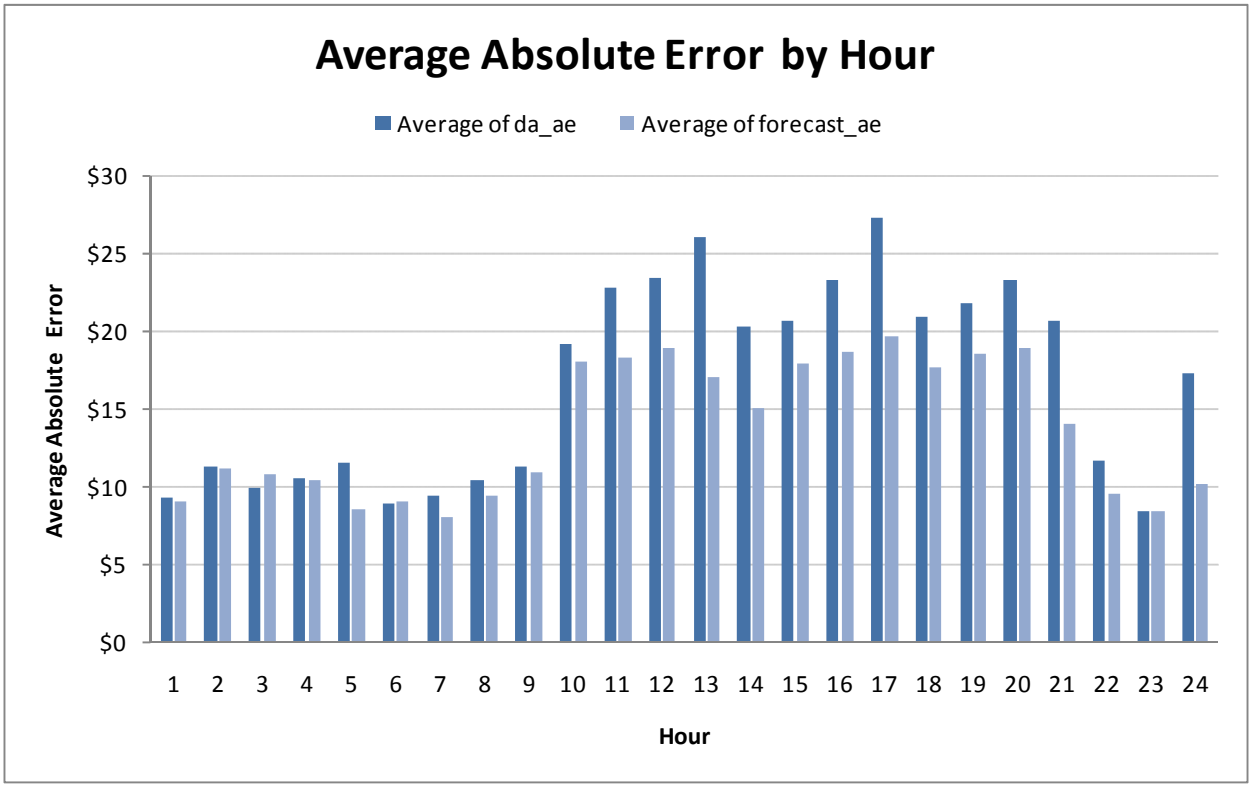
The efficiency score provides a measure of the inefficient consumption decisions induced by using the day ahead pre-dispatch price signal compared to using the day-ahead price forecasts. Over the period July to September 2008, the use of the day-ahead price forecast would have reduced the number of inefficient decisions by 44 per cent. For example, in the case of a consumer with a willingness to pay up to $50 for electricity, there were 27 hours where the day ahead pre-dispatch price signal would have led the consumer to consume electricity, when in fact, it would have been efficient to avoid electricity consumption. In contrast there were only 5 hours where this inefficient decision would have occurred, had the consumer used the day-ahead price forecast.

Chart 1 Average Error by Hour



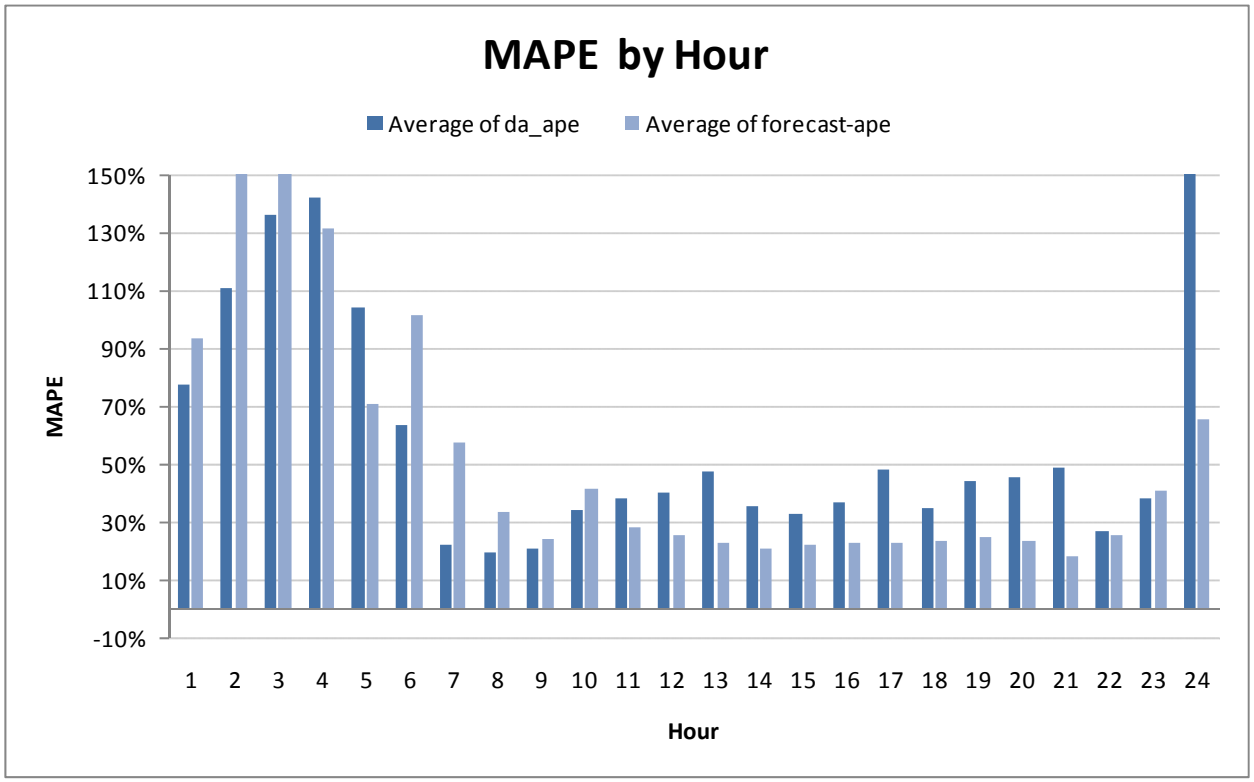
In this chart the dark blue bar represent the IESO Day-Ahead Predispatch Price and the light blue bar represent the IESO Day-Ahead Forecast Price. The height of the bar represent the average error which is shown for each hour of the day.

Chart 2 Average Absolute Error by Hour



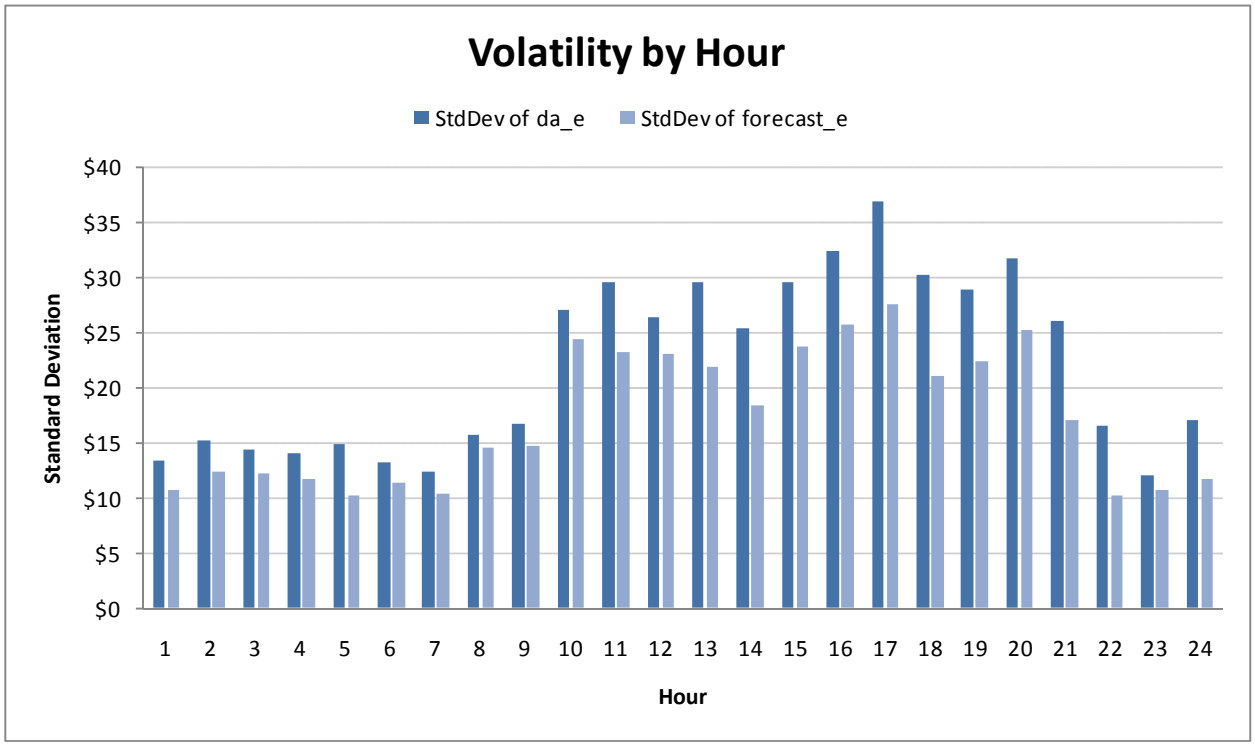
In this chart the dark blue bars represent the IESO Day-Ahead Predispatch Price and the light blue bars represent the IESO Day- Ahead Forecast Price. The height of the bar represents the average absolute error which is shown for each hour of the day. Except for hours 3 and 6, the day ahead price forecast was more accurate than the day-ahead pre-dispatch price signal.

Chart 3 Mean Absolute Percentage Error by Hour



In this chart the dark blue bars represent the IESO Day Ahead Predispatch Price and the light blue bars represent the IESO Day Ahead Forecast Price. The height of the bar represents the mean absolute percentage error which is shown for each hour of the day. By this metric, the day ahead price forecast perfomed better than the day-ahead pre-dispatch in all but 9 hours.

Chart 4 Volatility of Forecast Error by Hour



In this chart the dark blue bars represent the IESO Day Ahead Predispatch Price and the light blue bars represent the IESO Day Ahead Forecast Price. The height of the bar represents the standard deviation of the forecast error which is shown for each hour of the day. In each hour the forecast price will not be exactly equal to the actual price. The diffference between the two generates a forecast error. This error can be either large or small and it fluctuates around the average value of the forecast error. This dispersion around the average value is measured by the standard deviation. A high standard devaition value indicates a volatile forecast error which in turns mean it is more difficult to forecast the underlying price. The chart shows it more difficult to forecast prices during peak hours than during off-peak hours.

Appendix A -Efficiency Score

Case 1: Incentive to avoid electricity consumption (Table 7)

The efficiency score is calculated by analysing the number of times that the IESO price forecast exceeds a specified value given that that the actual price (HOEP) is below a threshold value. Assume a consumer has a valuation for energy at $75/MWh. That is the consumer is willing to pay up to $75 to buy electricity. Suppose the day-ahead price signal for hour 14 is $120/MWh. Clearly the consumer has an incentive to avoid consumption in hour 14. Now suppose the actual price (HOEP) comes in at $65/MWh. Had the consumer used the day-ahead price signal to avoid consumption in hour 14, he would have made an inefficient decision. At a price of $65/MWh, the consumer should have consumed to get a surplus of $5/MWh. The efficiency score quantifies the number of hours where such inefficient events occur. For example in Table 7, in 8 hours, the IESO day-ahead price forecast model predicted a price above or equal to $100. In those same eight hours the actual price (HOEP) turned out to be less than $75. In contrast, the IESO day-ahead pre-dispatch price projected a price above or equal to $100 in 19 hours and in those 19 hours the actual price turned out to be less than $75. Therefore the consumer is more likely to make an efficient decision if he used the IESO day ahead forecast model rather than the day-ahead pre-dispatch price signal.

Case II: Incentive to increase electricity consumption (Table 8)

We also analyse hours where the day-ahead pre-dispatch price (day-ahead price forecast) signal provided an incentive to consume electricity when in fact the consumer should have avoided electricity consumption. This again leads to inefficient consumption decisions. For example in Table 8, for the case of a consumer with a willingness to pay up to $50 for electricity, there were 27 hours where the day ahead pre-dispatch price signal would have led the consumer to consume electricity, when in fact, it would have been efficient to avoid electricity consumption. In contrast there were only 5 hours where this inefficient decision would have occurred, had the consumer used the day-ahead price forecast.

Appendix B-Calculation of the Benefits

To calculate the potential benefits we analyse hours where the IESO day-ahead forecast model provided better price forecasts than the IESO day-ahead pre-dispatch price signal. We consider two cases. In each case we assume a consumer has a valuation (strike price) of $75; that is, the consumer is willing to pay up to $75/MWh to buy electricity. We also assume that load totalling 50 MW is available to respond to high prices. This is a conservative load estimate and it is of the order of the Toronto Hydro peak saver program that was activated in July 2008[4].

Case I: Forecast is above $75, pre-dispatch is less than $75 and after the fact the HOEP is above $75

At the time of making its consumption decision, the consumer has two choices; either use the prices from the IESO day-ahead forecast model or use the day-ahead pre-dispatch prices. For example on July 2 in hour 13, the model forecast price was $90 and the pre-dispatch price was $62. Suppose the consumer is willing to pay up to $75 for electricity. In that case, using the forecast price of $90 as a guide, the consumer should avoid consuming electricity in hour 13. However if the consumer had made the decision based on a pre-dispatch price of $62, they would have consumed in hour 13. In this case the consumer would have paid $94 and the surplus would be negative $19 per MW (valuation of $75 minus HOEP of $94). Had the consumer used the day-ahead price forecast, they would have avoided a negative surplus of $19 per MW in that hour. For consumers totalling 50 MW, the avoided negative surplus amount would be $950 in that hour alone. There were 34 hours in the period July to September 2008 where the day-ahead price forecast model provided sufficient improvement to allow the consumers to potentially avoid negative surpluses amounting to almost $45,000.

[4] See http://www.powerauthority.on.ca/Page.asp?PageID=122&ContentID=6605&SiteNodeID=134&BL_ExpandID=

Case II: Forecast is less $75, pre-dispatch is greater than $75 and after the fact the HOEP is less than $75

At the time of making its decision, the consumer has two choices; either use the prices from the IESO day-ahead forecast model or use the day-ahead pre-dispatch prices. For example on July 8 in hour 8, the model forecast price was $65, the pre-dispatch price was $102 and the actual price was $59. Suppose the consumer is willing to pay up to $75 for electricity. In that case, using the forecast price $65 as a guide, the consumer should consume electricity in hour 8. However if the consumer had made the decision based on a pre-dispatch price signal of $102, they would have avoided consumption in that hour. For consumers totalling 50 MW, the estimated lost consumption value in this hour alone would be roughly $800 (strike price of $75 minus HOEP of $59 times 50). There were 21 such hours (totalling almost $16,000 in lost value) in the period July to September 2008 where the price forecast model provided sufficient improvement to prevent this loss of consumption value.

In a total of 56 hours over the period July to September 2008, the improved price forecasts would have generated benefits amounting to $61,000.