The Ontario Electricity Market – Global Adjustment Model, Over-contracted Supply Estimation, and Price Decomposition

By Jeremy D.W. Packard
3744540

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Supervisor: Professor Jean-Thomas Bernard

Eco 7997

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1. Abstract

The Ontario government has implemented guaranteed price contracts with renewable and nuclear electricity producers. When generation of the contracted supply is greater than Ontario's demand (less imports), the excess electricity must be exported and/or some contracted generators must be temporarily shut down (some still receive payment). This paper estimates over-contracted generation loss from 2006 to March 2012 and finds the yearly loss for 2011 was approximately $ 17.7 million dollars added with the forced shut down cost of $ 20.1 million. The export industry reduced the potential loss by $ 5.6 million by paying the Independent Electricity System Operator wholesale market price (lower than the contracted rate) for the excess contracted generation. The argument for keeping a discrepancy between export price (wholesale) and Ontario's consumer price (wholesale + global adjustment) is based on this value. The Ontario Independent Electricity System Operator market wholesale price dropped significantly with the decrease in the price of gas in 2009 (discovery of shale gas). However, from 2008 to 2011, the overall Ontario consumer price has increased, by $17.19/MWH to $20.00/MWH. At least $10.19/MWH of this increase is due to Ontario Power Authority renewable energy contracts and OPA programs.

2. Introduction

The purpose of this paper is to determine the cause of the increasing price of electricity Ontario consumers pay. Ontario consumers currently pay both the wholesale price and the global adjustment per kilowatt hour of the electricity they use. The global adjustment is a charge/credit per unit of electricity adjustment that accounts for the difference between wholesale price and contracted generators guaranteed prices and also accounts for other Ontario Power Authority contracts.[1] Since 2009, the wholesale price has greatly decreased while the global adjustment per unit of electricity continues to increase.[1 2] The global adjustment is not however, applied to the electricity exports of Ontario. **Figure 1** charts the breakdown of the monthly averages for the total Independent Electricity System Operator (IESO) market price (global adjustment + wholesale price), the global adjustment, and the wholesale price from January 2005 to March 2012.

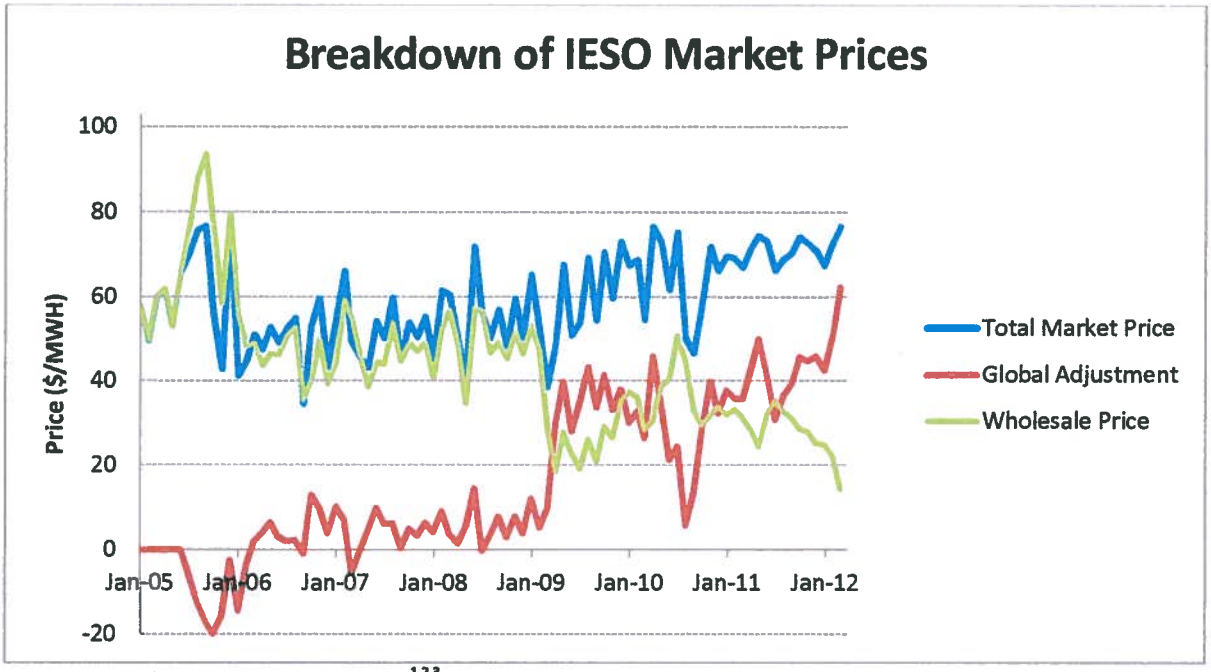

Figure 1: Breakdown of IESO Market Price [1 2 3]

In electricity markets guaranteed price long-run contracts are signed with generators to reduce uncertainty and risk. Without these contracts generators may not enter the market due to uncertainty of the price they will receive. Guaranteed price long-run contracts are used to ensure there is sufficient supply in the market and to encourage growth in higher cost technologies that have less environmental impact. A price distortion is caused by contracts usually leading to overall higher prices. The positive externalities electricity contracts are hard to measure and therefore it is uncertain to what extent contracts effect social welfare.

In response to insufficient supply before 2002, the Ontario government, through Ontario Hydro, signed guaranteed price long-run contracts, usually 15-20 years, with many gas-fired generators (Non-Utility Generators) (Trebilcock and Hrab, 2005). It also has procured guaranteed price long-run contracts with the Ontario Power Generation (OPG) for Nuclear and Hydro and Bruce Power for Nuclear.[4] After the Electricity Restructuring Act, the Ontario Power Authority (OPA) has created, through "green" energy initiatives, guaranteed price long-run contracts for wind, small hydro, solar and bio-energy.[5 6] Gas-fired generators (not including non-utility generators) and some of OPG's hydroelectric generators are the main sources of electricity that are not guaranteed price contracted.[7]

In its inception in 2005, the global adjustment was called the "provincial benefit" which only applied to Ontario consumers.[8] In 2005, the provincial benefit was slightly negative. This gave Ontario consumer's a credit because the average wholesale price was greater than the average contracted guaranteed price. The "provincial benefit" was slightly negative or positive from 2006 to 2008. However, since 2009 the provincial benefit has been positive as "green" programs have been initiated and the wholesale price has decreased. The driving factor of the wholesale price decrease is a result of the technological discovery of shale gas.[9] This discovery drove down the price of natural gas significantly.[10] The discovery therefore lowered the marginal cost of gas power plants which is determined mainly by the price of natural gas. Due to the absorption of OPA programs into the price Ontario consumers face, the overall price to Ontario consumers has been increasing over time and Ontario has not benefitted from gas prices being approximately three times lower than previous years. [A 10] However, the export market, mainly the United States, only pays the wholesale price and have greatly benefitted from the wholesale price being low. The export price is on average slightly higher than the wholesale price.[B] **Figure 2** charts monthly averages for the Registered Price Plan (RPP), the wholesale price added with the global adjustment, and the export Price from January 2005 to March 2012.

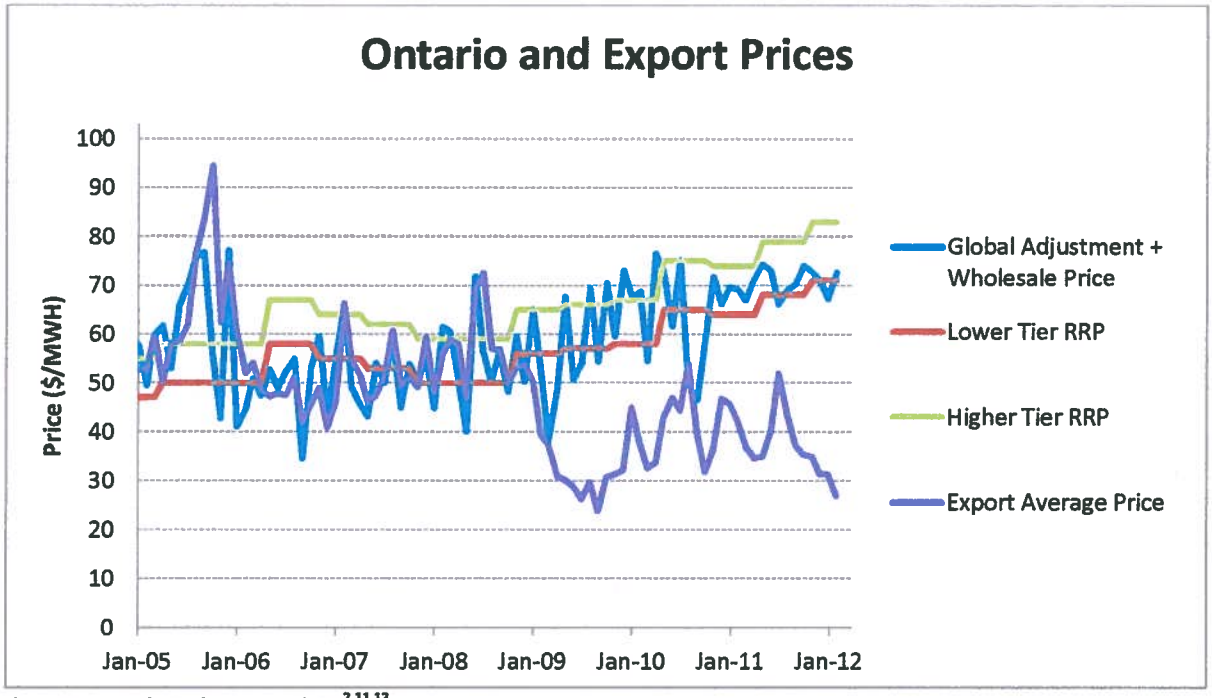

Figure 2: Ontario and Export Prices [2 11 12]

In January 2011, the Ontario government renamed the "provincial benefit" to the "global adjustment".[3] This price distortion, the difference between the Ontario consumer's price and the export price, has created a welfare loss for Ontario consumers. If export consumers were also responsible for paying the "global adjustment" total exports would decrease or disappear due to a higher wholesale price. However, since the export consumers would then pay a portion of the global adjustment and the more cost efficient plants could be used for Ontario's consumption, the overall price Ontario's consumer's face would drop and Ontario consumption and consumer surplus would increase. The argument against not applying the global adjustment to exports is that in the case of excess contracted supply, exports can

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[A] Average price of natural gas 2008 / average price of natural gas 2012 (January - March) = 3.15 [10]

[B] Average difference between monthly average export price and wholesale price from 2005 to 2011 = $2.06/MWH [2 12]

receive a positive (though low) price for electricity that Ontario consumers would have to pay for even if not produced. [13] According to the IESO "power can be exported when it's not needed in Ontario. Without the ability to export, Ontario's generators would lose important revenue streams which helps recoup some of the costs for maintaining their facilities and helps maintain reliability. These are costs that would otherwise be paid for by Ontario consumers."[14]

3. Literature Review of Papers on the Ontario Electricity Market

The **"Electricity Restructuring in Ontario" (Trebilcock and Hrab, 2005)** paper explains the reformation of Ontario's market in 2002 and explains why prices were frozen by the government again. They conclude the high temperature of summer, market design problems, and political economy problems played a part in the market.

The **"Electricity market price volatility: The case of Ontario" (Zareipoura, Bhattacharyab and Canizares, 2007)** paper quantifies Ontario's price volatility. It concludes that Ontario's prices are more volatile than their neighbours and among the most volatile prices in the world due to the real-time market.

The **"Forecasting short-term power prices in the Ontario Electricity Market (OEM) with a fuzzy logic based inference system" (Arciniegas and Arciniegas Rueda, 2008)** forecasts wholesale prices based on times of peak demand.

The **"High Frequency Export and Price Response in the Ontario Electricity Market" (Melino and Peerbocus, 2008)** analyses the effect of unanticipated Ontario supply shocks on the export/import market. It determines that an increase in price due to an Ontario Supply shock leads to a decrease in export volume from New York and an increase in import volume from Michigan.

"An analysis of capacity and price trajectories for the Ontario electricity model using dynamic Nash equilibrium under uncertainty" (Genc and Sen, 2008) examines trends of capital investment and the pricing behavior of suppliers. They examine the potential policy of reducing the market power of OPG and find a market with more players would reduce the market price.

The **"Response of industrial customers to hourly pricing in Ontario's deregulated electricity market" (Choi, Sen and White, 2011)** estimates the effects of the wholesale price on the demand on industrial consumers. The paper concluded that industrial consumers shift consumption to off-peak times due to lower prices and that this shift leads to lower on-peak prices.

The **"Competition, Contracts, and Entry in the Electricity Spot Market" (Newbery, 1998)** paper looks at the effect of contracts in the British electricity market. The paper was aimed at determining equilibrium in the supply market with contracts and contestable entry.

The **"Market Structure and the Price of Electricity: An Ex Ante Analysis of the Deregulated Swedish Electricity Market" (Andersson and Bergman, 1995)** paper concluded that the deregulation of the Swedish market would not lead to lower equilibrium prices. The paper used a quantitative model to show how the price is related to the number and size of the generators.

Gaps in the Literature:
Most current papers on the Ontario electricity market have looked at the effects of supply or demand on prices. There is however no theoretical framework to analyze Ontario's market. No formal research has been done to determine what effect the "green" initiatives are having on the price. Also, nothing has been produced to analyze the effect of exports not paying the same price as Ontario on Ontario's economic welfare.

Direction of Paper:
First an understanding of the history of the Ontario market is needed to understand the current Ontario electricity sector and then give the unique characteristics of electricity markets. A monthly Ontario theoretical model will be built and then used to explain the Ontario market since the Global Adjustment was implemented in 2005. This monthly model will be used to examine if Ontario would benefit from charging the global adjustment to exports. Next a theoretical hourly Ontario electricity market model will be built. Based on this hourly model, empirical data will be used to estimate the losses due to over-contracted supply in Ontario's market. Finally, empirical data will be used for a price decomposition that will be estimated to explain which factors are affecting the Ontario price.

4. History of the Ontario Electricity Market

As explained in the Trebilcock and Hrab (2005) paper the Ontario government reformed the government owned and controlled market in May 2002. The government sought to privatize the electricity system and sold or leased some of their assets. They still retained 70-75% of the generating facilities, through the Ontario Power Generation and most of the transmission network through Hydro One. The Ontario Energy Board would set transmission and distribution rates to regulate the monopoly segments of the electricity market. The government also created a time-of-use wholesale market with the marginal supplier setting the spot price where demand meets supply, with prices set every five minutes. Operated by the Independent Market Operator (IMO), the market was only open temporarily due to a hot summer and insufficient supply. While open, the monthly average price doubled compared to the initial price and at times spikes to more than $1000/MWH.[C] The province imported the maximum amount of electricity the transmission system could accommodate at that time. These price increases caused it to close in November 2002 and return to a frozen price. In October 2002 the IMO reported that "[t]here is a serious shortage of generating capacity to meet Ontario's growing demand for electricity. If steps are not taken to address this situation, Ontario could face even more serious reliability problems next summer, leading to the possibility of supply interruptions and continued upward pressure on prices during periods of peak demand" (Trebilcock and Hrab, 2005).

On December 9, 2002, the "Electricity Pricing, Conservation, and Supply Act" (2002) was passed which severed the link between wholesale and retail prices.[15] The retail price of electricity for low volume consumers (households, small businesses, farmers, etc), which was approximately half of electricity demand, was frozen "until there is sufficient electricity supply, at reasonable prices to meet Ontario's long term needs." The difference between the wholesale price and the frozen retail price would be paid by the government of Ontario to the suppliers" (Trebilcock and Hrab, 2005).

On October 2, 2003 the Liberal party took power and shortly after passed the Electricity Restructuring Act (ERA), 2004. The act created the Ontario Power Authority (OPA) and renamed the IMO the Independent Electricity System Operator (IESO). [15] The OPA was formed to create an adequate and

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[C] Hour 14 of September 3, 2002 - $1028/MWH. Note: Two hours have had higher wholesale prices. Hour 11 of February 18, 2009: $1039/MWH and Hour of 12 February 18, 2009: $1891/MWH.[2]

reliable electricity system for Ontario. It would forecast demand, engage in activities promoting efficiency and conservation, and facilitate stability in rates for certain types of consumers [ERA 25.2(1)].The directives determined by the Minister of Energy included increasing the variety of energy sources, using renewable energy sources, phasing-out coal burning plants, and energy conservation [ERA 25.30(2)]. The OPA was given the power to enter into contracts for the procurement of electricity supply or capacity including alternate and renewable energy sources [ERA 25.32(1)]. The IESO was to operate the market, enter into agreements with transmitters, direct the operation of transmission systems, and provide the OPA and the public with information regarding the current and short-run electricity needs of Ontario [ERA 5(1)]. To ensure that prices reflected costs "[t]he IESO shall, through its billing and settlement systems, make adjustments in accordance with the regulations that ensure that, over time, payments by market participants in Ontario reflect amounts paid to generators, the OPA and the Financial Corporation, whether the amounts are determined under the market rules or under sections 78.1 to 78.4 of the *Ontario Energy Board Act, 1998"* [ERA 25.33(1)].

The Electricity Restructuring Act led to the "Provincial Benefit" (later the "Global Adjustment"), Renewable Energy Systems contracts (RES), the "Renewable Energy Standard Offer Program" (RESOP) and more recently the Feed-in Tariff Program (FIT).

Provincial Benefit:
According to the IESO, "[t]he Provincial Benefit ensures reliability by providing adequate generating capacity for Ontario. It accounts for differences between the spot market price and the rates paid to regulated and contracted generators. As a result, its value may be positive or negative, depending on the fluctuation of prices in the spot market."[8] The rate is based on regulated price paid to:

- The Ontario Power Generation's baseload power generators
- Ontario Power Authority – IESO's original provincial benefit definition: "Payments made to suppliers that have been awarded contracts through the Ontario Power Authority. These include new gas-fired facilities, renewable facilities (like wind farms) and demand response programs."[8] IESO's current global adjustment definition: "Contracts with generators and suppliers of conservation services".[3]
- Contracts for Non-utility Generators (administered by the Ontario Electricity Financial Corporation – former Ontario Hydro's contracts).

The adjustment started in January 2005 and until December 2010 "the government set the preliminary daily [provincial benefit] rate on a monthly basis".[8] This was a fixed monthly rate for distributor billing which meant the "estimated global adjustment" was reflected in the next months fixed rate. This adjustment applies to customers who buy on the spot market, have a contract with an electricity retailer, and customers who pay the regulated price plan (it is factored into the total rate by the OEB). It does not apply to exports. In January 2011, the provincial benefit was renamed the global adjustment. The formatting changed to charge the adjustment (per MWH consumed) at the end of the month with two estimates during the month.[1]

Renewable Energy Standard Offer Program:
In March 2006 the Premier announced that there would be guaranteed prices for wind, hydro, biomass, and solar photovoltaic. The program is administered by the OPA and for projects under 10 MW. **Table 1** consists of the guaranteed prices for the RESOP, FIT, and Micro FIT programs. **Table 2** consists of the current and planned capacity of all renewable energy.

Table 1: "Green" Energy Guaranteed Prices ($/MWH) [5,6]

Energy Source	RESOP	FIT	Micro FIT
Biomass	110	130 – 138	138
Biogas	110	104 – 195	160
Landfill Gas	110	103 - 111	111
Hydroelectricity	110	122 – 131	131
Wind	110	135	135
Solar PV	420	443 – 713	642 – 802

Table 2: "Green" Capacity as of Q4-2011 (MW) [16]

Energy Source	RESOP		FIT		RES/Other		Micro FIT	
	Current	**Planned**	**Current**	**Planned**	**Current**	**Planned**	**Current**	**Planned**
Hydroelectricity	28.2	0.0	0.0	188.1	93.9	472.9	-	-
Wind	233.8	65.0	215	2918.2	1509.4	870.0	-	-
Bio-energy	41.6	24.6	8.8	50.2	9.1	78.0	-	-
Solar PV	311.2	170	22.6	1217.4	0.0	200.0	85.7	0.0

Feed-In Tariff Program:

The Ontario Green Energy Act was passed on February 23, 2009 to promote renewable energy production, energy conservation, and "green" jobs.[17] The RESOP was replaced by the micro FIT program (under 10MW) and the FIT program (commercial). In the fourth quarter of 2011, the capacity of renewable sources was 2,559 MW with 6,255 MW under development. Note: actual generation is measured by the capacity x capacity factor (%).[18]

5. Electricity Market Specifics

Currently Ontario has no way to store electricity and once generated it must be consumed. Since demand varies between time of day and seasonally, both baseload and peaking plants are used to create electricity. **Figure 3** charts the hourly quantity at each hour of the day for the day of the highest hourly quantity in 2011, lowest hourly quantity in 2011, and the 2011 average at each hour. **Figure 4** charts the average monthly hourly demand for each month from 2006 to 2011.

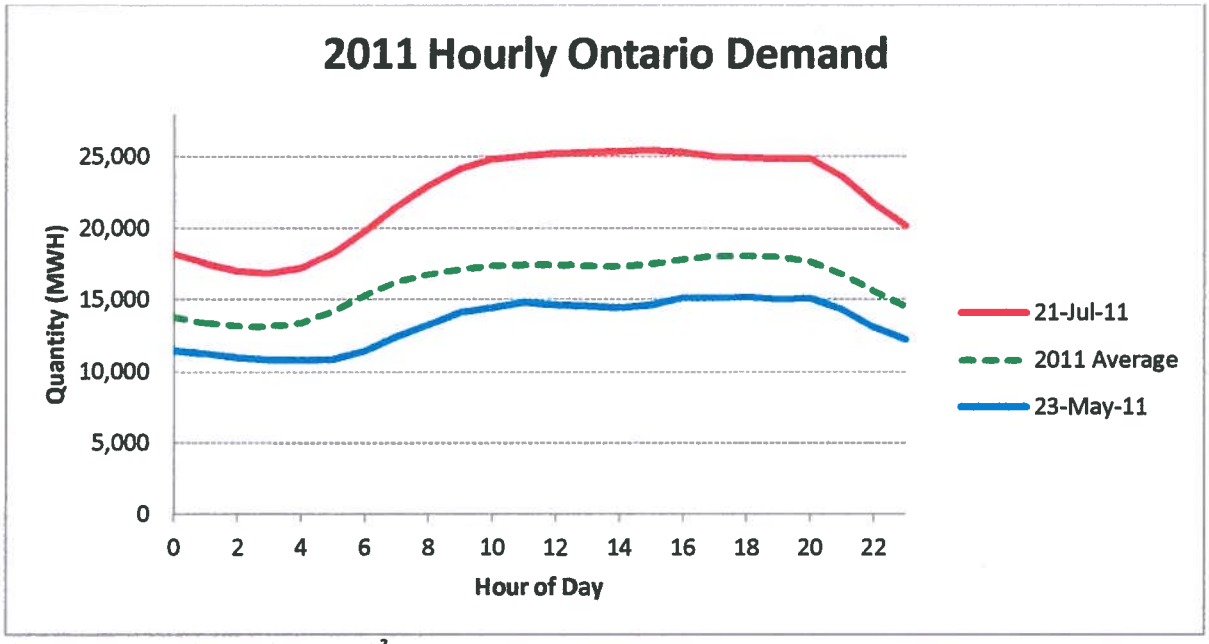

Figure 3: 2011 Hourly Ontario Demand [2]

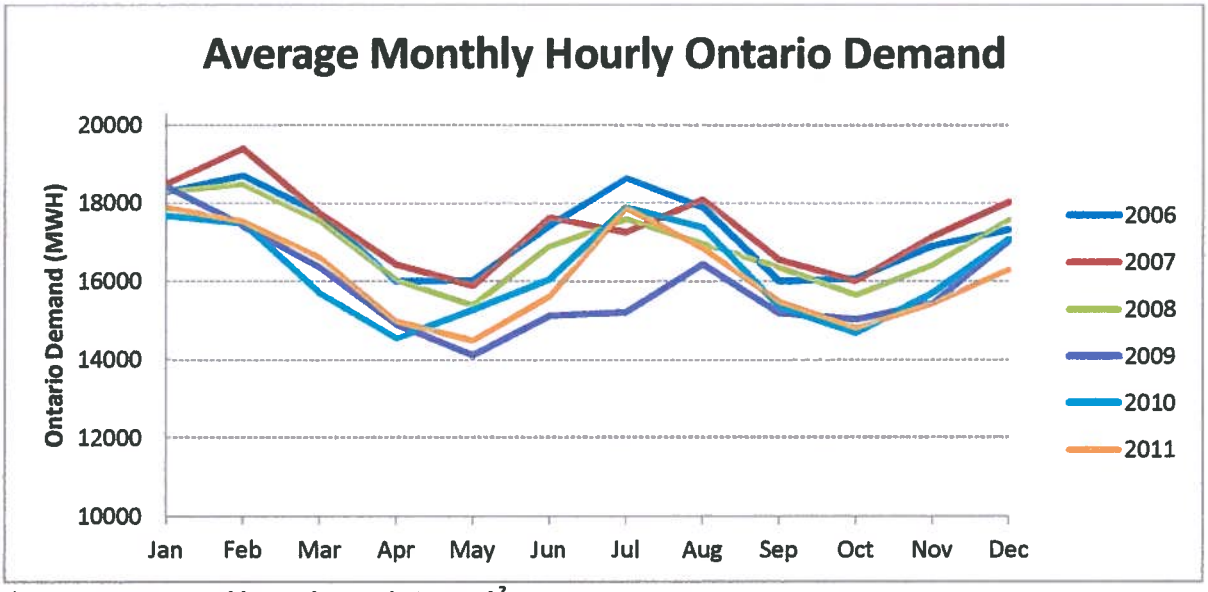

Figure 4: Average Monthly Hourly Ontario Demand [2]

Baseload Power:
Baseload generators must meet continuous demand and generate power at a constant rate, usually relatively low cost technologies such as nuclear, coal, hydroelectric. Nuclear and coal plants take a long time to shut down and start up again (days for nuclear).[19]

Peaking Power:
Peaking generators only run when demand is high (summer/daytime). Natural gas is the main fuel for peaking plants but diesel oil or jet fuel can be used as a backup. Some of the larger hydroelectric dams are also used as peaking plants.[19]

Embedded Demand/Supply:

The IESO market only deals with power generators over 20 MW.[20] When the generator is under 20 MW, such as all micro FIT and most FIT or RESOP generators, the power it produces goes to the local market. The local markets' demand for power from the IESO grid is now less this amount. Therefore, the IESO market demand is not the total Ontario market demand it is the "embedded" market demand. As the generators under 20 MW increase, through "green" energy programs, the IESO market demand will decrease over time. **Figure 5** charts RESOP, FIT, and Micro FIT estimated generation, during the fourth quarter of 2011, at the prices at which they are contracted at.[16] The figure also includes the average wholesale price for the quarter as comparison. There is additional non-embedded supply not included in **Figure 5**, but the generators would have been built before 2008 and there is no available data on them. For the fourth quarter of 2011, when the estimated non-embedded supply is added to the IESO market supply, non-embedded supply accounts for 2.28% of total Ontario generation.[2 5 6 16]

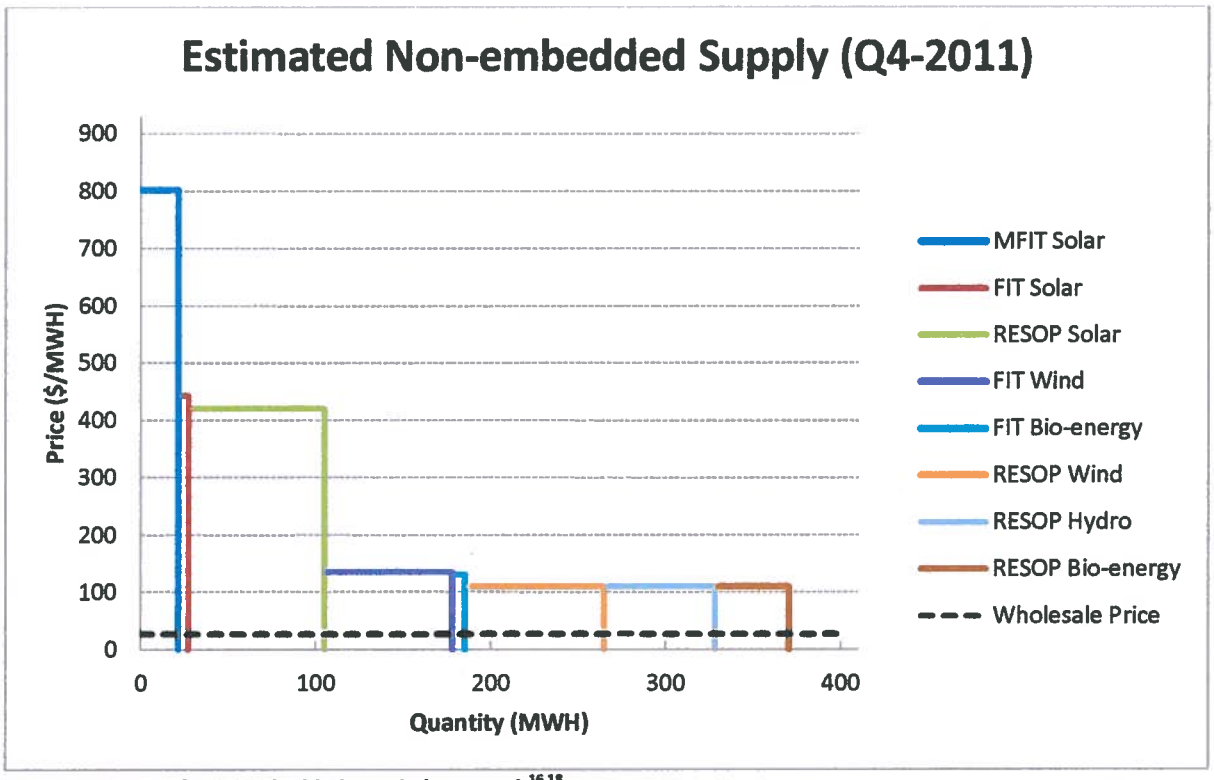

Figure 5: Estimated Non-embedded Supply (Q4 -2011) [16 18]

The Ontario demand, exports and imports are graphed in **Figure 6**. The IESO Ontario market demand for electricity is trending downward due to the non-embedded supply increasing, increased energy conservation and the higher prices faced by Ontario consumers. The imports by Ontario are slightly decreasing over time and since 2008 exports have been relatively high.

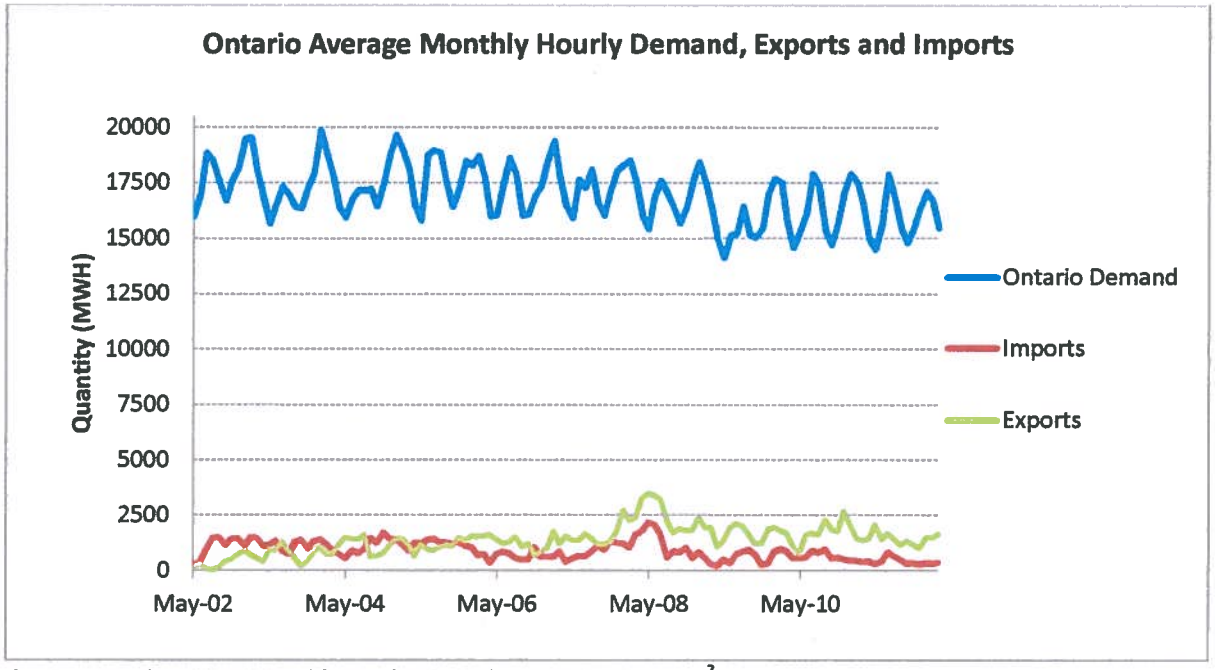

Figure 6: Ontario Average Monthly Hourly Demand, Exports and Imports [2]

6. The Ontario Electricity Market

The monthly theoretical model will use hourly prices and quantities to explain the equilibrium in the Ontario IESO wholesale market. The prices will be in Canadian dollars per megawatt hour ($10/megawatt hour = 1¢/kilowatt hour). The quantity of generation will be in megawatt hours (not to be confused with megawatts which measures generator capacity).

Ontario Demand for Electricity:

Residential and other low volume consumers face fixed prices (RPP) updated twice yearly (the global adjustment is absorbed in this price).[11] The OEB estimates the RPP rate to equal the wholesale price plus the global adjustment. The RRP consumer's monthly average demand mainly depends on the RPP price, the weather (air conditioning/heating), and their economic status (income/employment). The RPP consumers have fixed hourly prices and are therefore unaffected by hourly IESO market price fluctuations.

The industrial and commercial sectors, IESO market consumers, are hourly price elastic customers and pay the IESO market price plus the global adjustment. IESO market consumers face the residual of supply on the hourly market because RPP consumers hourly demand is unaffected by the IESO market price. Without information on the quantities that both types of consumers consume, it is impossible to determine the elasticity of demand for the total market.

The demand of the RPP consumers can vary greatly between months, which will change the amount and generation type of electricity available to the IESO market consumers. With high demand they will use more expensive technologies or less efficient plants. So, it would seem that as price and demand both increase/decrease at the same time. However, the RPP consumers will change their consumption pattern every six months with price changes. This effect can be estimated by using their price (RPP). Unfortunately in Ontario the total price (RPP or wholesale price plus global adjustment) is highly correlated with time. This makes it difficult to distinguish if Ontario demand is decreasing due to the

increasing price, poorer economy, or energy conservation. Also, higher electricity prices can, in the long run, cause lower economic growth and lower demand (cyclical effect). The IESO market Ontario demand may be misleading and overestimate this decrease since it does not include non-embedded demand.

IESO Market Supply:
The market is split into two types of producers; contracted and not contracted. The contracted generators (ones that the Global adjustment applies to) will produce their maximum regulated amount. They are price inelastic in the sense that they are paid a fixed predetermined rate (they can be paid to not produce electricity when total market demand is too low). **Figure 7** charts the fixed price contracted generation average production and prices for the fourth quarter of 2011.

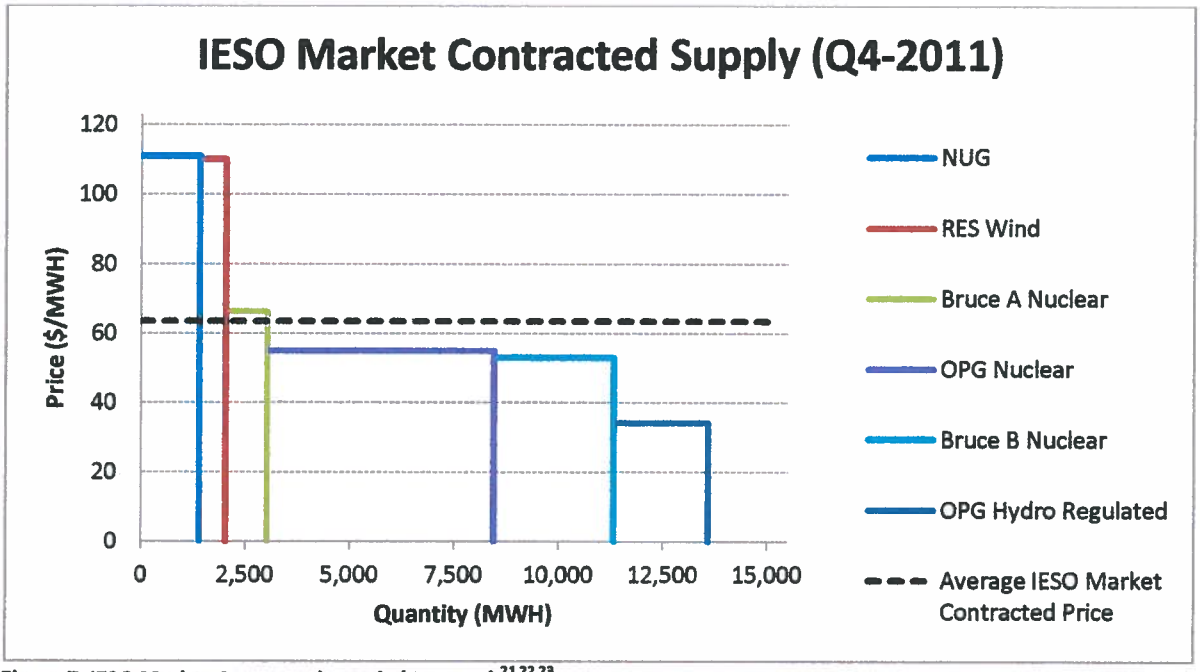

Figure 7: IESO Market Contracted Supply (Q4-2011) [21 22 23]

The second types of producers are the not contracted power plants which are mostly recently built natural gas fired generators or OPG's unregulated hydroelectric and fossil fuel generators. **Figure 8** charts the OPG's and other market not contracted average hourly generation and average price for the fourth quarter of 2011. The figure assumes the other not contracted generators receive the average wholesale price (this value is probably underestimated due to not contracted generators usually running during higher demand times).

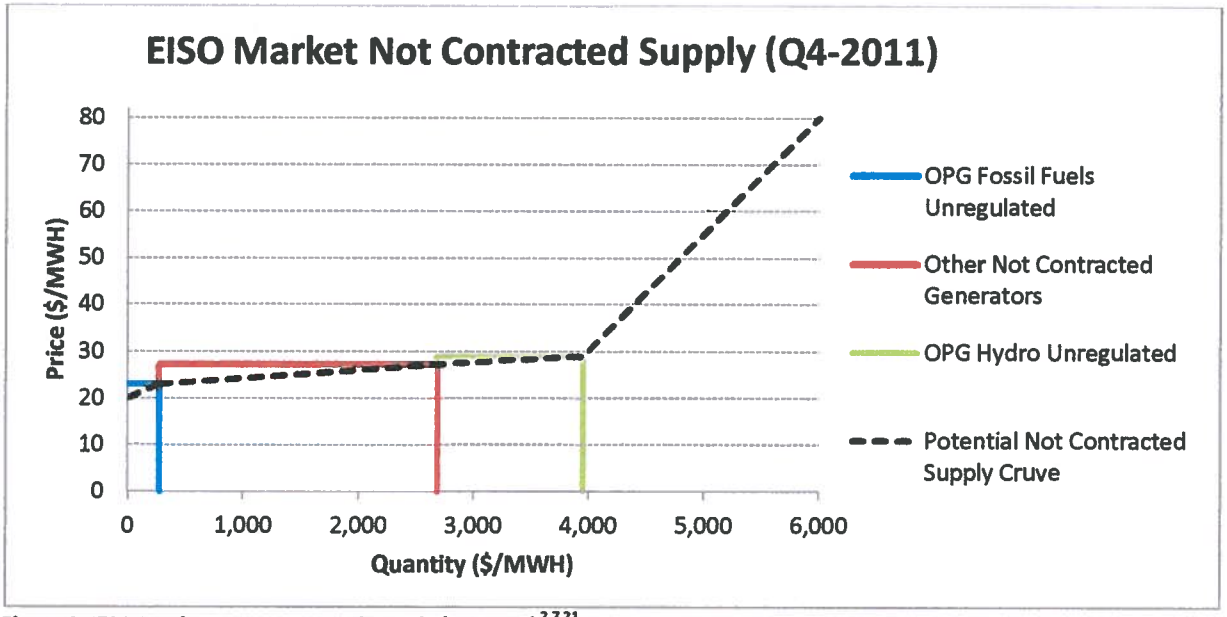

Figure 8: IESO Market Not Contracted Supply (Q4-2011)[2 7 21]

Adding the IESO market contracted and not contracted supply together yields the IESO total market supply curve. This market is faced by Ontario Demand (less imports and non-embedded supply) and export demand. Contracted Supply must be used first as it is guaranteed (Bruce, non-utility generators) or regulated (OPG) production. Next the not contracted supply is used unless Ontario demand is not sufficient to cover the contracted supply. The average contracted supply consists of the amount of contracted supply shown at the average contracted price.

The Global Adjustment:

The value of the Global Adjustment has been rising with the OPA "green" programs and the wholesale price dropping. The first part of the value is determined by the amount of contracted generation and the guaranteed prices that are given to them. The average guaranteed price is defiantly rising with the above market prices of the "green" technologies and the reduction of coal production (cost effective compared to "green"). An additional value which adds to the Global Adjustment each month is due to the price discrepancies between the wholesale price and guaranteed price for contracted non-embedded supply. The contracted non-embedded supply includes the non-utility generators (less than 20 MW capacity), FIT (less than 20 MW capacity), RESOP, and micro FIT programs.

The OPA has programs for energy conservation (2011 - $317 Million) and other programs which are created by the Minister of Energy's directives.[15] Also, it will include the values of the OPG's cost recovery fund (to make up for lost coal producing revenue due to new environmental regulations) and the OPA operating expenses.[1 7] **Appendix 1** contains the OPA expenses and programs from 2008-2011. These programs value are divided over the Ontario demand (less imports) and the total Global Adjustment value has increased in recent years due to them.

As of 2008 the IESO separated the value of the Global adjustment into three sections: amount of money given to the non-utility generators, the OPG and the OPA.[3] This value is the guaranteed price given to the generators subtracted by the wholesale price multiplied by the amount of contracted generation. **Figure 9** charts the total value of the global adjustment from 2006 and as of 2008 breaks down each source off the payment.

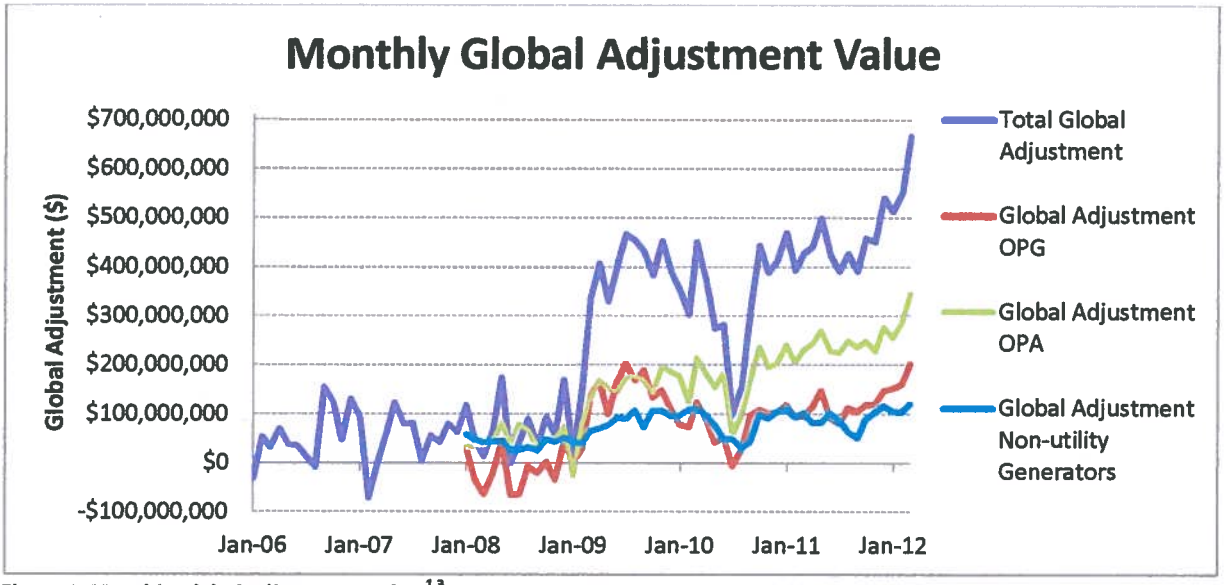

Figure 9: Monthly Global Adjustment Value [13]

Non-utility Generators:

According to the Association of Power Producers of Ontario (APPrO) non-utility generators "[f]irst were commissioned in the early 1990's and have PPAs [power purchase agreements] of 15 to 50 years".[22] The "[t]otal capacity of the PPAs is 1,652MW..." and "many of the projects are natural gas, biomass and hydro based". (APPrO, 2009) In 2004 the average price for non-utility generators per kilowatt hour was $80/MWH. In the OPA 2011 Annual Report "There are 31 of these facilities in Ontario, generating approximately 1,400 MW of electricity from natural gas, biomass and energy from waste facilities...".[4] In the APPrO report 15 gas and biomass non-utility generators are named and in 2011 their average aggregate production was 808MW/h. Information on the other non-utility generators is not available from the OPA. **Appendix 2** contains the list of the non-utility generators listed.

Ontario Power Generation:

The OPG has regulated and unregulated electricity generators. Regulated plants include the larger hydroelectric and nuclear and receive the guaranteed prices through the global adjustment if the wholesale price is below this price. Unregulated plants only receive the wholesale price and are the other hydroelectric and fossil fuel. The OPG also receives a cost recovery fund for lost revenues due to forced reduction in coal production.[7]

Ontario Power Authority:

The OPA has contracts for Bruce power, FIT, RESOP, micro FIT and other electricity production contracts.[4] Bruce A has a guaranteed price, like the OPG, while Bruce B faces a price floor and benefits from higher wholesale prices.[20] [21] The "green" programs pay higher than market price to encourage less cost effective technologies and are mostly included in the non-embedded supply. Also the global adjustment includes conservation programs and operating expenses.[1] **Figure 10** shows the contribution to each global adjustment type and the wholesale to the total price.

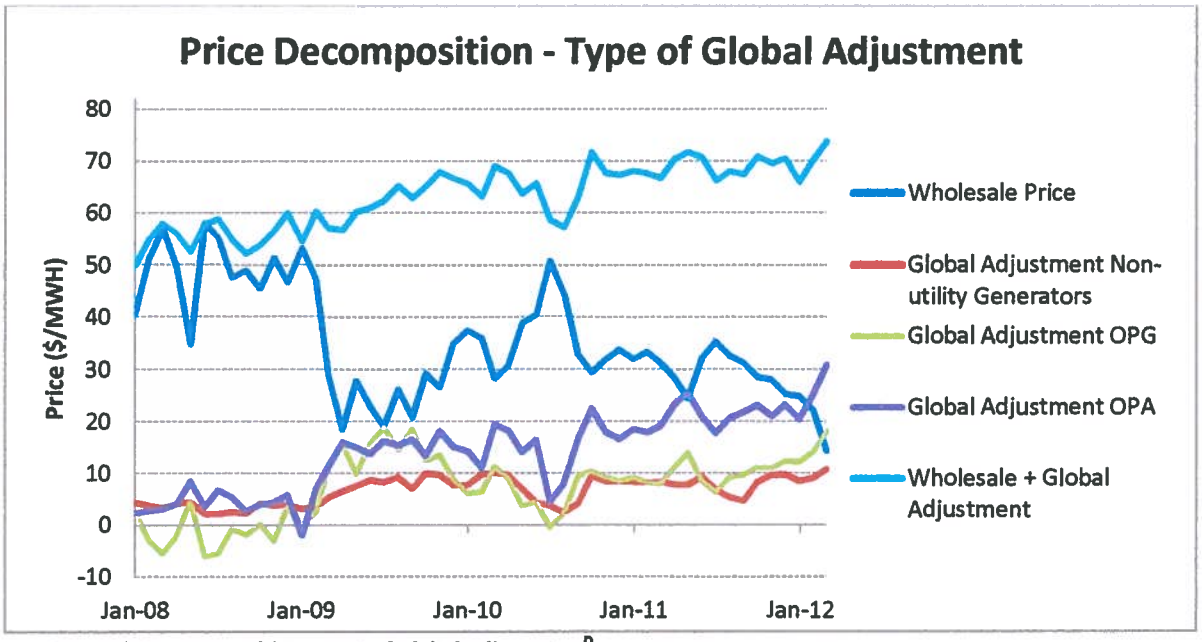

Figure 10: Price Decomposition - Type of Global Adjustment [D]

The Wholesale Price:

After 2006, the wholesale price has been mainly determined by the price of natural gas. Factors that drive the average wholesale price down could include when the contracted supply is greater than the Ontario demand (less imports). In order to avoid costly shutdowns power plants may "dump" their power.[E] If the demand is expected to rise again soon it may be more efficient to have a negative hourly price. The contracted generators just receive a greater value of global adjustment at the end of the month. It seems unlikely a not contracted plant would have a negative marginal cost and be willing to "dump" its power. The average monthly wholesale price would be greater if there are periods when demand is high and other more costly electricity technologies (oil, etc) have to be used. Also, if there are differences in the efficiencies of natural gas or hydroelectric plants, the residual supply curve would be upward sloping. **Figure 11** charts the relationship between the wholesale market price and the US natural gas price (exchange rate adjusted).

[D] **Figure 10** global adjustment is shown in hourly figures. The total monthly global adjustment value is divided by the monthly average Ontario demand (less imports) then divided by the number of days in the month divided by 24 hours.

[E] The lowest hourly price April 30, 2009: -$139/MWH. Note: The hourly wholesale price has been negative 656 times, 613 were after January 2009 and only 5 times before 2008. (since market opened in May 1, 2002-March 31,2012)

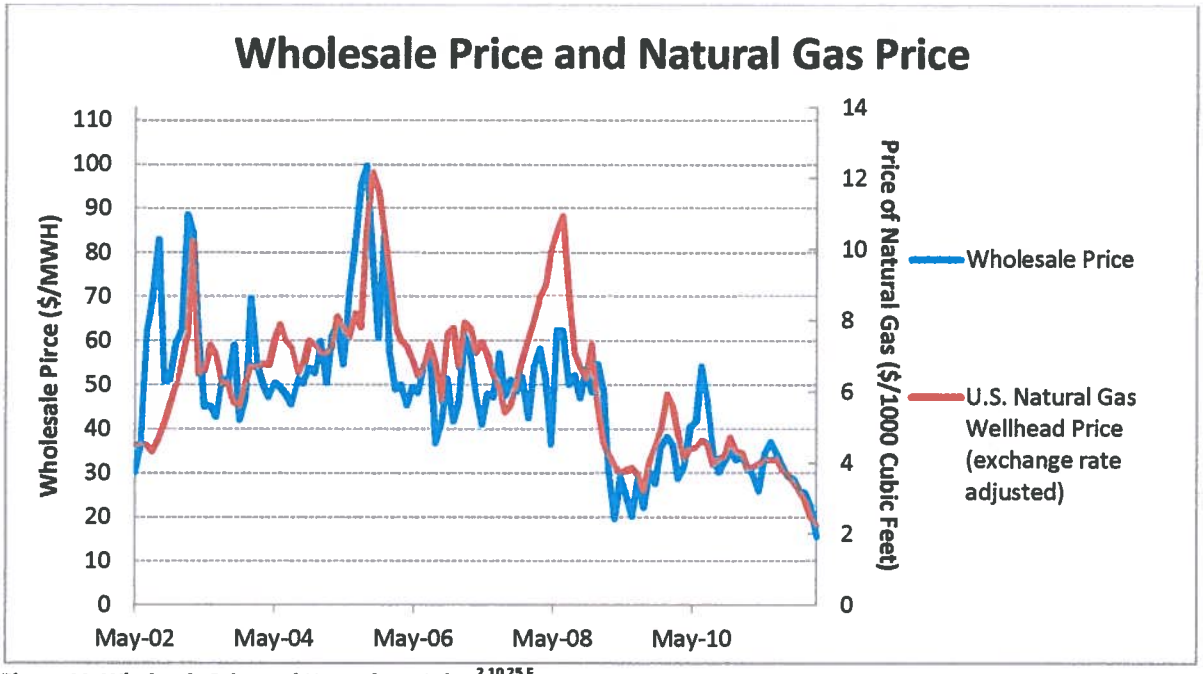

Figure 11: Wholesale Price and Natural Gas Price [2 10 25 F]

7. Theoretical Monthly Model

For this model, both Ontario demand and export demand will be price elastic (not perfectly price elastic or inelastic). The Ontario demand includes both RRP and IESO market consumers. It will be assumed that the expected value of the RRP is equal to the wholesale price plus the global adjustment. Therefore all Ontario consumers face the same total price. The OEB (sets the RRP rates) would have to now both the supply curve and the Ontario demand curves. The model occurs in the short-run with the demand and supply curves exogenous.

The contracted plants will receive the average guaranteed price and the not contracted plants will receive the market clearing marginal cost of the not contracted plants. In **Figure 12** the Ontario market supply curve is the contracted supply at the average guaranteed price added with the not contracted supply curve.

Ontario consumers face the average price of supply curve. This curve accounts for contracted supply being generated to be generated compared to the not contracted supply which is not guaranteed. In **Figure 12** after point B the average price of supply initially drops due to the low marginal cost of not contracted supply. The average price of supply is above the not contracted supply curve until the marginal cost of not contracted supply crosses the average price of contracted supply (point C). After point C the average price of supply is less than the not contracted supply curve because of the relatively lower cost of the contracted supply.

[F] The lowest hourly price April 30, 2009: -$139/MWH. Note: The hourly wholesale price has been negative 656 times, 613 were after January 2009 and only 5 times before 2008. (since market opened in May 1, 2002-March 31,2012)

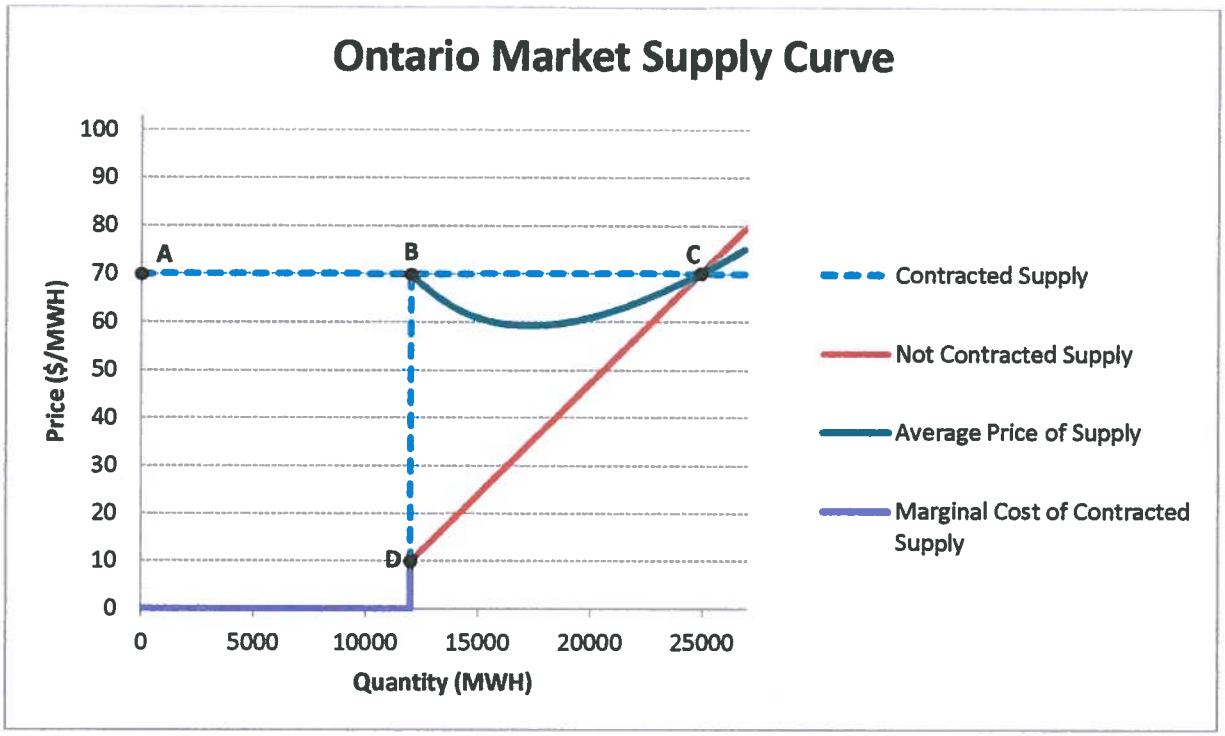

Figure 12: Ontario Market Supply Curve

Figure 13 is the basic global adjustment model with equilibrium being reached when average price of supply intersects with Ontario demand (point E). The wholesale price is determined at the equilibrium quantity that crosses the not contracted supply curve (point F). The total price is higher than the wholesale price to adjust for the fixed prices paid to contracted generators. The global adjustment per MWH is the vertical distance between the average price of supply and the not contracted supply curve. In this figure the global adjustment per MWH is distance between points E and F. In the figure the amount of contracted supply multiplied by the difference between the wholesale and guaranteed price (area ABGH) must equal the Ontario Demand multiplied by the difference between the total price and the wholesale price (area DEFH). Point N represents where Ontario would be in equilibrium if consumers where not responsible for paying the global adjustment. Area EFN is a price distortion loss due to the average contracted supply price being higher than the total price.

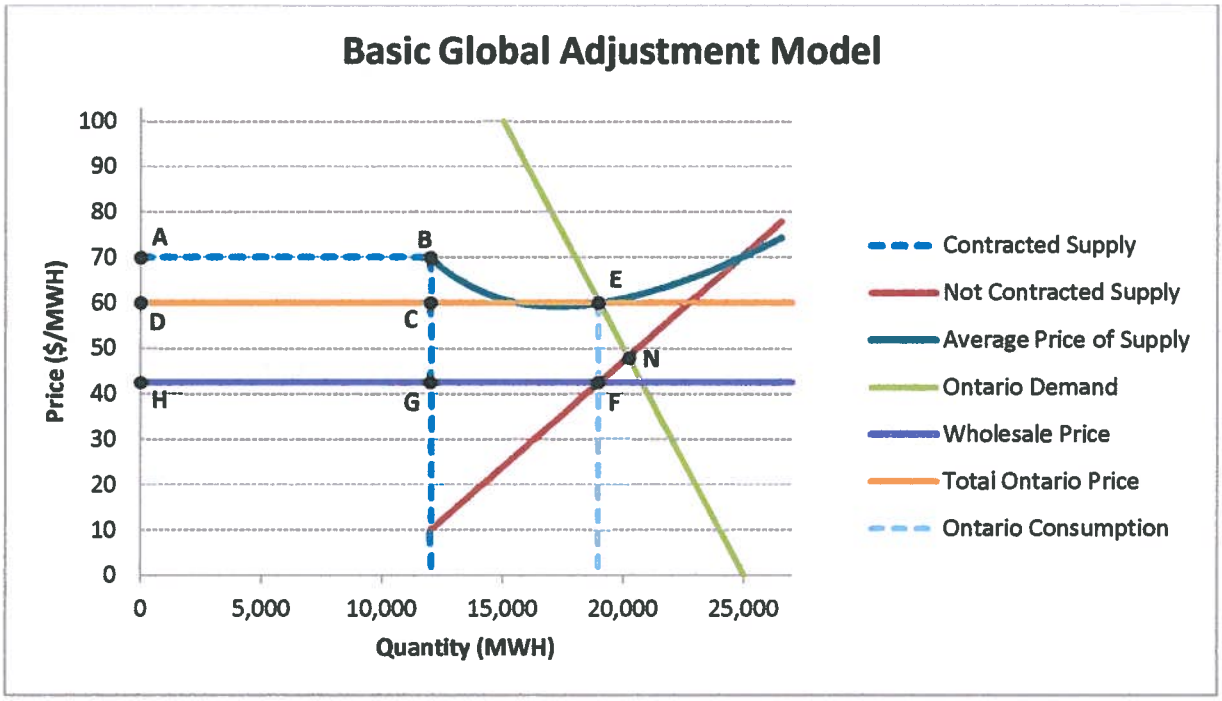

Figure 13: Basic Global Adjustment Model

Since Exports face the marginal cost of the not contracted supply, the Ontario Supply curve will be the residual of this demand and the total supply curve at each price. Exports will be price elastic up to the price of their local market. After the price goes above the local market exports will fall to zero. The results of the model would be unchanged if export demand was price inelastic under the local market price. However, one possible explanation is the increased transmission costs faced by the exporting market. As the Ontario price gets lower the electricity is used by further away consumers in the exporting market. **Figure 14** shows the effect of exports on the not contracted supply curve. The residual not contracted supply curve is the not contracted supply curve minus exports at every price. On the figure, the distance of line AB equals the distance of line CD and the distance of line EF equals the distance of line GH. On this figure the export market local price is $80/MWH which means exports will disappear above that price. There are limited amount of export/import connections from Ontario to its neighbours. Empirically, the greatest amount of exports was 5571 MWH on June 3, 2008 (hour 18).[2]

Figure 15 then adds the new residual not contracted supply curve to the basic model. The average price of supply is now the average of contracted supply and the residual not contracted supply curve. Compared to the basic model in **Figure 13**, the average price of supply is higher at every point. Intuitively, exports take away from the supply which causes Ontario consumers to face higher prices. The same condition as the basic model applies (area ABGH equals area DEFH) but now point F intersects with the residual not contracted supply curve. Point J is where the not contracted supply curve crosses the wholesale price (exports only face the wholesale price). The quantity of point J minus the Ontario quantity at point F is the amount of exported generation. Overall, compared to the basic model without exports total price has increased, Ontario consumption has decreased, and the total market production has increased.

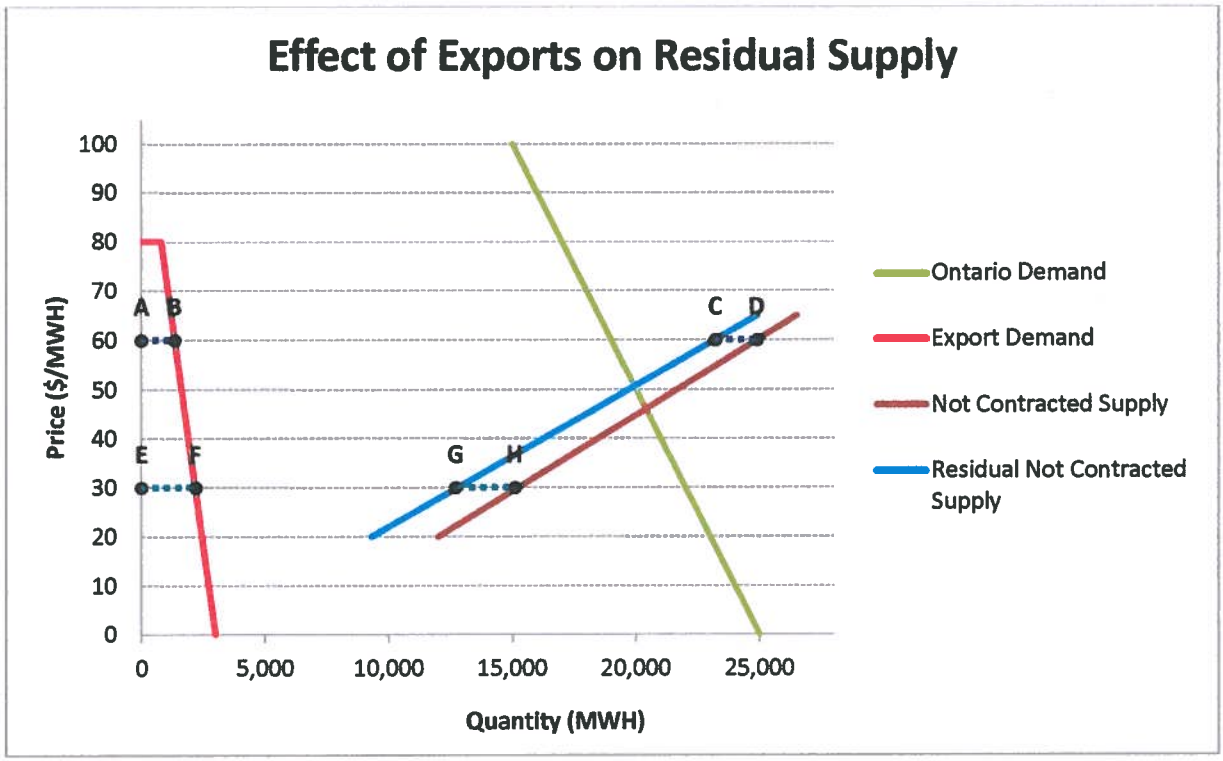

Figure 14: Effect of Exports on Residual Supply

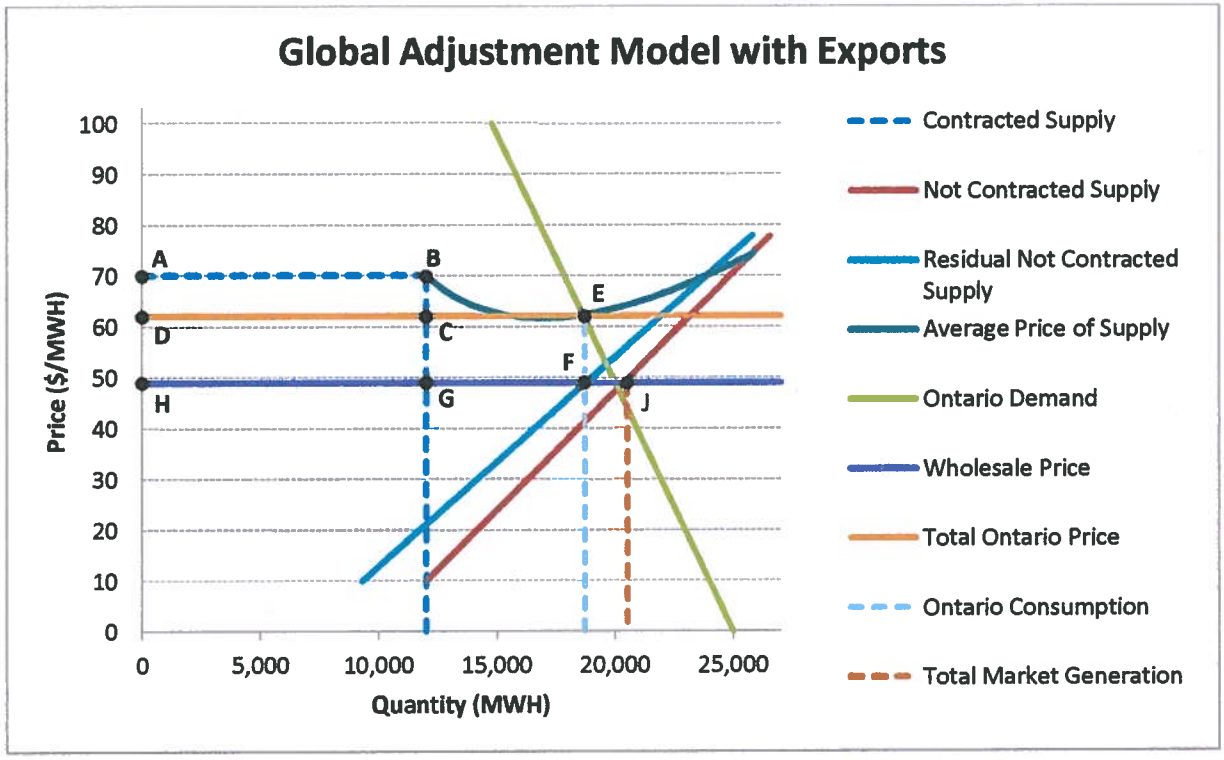

Figure 15: Global Adjustment Model with Exports

The total value of each month's global adjustment is broken into two parts. The first part is the adjustment shown in the basic model due to guaranteed price contracts. The second type is the OPA's programs not effecting supply including conservation programs and operating expenses. In **Figure 16** the second type of global adjustment is shown as an increase in the residual supply curve. The total value of the program per MWH decreases because Ontario demand increases as it is spread over more consumption. The vertical distances of the global adjustment per MWH is equal to the global adjustment per MWH plus residual not contracted supply minus the residual not contracted supply at each quantity. The distance of AB equals the distance of CD and the distance of EF equals the distance of GH. The total amount of the conservation program is area IEFJ. Note: This hourly area is multiplied by 24 hours and the amount of days in the year to get the yearly conservation programs value.

Figure 17 adds the new global adjustment per MWH due to OPA programs plus residual not contracted supply curve to the model. The average price of supply now averages the prices of the contracted supply and the residual not contracted supply curve plus OPA programs per MWH. The OPA spending increases the average price of supply faced by Ontario consumers. The area ABGH is now equal to area DELM (due to guaranteed price contracted supply) and area MLFH is the value of the OPA's programs and operating expenses. With OPA programs and operating expenses added to the model , total price increases, wholesale price decreases, Ontario consumption decreases, and total market production is ambiguous (depending on export demand and Ontario demand price elasticity's).

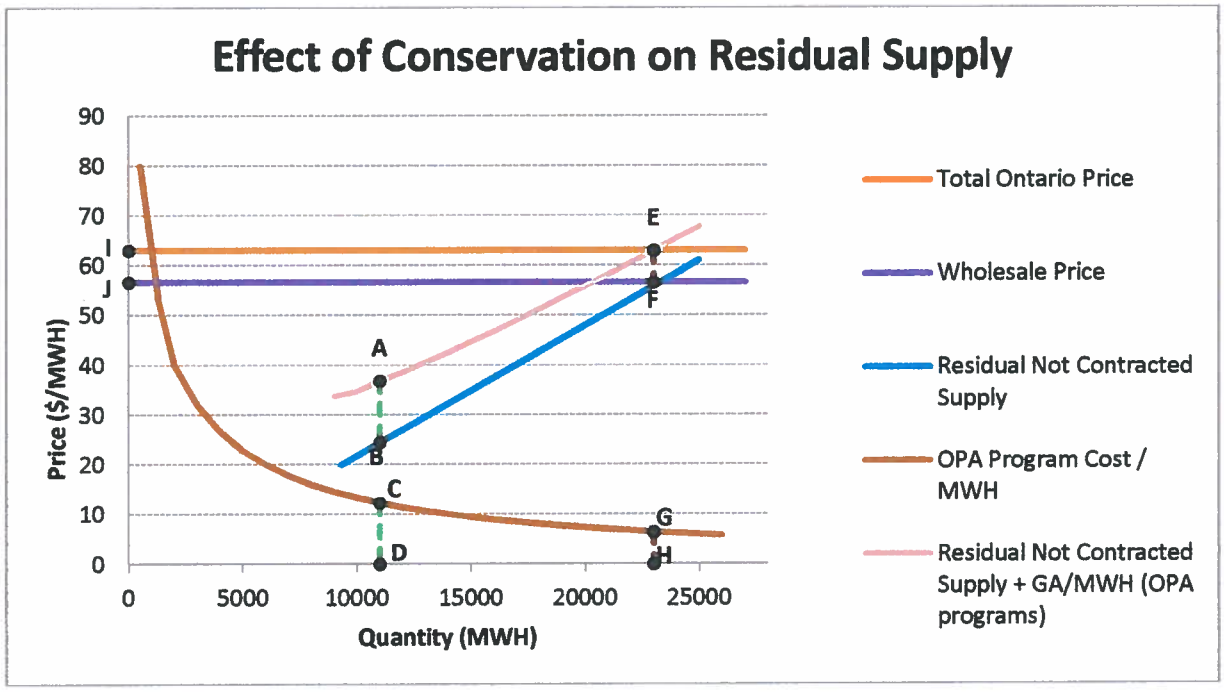

Figure 16: Effect of Conservation on Residual Supply

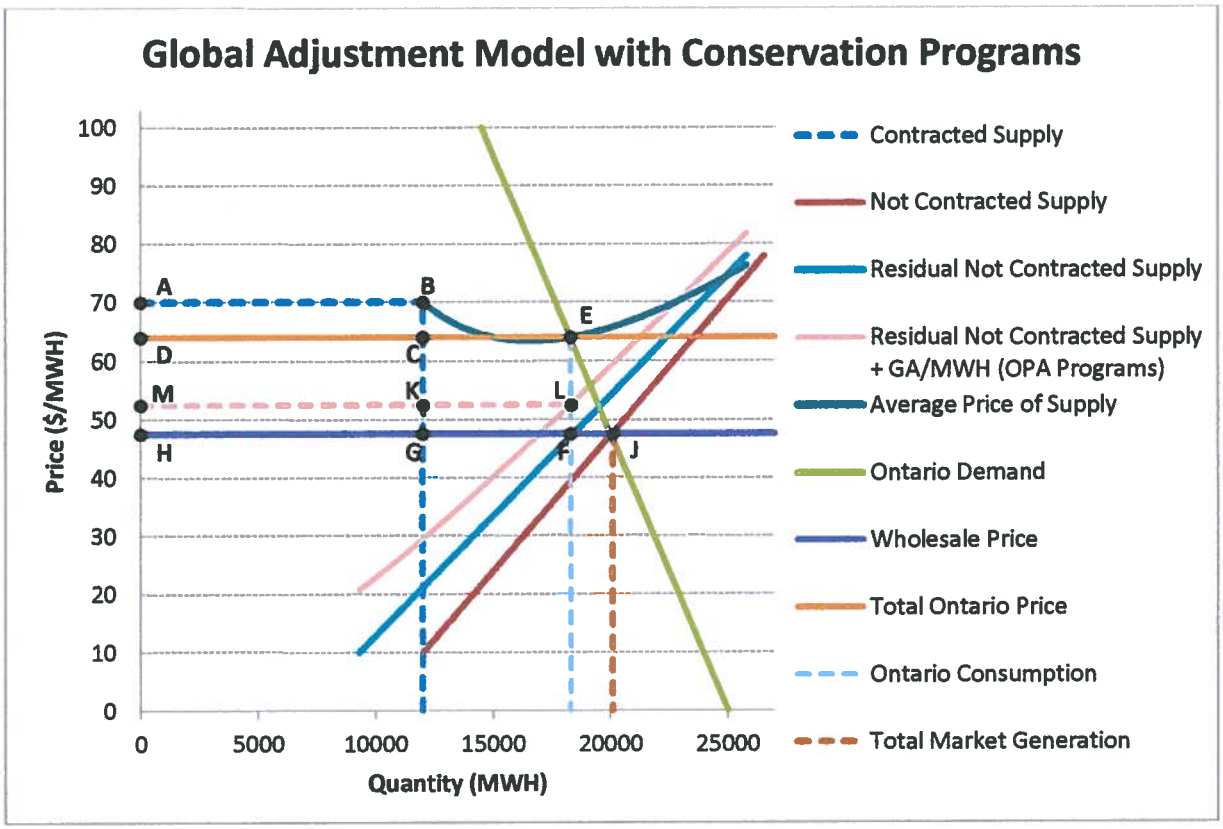

Figure 17: Global Adjustment Model with Conservation Programs

Note: Imports of electricity can be shown in the model as a reduction in Ontario demand at each price. They will be omitted for simplicity as they would affect the Ontario demand price elasticity which is not needed for the analysis.

8. Applying the Theoretical Model to Ontario

Originally in 2005 the wholesale price was greater than average guaranteed price and Ontario consumers faced a lower price than the export market. This was due to the price of gas being high and the average guaranteed price being very low since it was based on more cost effective technologies and not promoting "green" initiatives.

From 2006 to 2008, the "green" initiatives (RESOP and RES) started to be implemented causing the average guaranteed price to slightly increase. Conservation programs started and Ontario demand was stagnant due to conservation (programs and knowledge), higher prices, and a slowing Ontario economy. These changes would lead to the global adjustment becoming slightly positive or slightly negative depending on the demand for the month.

In 2009, the price of natural gas dropped significantly, shifting the gas power plants supply curve down.[10] The natural gas price decrease caused the wholesale price to drop and the global adjustment to greatly increase to make up for the large difference between average guaranteed price and the wholesale price. Since the US also uses natural gas in electricity production, the lower cost of gas could also lead to a decreased demand for Ontario exports.

After 2009 the average guaranteed price has greatly increased due to the Micro FIT and FIT program taking effect and the older "green" programs continuing to grow. Also, conservation spending grew significantly since 2009. This added with decreasing demand due to conservation, a poorer economy, and the reduction in IESO market (non-embedded supply), has led to the total price rising over $10/MWH above inflation.[2 26] The wholesale price continues to decrease as the price of gas is still decreasing. The not contracted supply curve continues to be shifted lower and the average guaranteed price is much higher, leading to lower Ontario consumption and greater global adjustment values. Exports continue to increase as the wholesale price gets lower.

9. Effect of Exports on Ontario's Consumers

If exports were charged the global adjustment the wholesale price would be determined by the not contracted supply curve and the weight of the global adjustment would be spread out among total market demand (minus imports). The average price of supply curve is now faced by both Ontario and exports consumers. The export demand can now be shown as an addition at each price to the Ontario demand curve since both now face the same price. In **Figure 18** the quantity of AB equals the quantity of CD and the quantity of EF equals the quantity of GH.

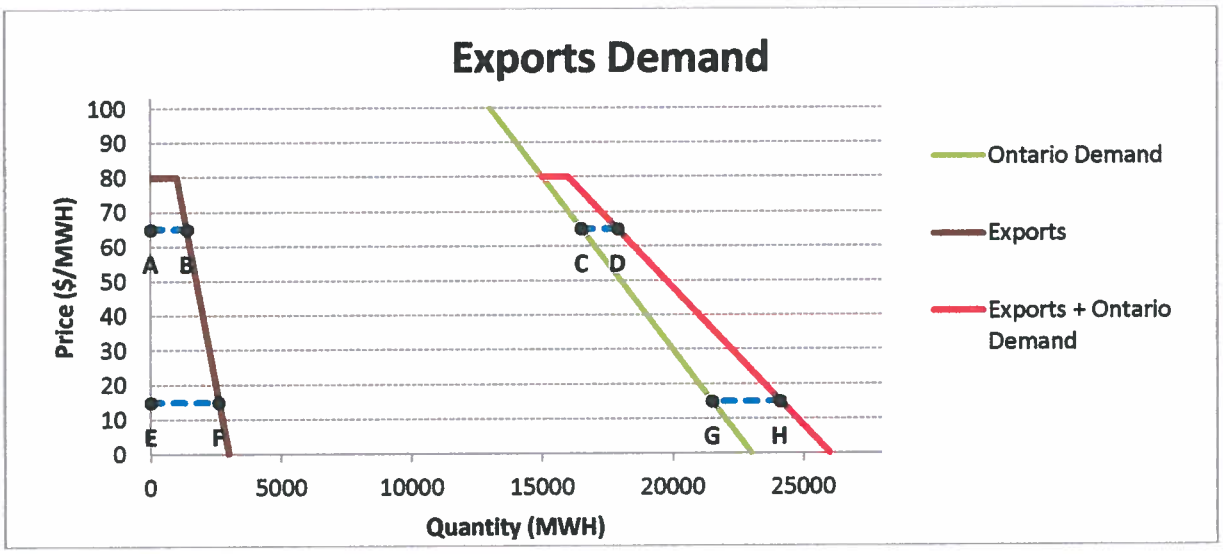

Figure 18: Export Demand

As shown in **Figure 19**, the Ontario market would now face the actual average supply curve which causes the global per MWH to be lower and therefore the Ontario quantity demanded would be greater. Point J is the total market equilibrium quantity where the average price of supply intersects export plus Ontario demand. The wholesale price is determined where the quantity at equilibrium meets the not contracted supply curve (point I). Where total price intersects the Ontario demand curve (point E) the quantity that Ontario consumes is determined. The exports would decrease (if price elastic), with the higher total price. In the figure the total global adjustment (area CJIG) is now partially paid by the exports (area EJIF). To determine the global adjustment per MWH it is necessary to estimate both Ontario and export demand curves. However, because of the reverse causality between exports and Ontario price it is difficult to estimate these effects. An increase in demand for exports will cause the wholesale price to increase. A decrease in Ontario demand will cause the wholesale price to decrease causing exports to increase. Both demand shocks increase exports, but have opposite effects on the price. Both export

demand and Ontario demand would have to be accurately estimated to determine the effect of the higher price of exports. With these estimates and some algebra it would be possible to estimate the effects of applying the global adjustment to exports. The effect on producer surplus is ambiguous and would depend on the price elasticity of demand of Ontario compared to the price elasticity of the export market. If the price change leads to more overall consumption then producer surplus would increase (vise versa).

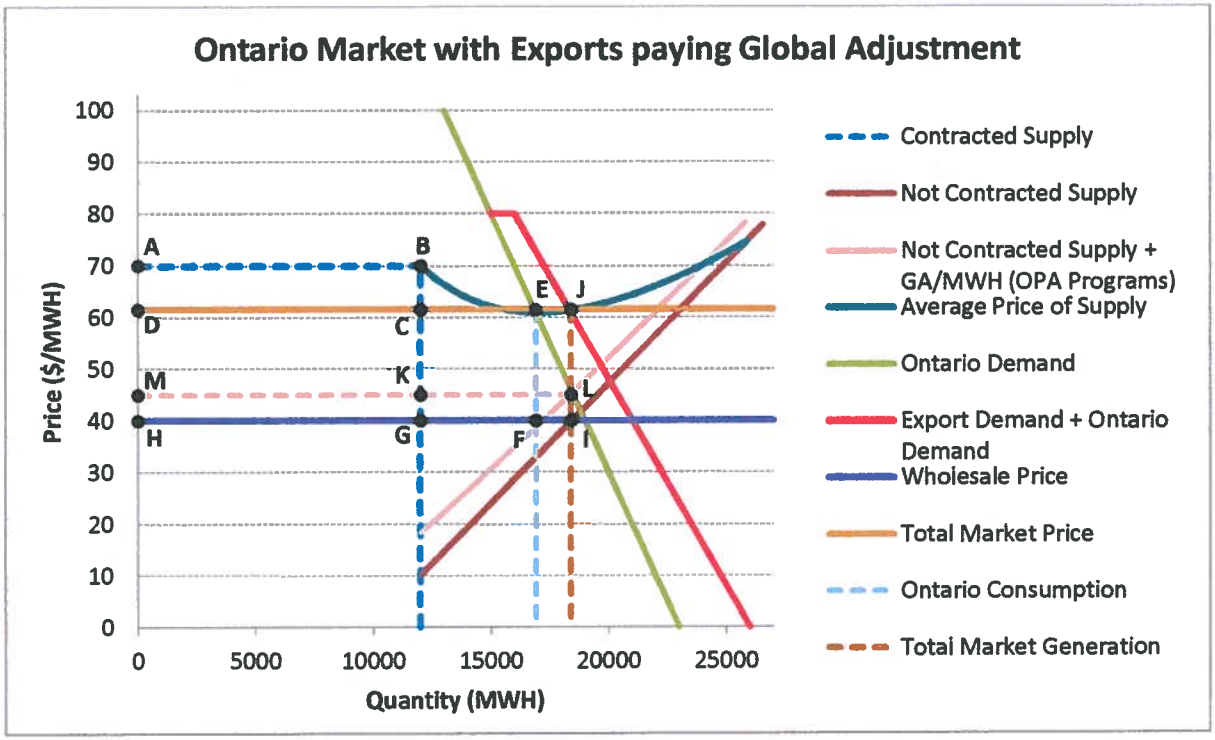

Figure 19: Ontario Market with Exports paying Global Adjustment

Possible arguments against applying the global adjustment to exports:

The Ministry of Energy claims exports bring in revenues that make the price lower for Ontario consumers.[13] They explain that the export market is highly price elastic and when the price is increased to the price Ontario consumers' face it will diminish over time and eventually go to zero. If the Ontario total price does not go above the local price of the exporting market, there would be a demand for exports. Although New York's prices are usually well above Ontario's total price, recently the industrial price has fallen below Ontario's total price. This gives evidence that the export market may disappear if charged the global adjustment. In **Figure 20** the export demand curve stops at a price of $50/MWH which is below the total price and no electricity is exported. Also to be considered are externalities such as trade relations with export/import neighbours.

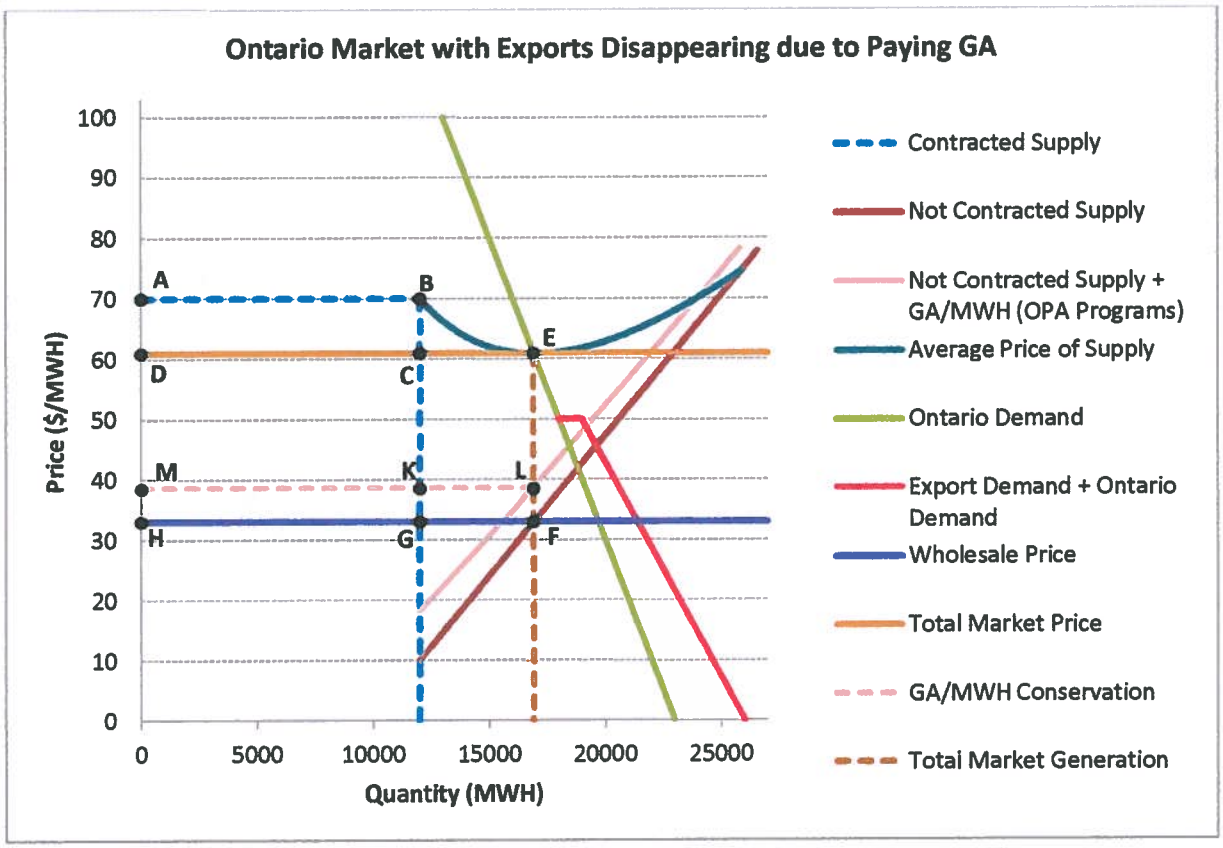

Figure 20: Ontario Market with Exports Disappearing due to Paying GA

Even if this is the case the diminishment of exports may still benefit Ontario consumers since they no longer face a residual supply curve. Ontario consumers can use more cost efficient producers for their own production. This would lower the price directly and since Ontario Consumption would also increase due to this lower price, the global adjustment would be spread out more also decreasing costs per MWH. Also, when the Ontario demand does not meet its contracted supply it is the Ontario consumers paying (through the global adjustment) for the US to take Ontario's excess power instead of Ontario's elastic consumers benefitting fully from lower prices.

10. Hourly Ontario Market Model

The residual not contracted supply curve and the contracted supply curve are used as developed in the monthly model, but now they represent hourly values and not monthly averages. Under hourly conditions Ontario's EISO market consumers face the estimated global adjustment added to the wholesale price. The RPP consumers have a fixed hourly price and demand is determined exogenous of the hourly model. Since hourly fluctuations have a very marginal effect on the total month's global adjustment Ontario's EISO market consumers face the residual not contracted supply curve added to the estimate global adjustment at every price. **Figure 21** shows how the monthly global adjustment (in hourly terms) is added to the residual not contracted curve at every quantity (distance AB equals distance CD). In **Figure 22** with normal Ontario Demand contracted power is covered and Ontario uses not contracted power to make up the difference. Point A represents the equilibrium point for Ontario consumers and is determined where the Ontario demand intersects the residual not contracted supply plus the average global adjustment curve. Point C is the market equilibrium and is determined where

the wholesale price intersects the not contracted supply. The quantity of point C minus the quantity at point B is the exported generation. As the marginal cost of guaranteed price contracted generation is zero, contracted generation does not influence the hourly price directly compared to the monthly model.

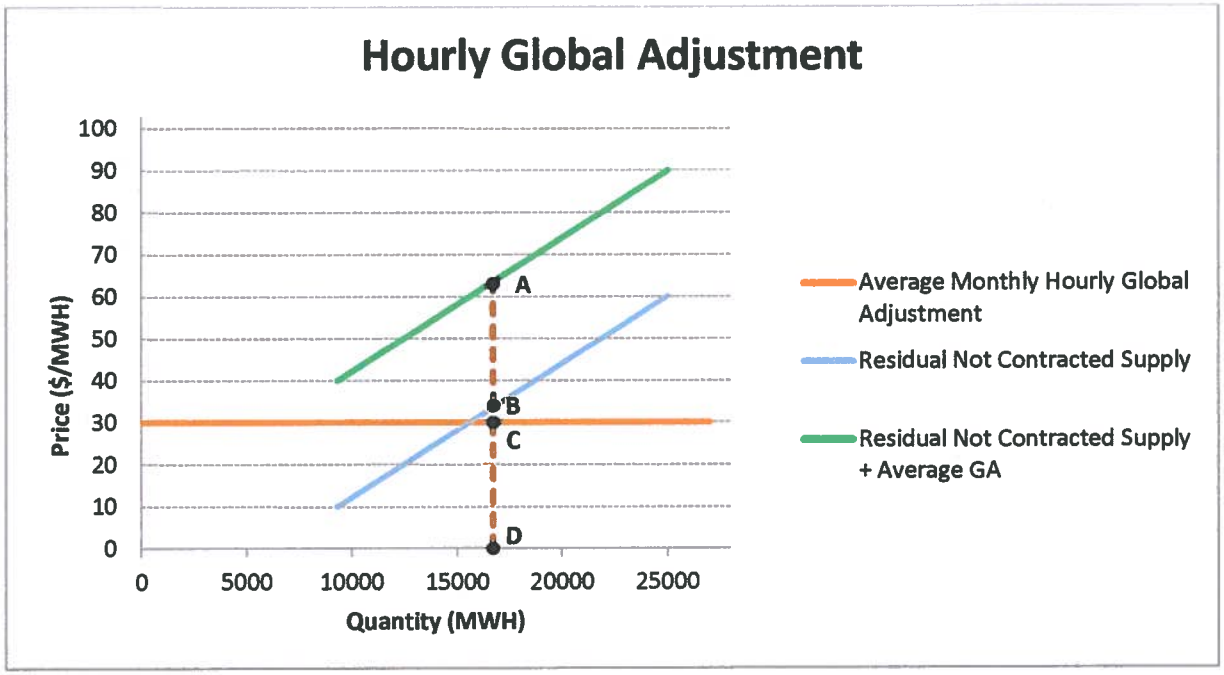

Figure 21: Hourly Global Adjustment

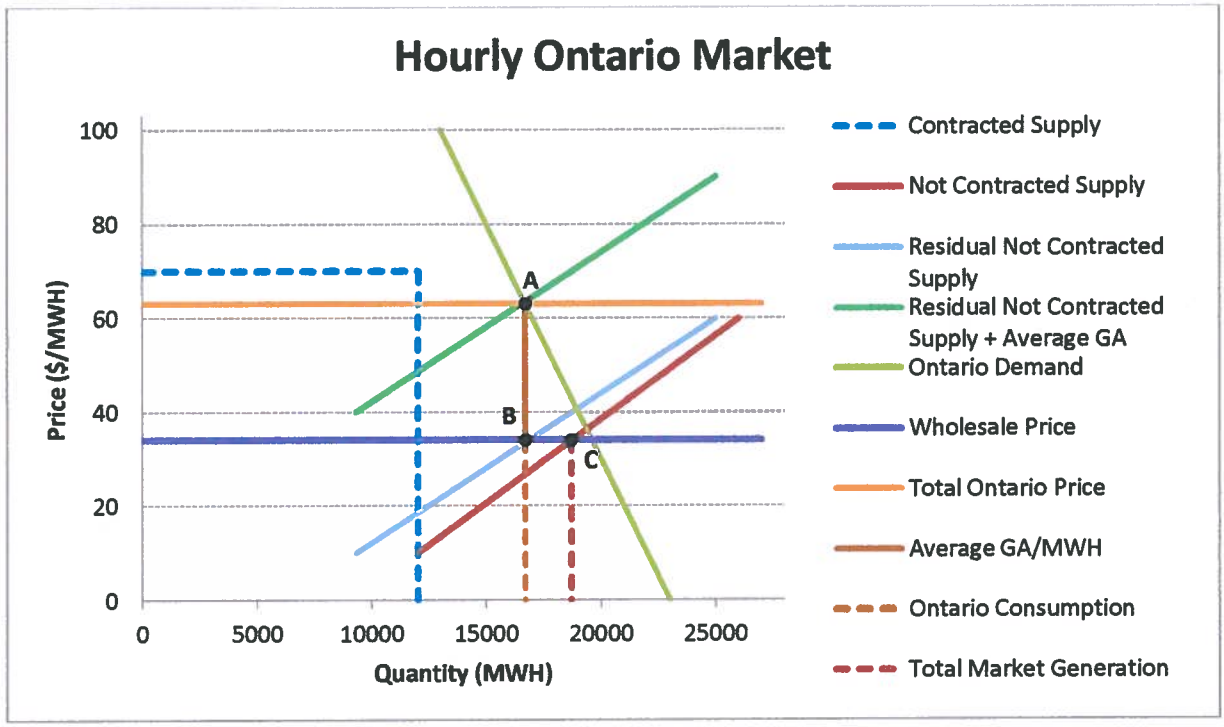

Figure 22: Hourly Ontario Market

However, as **Figure 23** displays, under low demand times (usually moderate temperature months at off peak hours) Ontario demand (less imports) may not be sufficient to cover the contracted supply. The Ontario equilibrium is still point A, but it occurs at a quantity lower than the amount of contracted generation. This results in contracted generation needing to be exported (in the quantity between points B and E). Ontario consumers now incur a loss of the amount of contracted supply being exported multiplied by the difference between the wholesale price and the average guaranteed price (area ADEB). The amount of loss not incurred due to exports (compared to shutting down) is the quantity of contracted supply being exported multiplied by the wholesale price (area BEGF). Under very low demand the wholesale price can go into the negative to dump the electricity and generators may have to be forced to shut down.

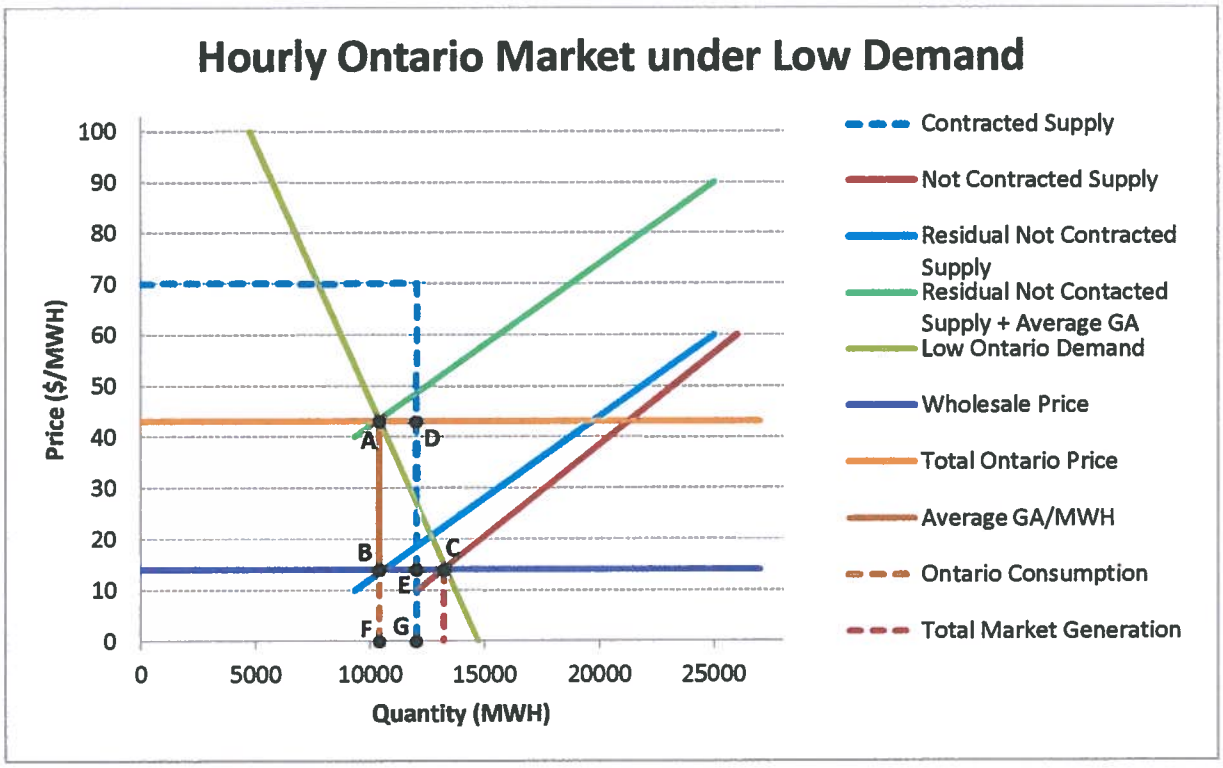

Figure 23: Hourly Ontario Market under Low Demand

11. Hourly Estimated Loss due to Over-contracted Generation Model

The model will determine the hours in which guaranteed price contracted is greater than the Ontario demand for electricity (less imports). Note: Imports reduce the amount of Ontario produced supply needed to meet Ontario's demand. The model will produce values of loss when Ontario demand is too low to cover contract obligations and also estimate the potential welfare gain exports give Ontario consumers by paying a portion of the potential loss. The loss is incurred by Ontario consumers through an increase in the global adjustment. The model is estimating areas ADEB and BEGF (**Figure 28**) for hours with excess contracted supply. An estimate of the amount contracted generation and the average guaranteed price is needed to determine the loss.

Data Sources for Empirical Models:

The Independent Electricity System Operator:

- Hourly wholesale price from May 2002 to March 31, 2012.[2]
- Global adjustment values from January 2005 to March 2012. Break-down of global adjustment values to payee from January 2008 to March 2012.[13]
- Daily reports on hourly generators (over 20MW) capacity and production from January 1, 2006 to March 31, 2012. (available upon request) Note: daily reports compiled into one spreadsheet for the analysis.[21]

Ontario Power Authority:

- Feed- in Tariff, RESOP, and Micro FIT prices on the time of inception of each program.[5][6] Quarterly Feed- in Tariff, RESOP, and Micro FIT capacities for 2008-Q1 to 2008-Q2, 2009-Q1 to 2011-Q4 (OPA's quarterly Progress Report on Electricity Supply).[16]
- Yearly conservation program and operating expenses from 2007 to 2011 (2008-2011 OPA annual reports).[4]

Ontario Power Generation:

- List of regulated generators (guaranteed price contracted but not guaranteed generation). See **appendix 3** for regulated generators and corresponding IESO generator names.[7]
- Regulated Generators guaranteed prices for each quarter from 2006-Q1 to 2011-Q4 (quarterly financial statement).[7]

Cameco - part owner of Bruce B Nuclear generator:

- The price floor and average price of Bruce B's generation for each quarter from 2006-Q1 to 2011-Q4 (quarterly financial statements).[22]
- "Deemed" generation (quarterly financial statements).[22]

TransCanada Corporation - part owner of Bruce A and B

- Contracted price for Bruce A (quarterly financial statements). [23]

Association of Power Producers of Ontario:

- List of 15 Non-utility Generators (Macquarie Power and Infrastructure report). [24] **Appendix 2** lists all named non-utility generators and the corresponding IESO generator name.

"Deemed" Generation:

During long periods of very low Ontario demand it may be necessary for the IESO to instruct a contracted generator to shut down. In the case of Bruce B, which has a guaranteed price floor, the electricity is not produced but still paid for. This "deemed" generation started in the third quarter of 2009.[22] This loss will be added with the estimated loss by the model to determine the cost of over contracted power that Ontario consumers pay through the global adjustment. The OPG is regulated by the IESO so they are not paid if power is not generated.

Average Contracted Guaranteed Price:
The average price of non-utility generator contracts will be assumed to increase with inflation (2.5%). Given the IESO global adjustment data, this assumption seems to be an underestimation of the price, but without data on the exact amount of non-utility generator production per month it is not possible to distinguish if production or price causes the changes. The price for wind power through the RES (Renewable Energy Systems Ltd) contract will be assumed to be $110 MW based off of the prices for the RESOP program. All the contracted prices will be weighted by their generation to determine every hour's average guaranteed price. For this model only IESO market supply will be used though the use of non-embedded supply would increase overall contracted price.

Amount of Contracted Generation:
Hourly data since 2006 will be used for generation of Nuclear, Wind, Biomass and Imports as well as the wholesale price. All these technologies are fully contracted, though it is unknown (except with Bruce B "deemed" generation) if decreases in production are caused by planned maintenance or the IESO instructing the plant to shut down. It will be assumed that reductions are from maintenance for this model. The amount of Bruce A, Bruce B and the OPG Nuclear production is obtained through quarterly financial reports. The non-utility generator's production will be estimated at using the plants obtained through OPPRA's report and OPG quarterly data on the regulated hydroelectric production will be used. Using an excel spreadsheet, exact hourly production of each generator is obtained. The contracted generation is aggregated and then subtracted by Ontario's demand (less Import) for that hour. If this value is positive then contracted power is being exported.

Using this data it can be estimated when Ontario demand (less imports) is less than contracted supply and a loss occurs. To estimate this loss; the amount of excess power will multiplied by the monthly hourly contracted guaranteed price minus the hourly wholesale price. To estimate the potential loss avoidance from exports, the amount of over-contracted supply is multiplied by the wholesale price for each hour. The values will be aggregated for each month to determine the monthly loss. This value may be underestimated due to not having information on all of the non-utility generators.

Calculation Example:
Total contracted generation – (Ontario demand + imports) = over-contracted generation (if negative)
Over-contracted generation x (average contracted price – wholesale price) = over-contracted loss
Over-contracted generation x wholesale price = potential loss avoidance from exports

Results of Over-contracted Model:
The results of the model are aggregated over each year and presented in **Table 3** (for quarterly results see **appendix 4**). Since 2006, the loss due to over contracted has been steadily increasing and deemed Bruce B production spiked in 2009. With the "green" programs lowering IESO market demand, the loss due to contracted generation is increasing. The "gain" from exports has mitigated the total potential loss by 13.4% from 2006 to 2011. Once spread out over the entire Ontario consumption the loss averaged $0.084/MWH and highest quarterly loss was $0.513/MWH (2009-Q3). Though not insignificant, over contracted power is not a driving force as of yet in Ontario's price increase. This result suggests the argument that exports are needed to mitigate the loss due to over-contracted may not yet be correct. Also, it could be concluded that over-contracted generation is not currently a significant problem in the Ontario market.

Table 3: Aggregated Yearly results of Over-contracted Model

Year	Over-contracted Generation (MWH)	Over-contracted Loss	Deemed Bruce B	Total Loss	Potential Loss Avoidance from Exports
2006	17,515	$546,720	$0	$546,720	$347,725
2007	8,025	$310,722	$0	$310,722	$101,622
2008	116,968	$5,221,190	$0	$5,221,190	$1,644,228
2009	397,614	$19,335,169	$58,512,000	$77,847,169	$4,562,391
2010	464,608	$18,942,032	$0	$18,942,032	$9,490,040
2011	390,136	$17,688,245	$20,072,000	$37,760,245	$5,576,760

12. Price Decomposition

The price decomposition will take the total quarterly amount paid for the electricity or program and divide it by the number of days in the quarter and by 24 hours. This value is then divided by the quarterly average hourly Ontario demand less imports. It is less imports since importers do not pay for or use Ontario's electricity. For producers the value represents the hourly average payment (generators average production x generators average price), it receives for their electricity divided by Ontario demand (less imports).

With the OPA's quarterly Progress Report on Electricity Supply, information on the OPA's supply program can be obtained since 2008 (2008 Q3 and Q4 not found). The OPA's "green" generation will be estimated for Q3 and Q4 of 2008 using a linear growth assumption. The annual OPA reports have the amount of the conservation program spending since 2008. With this information and the information obtained for the model, it is possible to decompose the Ontario price for each quarter. Only capacity is given in the OPA reports and since RESOP, micro FIT and some FIT programs are under 20MW, the IESO does not have production data on these projects. Multiplying by capacity factor's given by the Energy Information Administration and the Capacity (MW), an estimate of production (MWH) can be produced. Non-utility generators value is based on the actual global adjustment (from IESO) and the estimated price for non-utility generators.

The residual between the total estimate and actual is due to the exact non-utility generators production and price not being known. As well, the exact production of the "green" plants under 20 MW is unknown and other OPA programs may be increasing. It also unclear how the OPA pays for the "deemed" generation of Bruce B. The OPA category represents the "green" programs (FIT, RESOP, RES, conservation) and operating expenses (does not include Bruce or "deemed" generation). The "share of exports" category calculation accounts for the portion of OPG, Bruce power, and estimated non-utility generator power that is being exported. It assumes that the average wholesale price is received for these exports. Also the decomposition assumes any other production is absorbed by exports. The estimate should be between the RPP and the total IESO market price (wholesale + global adjustment). Discrepancies could be due to the prices of not included peaking power generators or due to over contracted power being offloaded. A percent change between the values for quarter 1 of 2008 and quarter 4 of 2011 is produced at the bottom of the **table 4**.

Results of Price Decomposition:

Based on the results of the price decomposition, shown in **Table 4**, it appears the main cause of the price increase is the OPA programs. Bruce and the non-utility generators are also adding a little to the overall increase. The OPG decrease and the increase in the "share of exports" are highly correlated and due to the OPG unregulated plants exporting less because of the lower wholesale price. It appears "deemed" generation may be spread out over time to avoid spikes in price. Since non-utility generators data is calculated using actual global adjustment data and OPG and Bruce financial data are accurate, the residual most be due to not accounting for or underestimation OPA programs. Since this value has increased by 478% it is clear it is the driving force behind the price increase. Without the OPA category, total price seems to be increasing at about the rate of inflation.[G 26]

Table 4: Price Decomposition ($/MWH)

Quarter	OPG	Bruce	NUG	OPA Explained	OPA-GA Residual	Share of Exports	Total Estimate	RPP	WP+GA
2008 - Q1	35.63	12.84	7.55	2.70	-0.28	-7.63	51.18	50.00	56.12
2008 - Q2	39.14	15.99	7.81	2.94	1.51	-11.62	56.72	50.00	57.07
2008 - Q3	36.65	16.68	7.15	2.42	0.25	-8.28	57.26	50.00	59.27
2008 - Q4	35.75	15.36	6.05	3.66	1.08	-5.33	56.68	54.00	58.09
2009 - Q1	34.13	15.02	4.40	4.11	0.16	-3.53	55.23	56.00	59.88
2009 - Q2	28.21	18.48	3.38	4.66	2.10	-0.83	64.28	56.67	60.08
2009 - Q3	31.14	17.23	3.18	4.02	4.13	-0.99	66.59	57.00	61.36
2009 - Q4	31.58	14.85	4.26	5.25	5.81	-1.27	64.94	57.67	66.71
2010 - Q1	31.80	15.23	4.75	5.69	10.21	-2.70	69.06	58.00	66.14
2010 - Q2	28.64	15.99	6.70	6.06	2.44	-0.37	63.28	62.67	67.04
2010 - Q3	32.41	16.01	6.37	6.17	-0.86	-1.37	61.13	65.00	62.24
2010 - Q4	29.87	18.05	5.61	8.71	4.53	-2.38	70.03	64.33	69.19
2011 - Q1	27.99	15.00	5.58	8.61	4.94	-0.19	66.78	64.00	69.10
2011 - Q2	29.17	16.12	7.39	9.81	6.68	-1.78	74.21	66.67	74.86
2011 - Q3	28.88	16.23	8.45	8.38	5.90	-0.66	72.91	68.00	69.94
2011 - Q4	27.57	14.33	9.42	12.89	3.82	-1.23	72.57	70.00	73.31
Change	**77%**	**112%**	**125%**	**478%**	-	-	**142%**	**140%**	**131%**

Using average quarterly data on generation and prices for all of the OPG's generators (contracted and not contracted), Bruce Power generators, and estimated "green" generators, **Table 5** was produced. The table is shown in hourly generation. Overall, the average price of the OPG is falling since the unregulated plants are facing a lower price. Bruce's prices have been fairly constant and the main change is the "green" power increasing both average price and production. With the average hourly IESO Ontario demand (minus imports) since 2008 at 15,548 MWH's it seems more cost effective technologies are not being used and instead green energy is being used. [2] The advantages of "green" technologies (better health, less pollution) are not taken into account in this analysis.

[G] Using the consumer price index (seasonally adjusted) inflation from January 2008 to December 2011 is approximately 7.92%.

Table 5: OPG, Bruce, "Green" Energy Quarterly Average Price ($/MWH) and Hourly Generation (MWH)

Quarter	OPG		Bruce		Green	
	Generation	Ave Price	Generation	Ave Price	Generation	Ave Price
2008 - Q1	13462	46.65	3764	57.38	186	110.17
2008 - Q2	11859	46.53	3870	58.23	150	110.26
2008 - Q3	12364	47.63	4417	60.15	125	110.69
2008 - Q4	11413	49.31	4146	58.31	299	110.37
2009 - Q1	11852	48.49	4562	55.41	326	110.45
2009 - Q2	9570	42.33	3907	67.94	307	110.48
2009 - Q3	10236	44.94	3880	65.60	237	113.57
2009 - Q4	10598	45.87	3659	62.47	411	117.54
2010 - Q1	11343	45.01	4108	59.51	394	119.85
2010 - Q2	9020	46.77	3937	59.82	379	120.08
2010 - Q3	10281	50.38	4299	59.48	410	134.68
2010 - Q4	9828	46.39	4480	61.50	666	134.63
2011 - Q1	10278	46.02	4454	56.92	728	139.54
2011 - Q2	9478	45.09	4003	58.99	670	149.51
2011 - Q3	9692	47.91	4510	57.85	525	174.53
2011 - Q4	9239	45.34	3860	56.42	1001	152.78

13. Future of the Market

According to the Ministry of Energy's Ontario's Long-Term Energy Plan "Over the next five years, however, residential electricity prices are expected to rise by about 7.9 per cent annually (or 46 per cent over five years). This increase will help pay for critical improvements to the electricity capacity in nuclear and gas, transmission and distribution (accounting for about 44 per cent of the price increase) and investment in new, clean renewable energy generation (56 per cent of the increase)".[27] From 2012 to 2015, the OPA has already contracted 1500 MW of Nuclear through Bruce A, 6254 MW of renewable energy and 399 MW of "clean" (natural gas) energy capacity.[16] After using capacity factors, this amounts to an average hourly production of 1350 MWH for nuclear, 2177 MWH for renewable, and 347 MWH for gas. The nuclear and renewable will add to the contracted supply by an average of 3527 MWH.[16][18] Also, 600MW of NUG supply are expected, to expire by 2015.[4] If these plants were not contracted and turned into peaking plants, then total contracted supply and the global adjustment for non-utility generators would decrease.

The analysis given in this paper would predict that in the future the Ontario price will continue to rise. The price increase will be caused by three main factors; increases in OPA program spending, "green" contracts which increase the average contracted price, and the global adjustment not being applied to exports. However, externalities not related to price must also be considered. These include the reliability of the electricity supply, the effect of different generation technologies on health and the mitigating effects exports can have on over-contracted supply. These externalities must be weighed against the negative impacts of higher electricity prices. Ontario demand will continue to decrease and in the long-run economic growth may be affected. A policy to not absorb "green" energy programs into the price of electricity should be considered.

In the future, if the wholesale price remains below the average contracted price it may be beneficial for Ontario to charge the global adjustment to exports. Also, programs like the Regional Greenhouse Gas Initiative (RGGI) in the United States should be considered compared to the feed-in tariff programs.[28] The RGGI is a cap and trade program which sells the rights to produce greenhouse gas emissions to generators. The cap and trade program governs the amount of emissions produced and creates revenue which can be invested in green programs.

14. Conclusions

Two main events have shaped the Ontario electricity market over the last six years. The overall price for Ontario consumers is rising due to "green" contracts, conservation spending and a reduction in Ontario's IESO market demand. The second is the dramatic decrease in natural gas prices which has resulted in a lower wholesale price and potentially a lower export demand. However, due to exports not paying the Global Adjustment, this gas price change has benefitted US consumers and has actually increased exports.

The loss due to over-contracted supply has only played a minor role in increasing the overall price Ontario consumers face. However, in the future by adding more guaranteed price contracted supply and with off-peak demand unlikely to increase at the same rate (conservation, poor economy); the value of the over-contracted supply loss may greatly increase.

Further research should be done on whether Ontario should continue to focus on increasing its baseload supply. Guaranteed price contracted generation increases Ontario's baseload supply, while the more cost efficient (large hydroelectric, gas) peaking plants are discouraged from entering the market due to lower wholesale prices.

Further research should be done to estimate Ontario demand and the export demand to determine the loss due to exports not paying the global adjustment. The effect of OPA programs being included in the Ontario price should also be considered since it creates a price distortion and higher prices. Without the "green" and other political initiatives, the price of electricity for Ontario consumers might actually be dropping. Further research should be done on how much Ontario consumers are willing to pay for "green" energy and if guaranteed price contracts are the most efficient methods (compared to research and development).

15. Appendices

Appendix 1: OPA Spending Table [4]

Year	Operating Expense	Conservation	Generation
2008	$57,600,000	$160,100,000	$429,100,000
2009	$64,100,000	$223,500,000	$1,402,200,000
2010	$64,100,000	$223,500,000	$1,402,200,000
2011	$65,200,000	$317,600,000	$1,619,600,000

Appendix 2: APPrO Listed Non-Utility Generators and Corresponding IESO Generator Name Table [24]

IESO Generator Name	IESO Type	APPrO Report	Location
CARDINAL	Gas	Cardinal Power	Cardinal
DESTEC	Gas	Northland - Kingston	Bath
TCKAP	Gas	Kapuskasing	Kapuskasing
LAKESUPERIOR	Gas	Lake Superior Power	Saulte Ste Marie
TCNIPIGON	Gas	Nipigon	Nipigon
TCNORTHBAY	Gas	North Bay	North Bay
NPIROQFALLS	Gas	Iroquois Falls	Iroquois Falls
NPKIRKLAND-G6	Gas	Northland - Kirkland Lake	Kirkland Lake
TADOUGLAS	Gas	TransAlta - Mississauga	Mississauga
TAOHSC	Gas	TransAlta - Ottawa	Ottawa
TAWINDSOR	Gas	TransAlta - Windsor	Windsor
TCPLTUNIS	Gas	Tunis	Tunis
WESTWINDSOR	Gas	West Windsor	Windsor
NPCOCHRANE	Other	Cochrane	Cochrane
NPKIRKLAND-G1-G5	Other	Northland - Kirkland Lake	Kirkland Lake
TCPLCALSTOCK	Other	Calstock (Hearst)	Hearst

Appendix 3: Contracted Generators Table[7]

IESO Generator Name	IESO Type	Owner
BECK1	Hydro	OPG
BECK2	Hydro	OPG
BECK2 PGS	Hydro	OPG
DECEWFALLS	Hydro	OPG
DECEWND1	Hydro	OPG
SAUNDERS	Hydro	OPG
BRUCEA-G3	Nuclear	Bruce Power
BRUCEA-G4	Nuclear	Bruce Power
BRUCEB-G5	Nuclear	Bruce Power
BRUCEB-G6	Nuclear	Bruce Power
BRUCEB-G7	Nuclear	Bruce Power
BRUCEB-G8	Nuclear	Bruce Power
DARLINGTON-G1	Nuclear	OPG
DARLINGTON-G2	Nuclear	OPG
DARLINGTON-G3	Nuclear	OPG
DARLINGTON-G4	Nuclear	OPG
PICKERINGA-G1	Nuclear	OPG
PICKERINGA-G4	Nuclear	OPG
PICKERINGB-G5	Nuclear	OPG
PICKERINGB-G6	Nuclear	OPG
PICKERINGB-G7	Nuclear	OPG
PICKERINGB-G8	Nuclear	OPG

Appendix 4: Quarterly Over-contracted Estimation Table

Quarter	Over-contracted Production (MWH)	Over-contracted Loss	"Deemed" Generation	Prevented Loss from Exports
2006 - Q1	0	$0	$0	$0
2006 - Q2	0	$0	$0	$0
2006 - Q3	11,485	$343,527	$0	$237,305
2006 - Q4	6,030	$203,194	$0	$110,420
2007 - Q1	0	$0	$0	$0
2007 - Q2	6,112	$224,802	$0	$85,983
2007 - Q3	378	$17,724	$0	$1,935
2007 - Q4	1,535	$68,196	$0	$13,704
2008 - Q1	3,058	$152,446	$0	$19,795
2008 - Q2	40,012	$1,661,820	$0	$502,562
2008 - Q3	26,715	$1,223,656	$0	$234,395
2008 - Q4	47,183	$2,183,269	$0	$887,476
2009 - Q1	14,181	$553,061	$0	$256,063
2009 - Q2	51,250	$2,491,252	$0	$654,779
2009 - Q3	299,493	$15,061,192	$39,008,000	$2,897,713
2009 - Q4	32,690	$1,229,664	$19,504,000	$753,835
2010 - Q1	8,680	$343,049	$0	$175,564
2010 - Q2	37,358	$1,498,895	$0	$787,764
2010 - Q3	209,828	$8,513,084	$0	$4,131,515
2010 - Q4	208,742	$8,587,004	$0	$4,395,198
2011 - Q1	23,546	$1,873,903	$0	-$359,271
2011 - Q2	101,482	$4,741,275	$10,036,000	$1,211,193
2011 - Q3	193,642	$7,579,065	$0	$3,848,645
2011 - Q4	71,466	$3,494,002	$10,036,000	$876,193
2012 - Q1	17,252	$853,273	$5,162,000	$190,783
Total	**1,412,118**	**$62,897,352**	**$83,746,000**	**$21,913,549**

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