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E-BRIEF

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ECONOMIC GROWTH AND INNOVATION

Peak Power Problems: How Ontario's Industrial Electricity Pricing System Impacts Consumers

by
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- One of the government's main electricity pricing policies is the High-5 program, also known as the Industrial Conservation Initiative. Under the High-5 program, a significant share of annual electricity costs for large industrial electricity consumers is based on their energy consumption during the five highest demand hours that occur in Ontario each year.
- By reducing consumption during those five peak hours, large industrials can reduce their share of the so-called Global Adjustment, which the province charges all electricity customers to help pay its fixed contracts with generators. Hence, the High-5 program transfers costs from large customers to smaller customers. It is estimated that this program is responsible for up to one-quarter of the increased costs of electricity for households.
- At a time when electricity costs in Ontario are higher across the board than in comparable jurisdictions elsewhere, reform is needed. High costs for industrials and households alike would be lower if the government introduced a market-based demand management service.

High and rising electricity prices faced by industrial consumers in Ontario are a concern for those worried about attracting and keeping businesses.

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A recent survey by the Association of Major Power Consumers of Ontario (AMPCO) suggests that Ontario industrial businesses pay 26 to 29 percent more than businesses in New York and the New England states. Ontario businesses pay 40 percent more than the average business in 14 jurisdictions around the Pennsylvania-New Jersey-Maryland area. However, Ontario prices are not only high relative to the US, but also in comparison to other Canadian provinces.

Such discrepancies suggest that businesses in Ontario suffer a cost disadvantage in comparison to competitors in other jurisdictions. The result could be the relocation of businesses and a flow of private investment capital away from Ontario to other competing jurisdictions.

One of the government's main policy approaches related to electricity pricing is the High-5 program, also known as the Industrial Conservation Initiative. The province introduced the High-5 program in 2011, and the government's 2014 budget brought more firms into the program.

The originally stated policy objective of the High-5 program was to provide large industrials with incentives to reduce peak demand. That would mean less need for investment in new generation and reduce the need for imports.[1] Under the program, a large share of the annual electricity cost for eligible companies is based on consumption during the province's highest five demand hours during the year, and High-5 therefore encourages firms to reduce their consumption during those hours.

The program seems to meet two aims: reducing electricity costs for industry and reducing the need for investment in new peak-period generation. However, because actual peak hours are never known in advance, firms do not know which hours of the year will determine their electricity costs for the rest of the year. Is there a better way to meet the program's goals?

I find that the program encourages companies to reduce electricity consumption over a range of peak demand hours, not only the top five hours. This is not surprising: I also find the potential cost that industrial consumers face during peak periods is higher than reasonable estimates of the cost of that peak-period electricity. Equally problematic, I find that the High-5 program has led to large cost transfers from some large industrial consumers to other consumers.[2]

A better solution would be to target consumption reductions through a better alignment of supply and demand. The government should move industrial customers from the blunt and imprecise High-5 program into a market-based demand management program as part of the electricity market reforms under development.

1 For further details please refer to http://www.ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTEwNzI0&statusId=MTY2MTgw.

2 There are other incentive and rebate programs for industrials. One example is the Northern Industrial Electricity Rebate program through which participants can receive a rebate of two cents per kilowatt hour with individual rebates capped at 2011-12 consumption levels, or $20 million per year per company (http://www.mndm.gov.on.ca/en/northern-development/business-support/northern-industrial-electricity-rate-program). There are also other sector specific rebates and programs available for the following industries: iron and steel, pulp/paper, petroleum, mining, automotive, cement & non-metallic mineral, and food and beverage. For more information please go to https://saveonenergy.ca/Business/Programs-By-Sector.aspx. Further, industrial companies might be eligible for lower electricity rates through the Industrial Electricity Incentive program. The qualifying conditions for this program are either an expansion in operations or job creation.

Electricity Prices for Industrials in Ontario

Why are Ontario's electricity prices higher than those elsewhere? The reasons include: the Ontario *Green Energy Act*, which subsidizes clean electricity generation; the existence of contracts that mandate generous fixed prices for electricity supply; the costs of nuclear plant refurbishment, new transmission and distribution infrastructure; and the effects of new peak-period-supplying power plants coming online. There is no doubt that average electricity bills reflect the cumulative effects of the above factors and the legacy costs of Ontario Hydro's debt. (See Goulding 2013 for more on the causes of increasing energy prices.)

One particular component of higher electricity costs for consumers is the Global Adjustment (GA). The province established the GA in 2005, and initially called it the Provincial Benefit because, at the time, wholesale market prices were expected to be above the Ontario Energy Board-regulated rates that consumers were paying. Ontario consumers would then receive the benefits of this price difference through the Provincial Benefit.[3] However, the relationship between wholesale prices and consumer prices has since reversed. The province renamed the Provincial Benefit to the Global Adjustment, which is now a charge to electricity purchasers that is passed on to retail consumers. It is intended to recover any shortfall between generators' wholesale market revenue, on one hand, and the costs of generation plus various demand and conservation programs, on the other.[4] For example, if a generator has a contract to deliver energy at a price of $70/MWh but the hourly Ontario energy price (HOEP) is only $40/MWh, customers must pay a GA charge of $30/MWh to meet the generator's guaranteed price, set out in fixed, long-term contracts with the province.[5]

The total GA charge payable by all Ontario consumers has been rising (Table 1).[6] The negative values in 2005 were attributable to high wholesale prices that surpassed the retail prices for consumers. However, since then, regulated rates and prices paid under contracts to generators have, on average, exceeded the average HOEP and this gap has grown considerably over time. This means customers have faced rising Global Adjustment charges. From 2006 to 2014, total GA charges have risen from $654 million to $7 billion. On the other hand, total HOEP costs to all customers over the same time period have correspondingly declined over time from over $7 billion to approximately $5 billion, partially reflecting reduced demand.[7]

3 Further details on the history of the GA are available from the Ontario Electricity Conservation and Supply Task Force Report, available at http://mccarthy.ca/article_detail.aspx?id=1468.

4 Until 2015, generators obtained long-term, fixed-price contracts from the Ontario Power Authority (which has since been merged with the Independent Electricity System Operator), or the Ontario Electricity Financial Corporation. Wholesale markets are competitive, with generators being able to offer electricity to purchasers, such as large industrials and local distribution companies. The distribution companies then sell to small customers at retail prices fixed by the Ontario Energy Board. The wholesale HOEP will cover the short-term marginal costs of sellers, but is not high enough to cover the initial costs required to set up power plants. Regulated price contracts for generators are therefore intended to attract generation capacity and ensure a sufficient and stable supply of electricity.

5 Of course, this is an illustrative example. There are other factors, such as fuel mix and other programs that might also contribute to the magnitude of GA charges.

6 A possible reason for higher GA charges is a fall in energy demand. Specifically, fixed costs from new investment have to spread over reduced demand, which results in a higher Global Adjustment.

7 I calculate HOEP costs for Ontario by taking estimates of average annual HOEP and multiplying it by total Ontario energy demand. These data are released by the Independent Electricity System Operator. The price data are available from http://www.ieso.ca/Pages/Power-Data/price.aspx while annual Ontario energy demand can be found at http://www.ieso.ca/Pages/Power-Data/demand.aspx.

Table 1: Total Global Adjustment an Hourly Ontario Electricity Prices

Year	Total GA ($M)	Total HOEP Costs ($M)	Total Costs ($M)
2005	-1,153.0	11,319.7	10,166.7
2006	654.0	7,368.8	8,022.8
2007	597.0	7,676.0	8,273.0
2008	900.7	7,651. 6	8,552.3
2009	4,219.5	4,392.4	8,611.9
2010	3,847.7	5,381.8	9,229.5
2011	5,309.8	4,457.3	9.767.0
2012	6.455.7	3,405.3	9,861.0
2013	7.722.8	3,728.6	11,451.4
2014	7,034.9	5,032.8	12,067.7

Source: http://www.ieso.ca/Pages/Participate/Settlements/Global-Adjustment-Archive.aspx and http://www.ieso.ca/Pages/Power-Data/default.aspx.

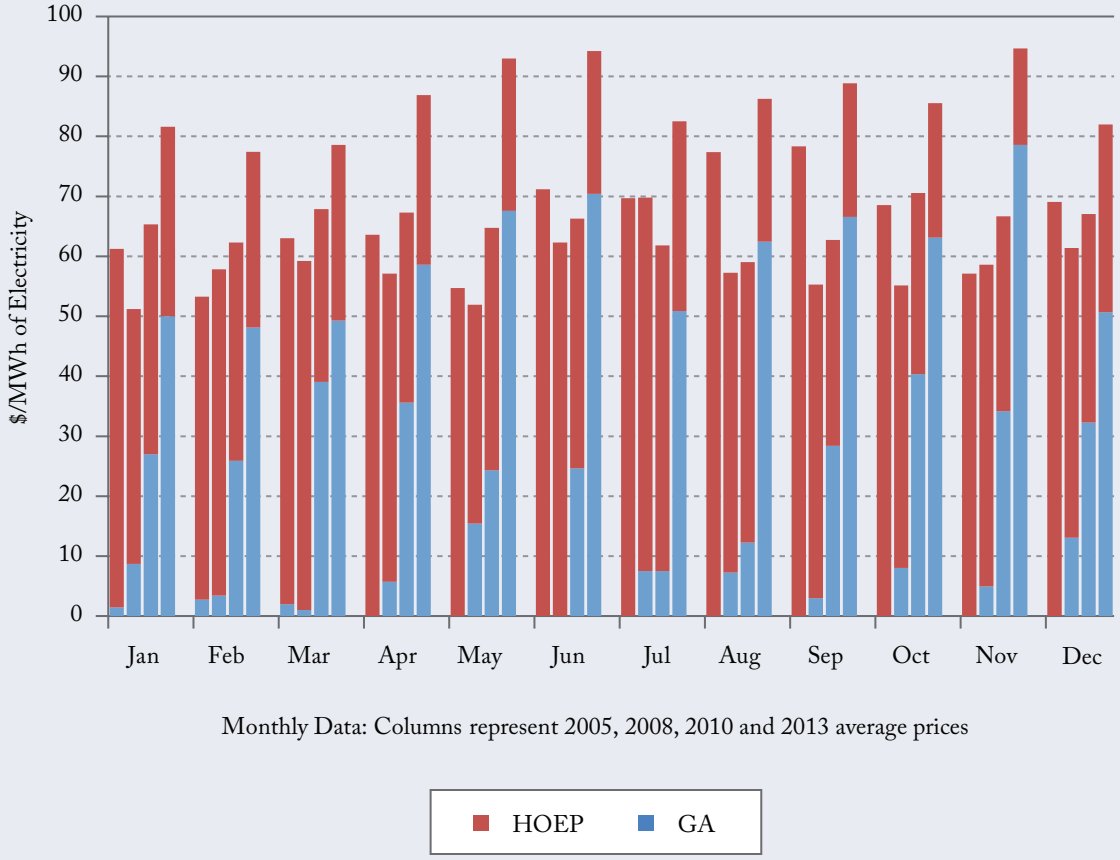
Averaged across months, the GA on a per MWh basis was 52 percent higher in 2013 than in 2010. On the other hand, averaged across months, the weighted average HOEP in 2013 was 28 percent lower than in 2010. From 2006-2013 HOEP costs have declined from 90 percent to slightly above 30 percent of total electricity costs, while GA charges over the same period have climbed from less than 10 percent to slightly under 67 percent (Figure 1). Further, the HOEP rose from 2013 to 2014, and the GA declined, although not as much as the HOEP rose.

High-5 Global Adjustment

Owing to the increasing size of the GA, and aiming to promote conservation, the Ontario Ministry of Energy implemented program changes effective as of January 2011. The province designated electricity consumers in Ontario as either Class A (large electricity consumers that have an average peak demand of more than 5 MW for a defined base period) or Class B customers (smaller industrials, commercial, and residential). Class A consumers account for about 20 percent of annual consumption in the province (Ontario Energy Board 2013). The province lowered the eligibility threshold for Class A customers to 3 MW of demand in the 2014 budget (Ontario 2014).

GA charges for Class A customers now are based on their average energy consumption during the five highest load hours that occur in Ontario each year, which are called the High-5 hours.

Figure 1: Average Monthly Electricity Price (GA plus HOEP, $/MWh)



Note: Averages are weighted by the amount of electricity used throughout the province within each hour. In months with negative average monthly GA (which mostly occur in 2005), I present only the net total price.

Source: Author's calculations from IESO.

The new billing structure is explained in the November 2011 Monitoring Report by the Market Surveillance Panel:

> …if Class A customers are responsible for 10% of system demand (MW) during the five peak hours in the Base Period, that group will be allocated 10% of the GA for the Billing Period. This is true even if Class A customers as a group consume more or less than 10% of the total energy (MW) used in Ontario during all the remaining hours in the Billing Period. (Ontario Energy Board 2011)

Further, once the GA has been allocated to each group, "…each Class A customer pays its share of the aggregate Class A GA amount based on its consumption during the five coincident peak hours in the Base Period" (Ontario Energy Board 2011).

In the extreme case, if a Class A customer's electricity consumption during system peak hours is zero, then it will not have any GA charge in the subsequent billing period. Hence, Class A customers have a strong incentive

to reduce electricity usage during system peak hours, which might result in significant cost savings. In contrast, the GA charge for each Class B customer is the share of that consumer's usage as a proportion of total electricity consumption of all Class B consumers during the billing period. The important point is that Class B customers are not given the same incentive to reduce peak hour consumption.

Estimating the Effects of High-5 Global Adjustment

This section establishes and quantifies the reduction in demand during the system peak demand hours by large industrials (Class A customers). To estimate how Class A customers responded to the High-5 program, I employ data on aggregate electricity usage (MWh) by all industrials that are directly connected to the transmission grid, and are Class A consumers (Table 2).[8] I examine the mean hourly consumption for Class A industrials separately for High-5 and the other remaining days in June, July, and August and for the pre-policy (2009, 2010) and post-implementation years (2011, 2012). I focus on these months because system peaks occur within this time frame during these years. For the 2009 and 2010 years, I identify the five peak days as High-5 days, hypothetically since the program was not yet in place (Table 2a).

I find that in contrast to the pre-policy period (2009 and 2010), during the post-implementation period (2011 and 2012), peak hour consumption during High-5 days is much lower relative to off-peak hour consumption on the same day, indicating a shift away from peak-period consumption (see Table 2a and 2b). Further, I make the following observations about the periods before and after implementation of the High-5 program.

Before:

- In 2009 and 2010, peak hour consumption was 4 and 8 percent lower than off-peak hour usage over all days (the bottom row of Table 2a).
- On average, the peak hour usage during High-5 days in 2009 (2010) was 6 percent (0 percent) higher than peak hour usage on non-High-5 days.

After:

- After the implementation of the High-5 program (2011-12), peak hour consumption was 14 to 19 percent lower during High-5 days and 6 to 7 percent lower in other days.[9]
- The reduction in peak hour consumption during High-5 days, in contrast to non-High-5 days, is 6 percent in 2011 and 14 percent in 2012, after implementation of the revised GA.

However, the differences in average consumption between peak and off-peak hours might be the result of unobserved differences in average temperature or weather, rather than the changes implemented to the GA. In order to assess this possibility, I control for the effects of other factors, while focusing on changes in electricity

8 These are not all Class A consumers, but a majority of them. According to the Market Surveillance Report (page 72), Market Surveillance Panel Monitoring Report on the IESO-Administered Electricity Markets for the period from May 2012 to April 2012), the consumers in my data constitute roughly 67 percent of all Class A consumers.

9 The patterns in off-peak hour consumption did not differ significantly for non-High-5 days after the new policy was introduced. Hence, I do not calculate a percentage difference.

Table 2: Average Hourly Electricity Consumption (MW) by Industrials by year

Table 2a: Before Introduction of "High-5" Pricing Program

	2009			2010		
	High-5 Days (hypothetical) MW	Other Days MW	Percent Difference in Peak Hour Use	High-5 Days (hypothetical) MW	Other Days MW	Percent Difference in Peak Hour Use
Peak Hours	1729	1622	6	1730	1725	0
Off Peak Hours	1831	1683		1883	1820	
Percentage difference between peak and off peak consumption	-6	-4		-8	-5	

Table 2b: After Introduction of "High-5" Pricing Program

	2011			2012		
	High-5 Days (hypothetical) MW	Other Days MW	Percent Difference in Peak Hour Use	High-5 Days (hypothetical) MW	Other Days MW	Percent Difference in Peak Hour Use
Peak Hours	1556	1650	-6	1549	1768	-14
Off Peak Hours	1801	1773		1909	1889	
Percentage difference between peak and off peak consumption	-14	-7		-19	-6	

Notes: Data are hourly and for the months of June, July, and August. Consumption are in MW. Standard deviations are in parentheses. The statistics are computed by year, by High-5 and other days, and peak hours. Peak hours are defined as being from 7 am to 7 pm, with off peak hours being the remainder.

consumption during High-5 days in the post-policy period (2011, 2012) relative to a pre-policy benchmark year (2009).[10]

10 Specifically, I use right hand side explanatory variables that control for movements in factors that vary by hour (such as the HOEP, hourly temperature and humidity, the specific hour of the day) or by week and month (through appropriate dummy variables) – all of which might affect trends in electricity consumption, independent of whether the day in question contains some system peak hours. I also evaluated the effects of adding month specific unemployment rates as a proxy for economic-growth driven demand. The addition of unemployment rates did not qualitatively change the estimates.

Table 3: Change in High-5 Consumption Peaks Based on Hourly Data – 2009, 2011, 2012

	High-5 Days	Top 1% of all hours	Top 5% of all hours
Consumption during High-5 days in 2011 and 2012 relative to High-5 days in 2009 (MW)	-195	-379	-188
Percentage change in consumption relative to 2009	-15	-23	-11

Notes: The effects of consumption during specific hours are measured through dummy variables. Controls for the Hourly Ontario Energy Price (HOEP), hourly temperature and relative humidity, day of week, month, and hour specific dummies were included in all regressions. The data are hourly for June, July, and August and consists of 6,624 observations. The reported results are statistically significant at the 1 percent level. Standard errors are Newey West corrected for unknown heteroskedasticity and second order autocorrelation. R-squared for all regression are 0.25.

On average, electricity consumption during High-5 days by industrials in 2011 and 2012 was 195 MW lower than High-5 days in 2009 (Column 1 Table 3). The results demonstrate that the implementation of the policy had some spillover effects, as industrials searched for system peaks with a view to reducing usage. Electricity consumption by industrials during the top 1 percent of all system consumption hours in 2012 was approximately 379 MW lower than the top 1 percent of system peaks in 2009 and 2010 (Column 2).

In summary, the empirical results offer some rather strong evidence of peak hour shifting after the introduction of the High-5 program. These are percentage reductions in consumption relative to 2009 of 11 to 23 percent (bottom row of Table 3). Unsurprisingly, the reduction in electricity consumption was lower for the top 5 percent of consumption hours relative to the top 1 percent of consumption hours. This implies that industrials were probably able to predict High-5 days.

However, it is also important to recognize significant differences across industries. Manufacturing does not display any reductions during system peaks and the automobile industry also exhibits limited response (Table 4). Industrial gas and equipment, chemicals, and mining responses range from 3 to 12 percent. In contrast, reductions by steel and paper and pulp are sizable, ranging from 24 to 54 percent. Conversations with industry experts suggest that these findings are consistent with expectations. Paper and pulp mills are relatively flexible in adjusting production schedules. This is not the case with manufacturing or the automobile sector.

Policy Implications

The empirical evidence implies that the High-5 program has encouraged reductions by industrial customers, overall, during system peak demand hours, and therefore, helped large industrials reduce their electricity costs. In summary, the above results demonstrate that in aggregate, Class A customers responded very strongly to the incentives offered by the new GA.

This is unsurprising given the benefits from cost savings. In its report, the Ontario Energy Board's Market Surveillance Panel calculated the benefits to Class A consumers of reducing consumption during system peak

Table 4: Effects of High-5 on Consumption Peaks – 2009, 2011, 2012 by Industrial Sector

Percentage change in consumption during High-5 days in 2011 and 2012 relative to High-5 days in 2009 (MW)	High-5 Days	Top 1% of all hours	Top 5% of all hours
Industrial Gas and Equipment	-12*	-12*	-7*
Auto	-10*	-1	-5
Chemicals	-8*	-8*	-3*
Mining	-9*	-13*	-4*
Manufacturing	-0.2	-0.4	-
Steel	-26*	-54*	-24*
Pulp and Paper	-37*	-52*	-38*

Notes: The effects of consumption during specific hours are measured through dummy variables. Controls for the Hourly Ontario Energy Price (HOEP), hourly temperature and relative humidity, day of week, month, and hour specific dummies were included in all regressions. The data are hourly for June, July, and August and consists of 6,624 observations. * denotes statistical significance of at least 5 percent. Standard errors are Newey West corrected for unknown heteroskedasticity and second order autocorrelation. R-squared for all regression are 0.25.

hours. The Panel uses a figure of $8.8 billion to estimate the total GA charges paid by all Class A and Class B customers from May 1, 2013 to April 30, 2014. However, publicly available data from the Independent Electricity System Operator reveals the total GA to be roughly $6.25 billion.[11] In the same time period, total electricity consumed during High-5 hours was 119,419 MWh. Therefore, the cost of consuming electricity during a single High-5 hour is roughly $52,337/MWh.[12]

These costs are significant and offer an explanation of why the econometric results demonstrate lower electricity usage during the top 1 percent system peaks in 2012, relative to 2009 and 2010. Firms benefitted from hunting for system peaks to avoid the potential cost of $52,337/MWh, for consuming electricity during those hours. Even such a high hourly cost for electricity, however, is nowhere near any reasonable cost for constructing new peak-load electricity generation or prices for market-based demand management services, which are a few hundred dollars per MWh.

11 Available at http://www.ieso.ca/Pages/Ontario's-Power-System/Electricity-Pricing-in-Ontario/Global-Adjustment.aspx.

12 This is calculated as $6.25 billion/119,419 MWh.

Cost Transfers from Class A to Class B Consumers

The High-5 program increases GA charges for other consumers. The Market Surveillance Panel estimates that the revised GA allocation results in, on average, about a $34 increase per year in the average Ontario household's electricity bill. A recent announcement by the Minister of Energy suggests that the average Ontario household's annual electricity bill is expected to increase by $120.[13] Over one-quarter of the increased costs of electricity for households is because of the transfer of costs from one group of customers to another.

The Economic Welfare Costs of the High-5 program

Class B consumers are paying more in GA charges so that Class A consumers can pay less. The panel estimates that the new GA formula resulted in Class A consumers paying $422 million less in 2012 than they would have paid under the former formula.[14] From a policy perspective, the relevant question is – is society better off?

In its analysis, the Market Surveillance Panel relies on the traditional economic concept of deadweight loss, which represents the loss (gain) in transactions from less (more) competition and higher (lower) prices. Based on collected evidence, the Panel concludes that electricity demand by Class A consumers is relatively inelastic. If this is true, then the decrease in GA charges for Class A customers is simply a transfer of higher payments that Class B customers must pay, and there is therefore, no change in societal surplus. For example, the above estimate of the cost transfer to households assumes that for a given year, the total costs of the system are fixed. However, this inference is based on a static perspective, which ignores dynamic efficiencies.

In other words, while electricity demand over a shorter time period may be inelastic, it is difficult to accept that industrials are unresponsive to significant changes in electricity costs. If avoided costs (from lower GA payments) are significant at the firm level, then industrials may then be able to allocate increased resources to other initiatives that improve productivity and create employment opportunities. For industrials that are electricity intensive, the cost savings from avoided Global Adjustment charges might be substantial and thus result in enhanced competitive advantages, that on the margin, makes Ontario an attractive venue for increased expansion.

On the other hand, it is also important to evaluate these avoided costs against the search costs associated with "peak hunting," which represents an economic cost of foregone electricity use, and presumable company production. From a system perspective, it is important to acknowledge that a properly designed peak demand management program would target a reduction in avoidable costs.

Reforming the Global Adjustment through a Capacity Market

The Independent Electricity System Operator is planning to introduce a capacity market. A capacity market is a mechanism in which wholesale electricity buyers and sellers engage in medium-term contracts to deliver

13 See "Average Ontario hydro bill to go up about $120 a year" by Richard J. Brennan, published by the *Toronto Star* on March 26th 2015 and available at http://www.thestar.com/news/queenspark/2015/03/26/average-ontario-hydro-bill-to-go-up-about-120-a-year.html.

14 It is important to acknowledge that some of this reduced burden would have automatically occurred because the peak load share of Class A customers was low, even before the implementation of the new sharing rule. The Panel estimates that roughly $290 million in avoided GA is attributable to the new rule, with the remainder due to demand reductions by Class A consumers in High-5 hours.

electricity at a particular time and price. A capacity market will allow the province to offer generators new ways of payment other than fixed-price contracts. A capacity market results in a separate payment to the generator for power availability, and an additional payment at the market price for electricity consumed. A competitive market among electricity suppliers will likely lead to a reduction in the amount that generators need to be paid on top of the hourly price. Reducing the amount all consumers pay for capacity availability can lead to widespread savings.

An Ontario capacity market can also evolve to include large industrial consumers as electricity buyers. Rather than designating them as subject to the High-5 pricing scheme, a capacity market can enable a market for demand management services, which will create a market to determine the lowest-cost options for consumers to reduce their consumption during peak periods. A market for demand management will be more effective than the imprecise pricing system of the High-5 program.

Conclusion

Ontario electricity consumers have seen their electricity costs rise dramatically since 2008. The High-5 program aims to reduce peak-period electricity consumption and reduce costs. However, it does so at a higher-than-necessary cost to industrial customers and results in a cost transfer to households and smaller electricity consumers. The Ontario government should phase out the High-5 pricing scheme and rely on a market-based demand management system as part of a capacity market.

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