CIGRE-411

2021 CIGRE Canada Conference & Expo
Montréal, Québec, October 25-28, 2021

Chasing the Peak – Potential Reduction in Global Adjustment Charge For McMaster University

F.Q. Huang, H. Yim, C. Tang
McMaster University
Canada

SUMMARY

Located in the city of Hamilton, Ontario, McMaster University is home to about 33,000 students and 7500 employees. Its main campus is comprised of approximately 300 acres of property, making the University a major electricity consumer in Ontario. Each year, the University consumes approximately 80,000 MWh of electrical energy and pays millions of dollars for electricity. The main objective of this paper is to evaluate the financial benefits of installing a new 10-MW peaking generator on campus, for the purpose of reducing the Global Adjustment charge.

Like all Ontario electricity customers, McMaster University's electricity bill includes both a wholesale electricity charge and a Global Adjustment (GA) charge, in addition to the delivery and other administrative charges. The GA charge is by far the biggest charge item on the electricity bill, through which the Independent Electricity System Operator (IESO) recovers the costs of regulated and contracted generation in Ontario, as well as any costs associated with administering energy conservation programs.

In 2010, Ontario introduced the Industrial Conservation Initiative (ICI), which is essentially a demand response program. To ensure grid reliability and adequate electricity supply to all load customers, all power grids are designed, built, and operated to accommodate system peak loads. Therefore, if the system peak is high even for a small percentage of time, significant amounts of generation and transmission capital investments need to be made to meet the system peaks. The ICI program is intended to incentivize electricity customers to shift their loads from peak hours to off-peak hours, thus lowering the system peak to delay any need for new generation and transmission facilities.

If an electricity customer chooses to participate in the ICI program and becomes a Class A customer, a Peak Demand Factor (PDF) will be calculated, based on the customer's percentage contribution to the top five Ontario coincident peaks for a 12-month base period from May1 to April 30. Based on this PDF, the customer's GA charge for the upcoming billing period (July 1 to June 30) will be determined. If a load customer can reduce its electricity consumption during the top five Ontario peaks, it can save significantly on its GA
cktang@mcmaster.ca

charge. Any mid-sized or large electricity customers in Ontario can participate in the ICI program and has its GA charge calculated based on its PDF. These customers are called Class A customers, as opposed to the Class B customers who pay their GA charge based on the monthly GA rates determined by the IESO, regardless of their energy consumption during the top five Ontario peaks.

The paper will evaluate the financial benefits of installing a new 10 MW peaking generator. First, the GA charge will be estimated for McMaster University as a Class B customer, based on power consumption data for years 2018 and 2019. The next step is to estimate the GA charge for McMaster assuming it is a Class A customer. Annual savings in GA charge can be determined based on these two calculations, which can then be used to determine the payback period for the new 10-MW peaking generator. Financial evaluations will be performed using the RETSCREEN software obtained from Natural Resources Canada. All capital and operating costs will be taken into consideration in the cost-benefit analysis.

Based on McMaster's power consumption data for years 2018 and 2019, results indicate that McMaster can reduce its global adjustment cost by $3.6M to $5.2M per year, provided the University is successful in catching Ontario's top five peaks 3 to 5 times. The corresponding payback periods are 3 to 6 years, depending on how Ontario peaks are caught. It has been identified that the peaking generator only needs to be run for about 300 hours a year, hence resulting in minimal impact on CO_2 emissions. A strategy on how to run the peaking generator in proposed.

This paper will provide incentives for Ontario load customers to evaluate the benefits of participating in Ontario's Industry Conservation Initiative (ICI) program. It will promote installation of more distributed generation resources in Ontario with the potential of deferring major generation and transmission upgrades in the province.

KEYWORDS

Global Adjustment, Peak Demand Factor, Load Response Management

1.0 INTRODUCTION

As a major electricity consumer in Ontario, cost of electricity is a major operating expense for McMaster University (Mac). Each year Mac pays millions of dollars on the electricity bill, of which the global adjustment (GA) charge is the biggest component. Global adjustment charge is the mechanism through which the Independent Electricity System Operator (IESO) recovers the cost of regulated and contracted generation such as nuclear and renewable energy, as well as any costs associated with energy conservation programs administered by the IESO.

As a major electricity consumer, Mac purchase electricity either as a Class A or a Class B customer. The global adjustment charge for a Class B customer is based on the customer's monthly electricity consumption and the monthly GA rates posted by the IESO, regardless of how much power the customer draws from the grid during peak Ontario electricity demand peaks. For a class A customer, the GA charge is based on the customer's peak demand factor (PDF) which is tied to the customer's electricity consumption during the top five provincial demand peaks over a 12-month period base period. The main idea is to incentivize electricity consumers to perform load response management such as peak shaving so that Ontario can reduce or delay capital investments on generating and transmission facilities while still maintaining system adequacy and reliability at the same time.

McMaster University has been doing its due diligence to reduce energy consumption by different means such as improving equipment efficiency, adjusting temperature setpoint, and conducting energy planning reviews [1, 2]. One way to reduce GA charge is to reduce electricity consumption during peak hours, which usually happen on hot summer days in Ontario. In this situation, if power consumption is reduced by raising the controlled temperature of the air conditioning, then University campus occupants such as students and staff will have to endure the discomfort arising from high ambient temperature and humidity.

Another option to reduce McMaster's GA charge is to back off electricity import from the grid during peak hours, by utilizing local peaking generation sources. Currently Mac has a 5.7 MW gas-fired generator, which is part of a co-generation facility to improve energy efficiency. In addition, the Mac campus is also connected to the McMaster University Medical Centre (MUMC) which has six diesel generators of 1.8 MW each. However, the total combined Mac and MUMC load can be as high as 26 MW, so that Mac still needs to import significant amounts of power from the grid during Ontario demand peaks. The purpose of this paper is to evaluate the financial benefits of installing a new 10 MW gas-fired peaking generator on campus, based on consideration of GA charge.

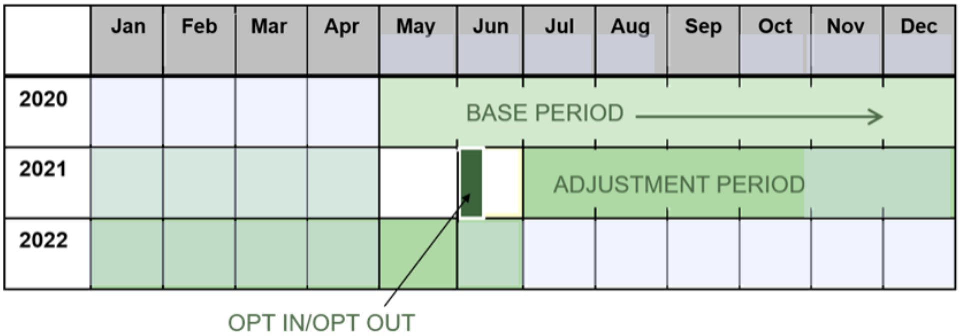
2.0 DESCRIPTION OF GLOBAL ADJUSTMENT

The IESO imposes a GA charge to all electricity customers to account for, among other expenses, the differences between the guaranteed price each producer gets from the IESO and the Hourly Ontario Energy Price (HOEP) price. For example, if a producer is guaranteed $8/MWh while the HOEP is $10/MWh, then all electricity users will share the $2 difference. In addition, the GA charge also recovers the money that the IESO incurs in administering various energy conservation programs. In Ontario all electricity consumers pay GA charge either as a Class A or Class B customer.

2.1 Class A Customer

The IESO computes a Peak Demand Factor (PDF) for each Class A customer based on the proportion of energy the customer has consumed during the top five provincial demand peaks over a 12-month base period (May 1 to April 30). Based on this PDF, the IESO determines the GA charge for the customer for the upcoming settlement period (July 1 to June 30). The timeline of the base period and settlement period is extracted from [3] and reproduced below:

Figure 1: Global Adjustment Base Period and Settlement Periord



As shown in Fig. 1, each cycle of GA calculation starts with the base period. At the end of the base period, the IESO will assess its customers for ICI (Class A) eligibility. Customers with average monthly peak demand between 0.5 MW and 5 MW will need to opt in, while customers with an average monthly peak demand over 5 MW are automatically considered Class A unless they choose to opt out [4].

2.2 Class B Customer

All electricity consumers that are not Class A customers are automatically Class B customers. The IESO calculates the total GA cost to the province and the GA charged to all Class A customers. The difference is then recovered from Class B customers. The IESO posts the monthly GA rates for Class B customers who pay their GA charge straightly based on total energy consumption and do not have to worry about peak demands.

2.3 Share of Ontario GA Cost between Class A and Class B Customers

For the year 2020, the GA cost shared by Class A and Class B customers is shown in Table 1, which shows that in 2020, Class A customers consumed 17.21% of the total energy but paid 28.46% of the total global adjustment cost. According to these figures, Class A customers have great opportunities to reduce their GA charge.

Table 1: Share of GA costs and Energy Consumption by Class A and Class B Customers

	Total $	**%**	**Total TWh**	**%**
Class A	38.898	28.46	2401.8	17.21
Class B	97.784	71.54	11557.4	82.79

3.0 COST-BENEFIT ANALYSIS

This section will present a cost-benefit analysis for the installation of the proposed new 10 MW peaking generator. Only the savings in GA charge is considered as it offers the most financial benefits. The calculation is based on McMaster electricity imports from the grid during 2018 and 2019.

3.1 McMaster University as Class B customer

Assuming McMaster University elects to be a Class B customer, its monthly GA costs are presented in Table 2, based on the 2018 and 2019 load and generation patterns. The annual GA cost is estimated to be about $6.425M.

Table 2: McMaster GA Costs as a Class B Customer

	Import (MWh)	GA price ($/MWh)	Monthly GA Cost
Jul, 2019	7646	96.45	737456.7
Aug, 2019	6641	126.07	837230.9
Sep, 2019	5642	122.63	691878.5
Oct, 2019	4379	136.80	599047.2
Nov. 2019	3568	99.53	355123
Dec, 2019	4209	93.21	392320.9
Jan, 2020	3201	102.32	327526.3
Feb, 2020	2611	113.31	295852.4
Mar, 2020	2849	119.42	340227.6
Apr, 2020	4976	115.00	572240
May, 2020	4789	115.00	550735
Jun, 2020	6304	115.00	724960
		Total $	6424598

3.2 McMaster University as Class A Customer

Table 3 summarizes the GA costs to McMaster as a Class A customer, based on five different scenarios: Catch-0 to Catch-5. The Catch-0 scenario assumes that McMaster fails to turn on the peaking generator during the top five provincial peak hours over the base period. On the other hand, the Catch-5 scenario assumes that the peaking generator runs during all of the top five provincial peak hours. The other scenarios are defined in a similar manner. The Peak Demand Factor (PDFs) for the different scenarios are provided in Table 3 and the monthly and annual GA costs are provided in Table 4.

Table 4 shows that McMaster can save $5.2M on annual GA cost if all top five provincial peaks are caught by the 10 MW peaking generator, roughly $0.5M for each MW of peaking generation provided. If none of the provincial top five demand peaks are caught, a very unlikely outcome, then McMaster will end up paying more on the GA charge as a Class A customer.

3.3 Payback Period Calculation

Table 5 provides the simple payback periods for the different scenarios, obtained from running the RETSCREEN software with the following assumptions:

- Peaking Generator Capital Cost = $10,000,000.
- Interest rate = 7%
- Inflation rate = 2.5%
- Project life = 20 years
- Debt ratio = 70%
- O&M cost is $200,000 per year (assuming 300 operation hours)
- Fuel cost is $80,000 per year (assuming 300 operation hours)

Table 3: McMaster Peak Demand Factors

	Mac Top 5 (MWh)	ONT Top 5 (MWh)	Mac PDF
Catch-5	9.81	115212	0.000085121
Catch-4	19.81	115212	0.000171918
Catch-3	29.81	115212	0.000258714
Catch-2	39.81	115212	0.000345511
Catch-1	49.81	115212	0.000432307
Catch-0	59.81	115212	0.000519104

Table 4: McMaster Global Adjustment Costs

	ONT Monthly GA cost($M)	Catch-5 ($M)	Catch-4 ($M)	Catch-3 ($M)	Catch-2 ($M)	Catch-1 ($M)	Catch-0 ($M)
Jul, 2019	1149.6	0.09786	0.19764	0.29742	0.39720	0.49698	0.59676
Aug, 2019	1327.7	0.11302	0.22826	0.34350	0.45873	0.57397	0.68921
Sep, 2019	1082.9	0.09218	0.18617	0.28016	0.37415	0.46815	0.56214
Oct, 2019	1209.6	0.10296	0.20795	0.31294	0.41793	0.52292	0.62791
Nov. 2019	979.0	0.08333	0.16831	0.25328	0.33826	0.42323	0.50820
Dec, 2019	1000.2	0.08514	0.17195	0.25877	0.34558	0.43239	0.51921
Jan, 2020	1107.8	0.09430	0.19045	0.28660	0.38276	0.47891	0.57506
Feb, 2020	1136.5	0.09674	0.19538	0.29403	0.39267	0.49132	0.58996
Mar, 2020	1168.4	0.09946	0.20087	0.30228	0.40369	0.50511	0.60652
Apr, 2020	1282.7	0.10919	0.22052	0.33185	0.44319	0.55452	0.66585
May, 2020	1293.6	0.11011	0.22239	0.33467	0.44695	0.55923	0.67151
Jun, 2020	1282.2	0.10914	0.22043	0.33172	0.44301	0.55430	0.66560
Annual GA	Cost($M)	1.19342	2.41032	3.62723	4.84413	6.06104	7.27794
Net GA Cost	Reduction ($)	5231180	4014276	2797371	1580467	363562.3	-853342

Table 5: Payback Periods for Different Scenarios

Scenario	Yearly Saving (M$)	Payback Years
Catch-3	1.763	6.4
Catch-4	2.766	3.9
Catch-5	3.769	2.8

Based on RETSCREEN results, the payback period for the proposed new 10 MW peaking generator varies from 3 years if all top five peaks are caught, to 6 years if only top 3 peaks are caught. Typically, a 3-year payback period is given high investment priority in private companies and a 6-year payback period is deemed acceptable to academic institutions.

4.0 PROPOSED STRATEGY FOR PEAKING GENERATOR OPERATION

In this section, a strategy on how to utilize the proposed new 10 MW gas-fired generator is proposed, based on observation of Ontario's top five demand peaks for the past 11 years.

To come up with a strategy on when to run the new peaking generator, top five provincial peaks for the past 11 years have been reviewed. Table 7 presents month of the year, day of the week and hour of the day at which the provincial top five demand peaks occurred. Note that the top five peaks have values ranging from 20885 MW to 25110 MW.

Table 7 Review of Ontario's Top Five Peaks from 2010 to 2020

Month	No. of Times	Day of Week	No. of Times	Hour of Day	No. of Times	Hour of Day	No. of Times
Jan	2	**Mon**	11	**HE 1**	0	**HE 13**	0
Feb	2	**Tue**	11	**HE 2**	0	**HE 14**	4
Mar	0	**Wed**	15	**HE 3**	0	**HE 15**	2
Apr	0	**Thu**	9	**HE 4**	0	**HE 16**	9
May	0	**Fri**	8	**HE 5**	0	**HE 17**	27
Jun	2	**Sat**	1	**HE 6**	0	**HE 18**	8
Jul	34	**Sun**	0	**HE 7**	0	**HE 19**	1
Aug	7	**Total**	55	**HE 8**	0	**HE 20**	2
Sep	8			**HE 9**	0	**HE 21**	0
Oct	0			**HE 10**	0	**HE 22**	0
Nov	0			**HE 11**	0	**HE 23**	0
Dec	0			**HE 12**	2	**HE 24**	0
Total	55			**Total**	2	**Total**	53

A strategy on peaking generator operation to catch the top five provincial demand peaks is proposed. Essentially the peaking generator should be operated if one of more of the following conditions are met:

- During the months of July, August and September
- During the weekdays (Monday through Friday) which is not a statutory holiday
- During 3 pm to 7 pm
- Demand forecast from IESO is over 20,000 MW

5.0 CONCLUSIONS

The financial benefits of adding a new 10 MW gas-fired peaking generator have been analyzed using RETSCREEN software. Based on McMaster's electricity import data for the years 2018 and 2019, results indicate that McMaster can save in its global adjustment cost by $3.6M to $5.2M per year, provided the University is successful in catching 3 to 5 top provincial demand peaks. The payback period is approximately 3 to 6 years, again depending on how many provincial top peaks are caught or missed. In addition, a strategy for peaking generator operation has been proposed to maximize the chance of catching provincial demand peaks while minimizing the hours of peaking generator operation.

ACKNOWLEDGEMENT

The authors wish to express their sincere thanks to Mr. Joe Emberson and Mr. Alvin Baldovino of McMaster Central Services Division for their valuable support to this research work.

BIBLIOGRAPHY

[1] Energy Management Plan, Facility Services, McMaster University, Fall 2016
[2] Net Zero Carbon Roadmap, Report by Footprint for McMaster University, December 2020
[3] Industrial Conservation Initiative (ICI) Overview, IESO, April 2021
[4] Industrial Conservation Initiative Backgrounder & FAQs, IESO, September 2020