London MRF Hydro Capacitor Upgrade
CIF Project Number #856

Final Report
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Prepared for:
Waste Diversion Ontario
Continuous Improvement Fund Office
Barrie, Ontario

Acknowledgement

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Table of Contents

List of Figures

List of Tables

1 Executive Summary

The City of London owns and contracts out the operation of a two-stream Regional Materials Recovery Facility (MRF) used to process Blue Box recyclables. The City purchased and installed a capacitor for the electrical system at the MRF to improve the power factor and reduce the variable demand/delivery electrical billing charges. The Continuous Improvement Fund (CIF) provided financial assistance in completing the capacitor upgrade at the MRF.

The MRF provides processing services to 9 municipalities in the area, including the City, and processes approximately 35,000 tonnes annually. The MRF itself is state-of-the-art and as such has equipment requiring a significant amount of power to operate. In 2014, the City was notified by London Hydro that the power factor at the MRF was below 90% and as such were paying additional electrical demand/delivery charges. To rectify the issue, London Hydro advised City staff to install a capacitor at the MRF. Adding a capacitor to the electrical system would improve the power factor efficiency measure and reduce electrical billing charges to the City.

London Hydro provided City staff with estimated savings on electrical billing charges following installation of a capacitor that would correct the MRFs power factor to 90% which amounted to approximately $10,000 annually. The payback period of the investment in power factor correction was initially estimated to be approximately 3 years based on preliminary estimates of purchasing and installing a scalable capacitor to provide the required power factor correction.

The initial cost estimates were revised, as they were provided for large and scalable capacitors. Given the MRF is designed for 75,000 tonnes per year it was decided that larger, scalable capacitors would not be required. As such, the City elected to purchase a smaller non-scalable capacitor for $9,800 plus taxes including installation. Installation of the capacitor took approximately 2 days and was completed on August 10, 2015.

City staff monitored electrical billings for a period of six months prior to installation of the capacitor and six months following installation. The billings provided the power factor and electrical charges. The power factor reported following installation of the capacitor has consistently been above the critical 90% threshold.

The result of this improvement is a reduction in electrical demand/delivery charges of nearly 20% or $892 per month on average. This average monthly savings provides an estimated annual reduction in electrical charges of approximately $10,700. As such, the City is able to demonstrate a payback period of less than one year.

The project was completed on schedule and below budget.

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2 Introduction

The City of London finished construction and began operations of a two-stream Regional Materials Recovery Facility (MRF) in 2011. In 2014, London Hydro advised via correspondence to the MRF operations contractor that there was an opportunity to reduce monthly electrical demand/delivery charges, via correcting the observed recurring power factor of below 90%. The power factor term is calculated by dividing the energy consumed (kW) by the apparent power (KVA). A Power factor of less than 90% results in higher than necessary electrical demand/delivery billing charges. In this case the additional fees were estimated to be approximately $10,000 per year.

London Hydro advised that installation of an appropriately sized capacitor would likely result in correcting the observed power factor to within the 90% threshold for demand/delivery billing purposes. The capacitor serves to provide temporary short term storage of energy which effectively smooth's out the energy supplied to equipment. As such, the apparent power is reduced as energy supplied to operating equipment is consistently available.

City staff initially received preliminary estimates from mechanical and electrical contracting companies, for a larger scalable capacitor (approx. 300kVAr) which would alleviate the current power factor issue and provide options for the future. The initial estimates for scalable capacitors estimated the purchase and installation cost to be approximately $30,000.

Staff applied for and received funding from the Continuous Improvement Fund (CIF) to purchase and install a capacitor. The project was awarded funding as a Cost Savings project as staff were able to demonstrate a payback on the project of approximately three years.

Staff elected to purchase a smaller non-scalable capacitor than initially scoped, a 225 kVAr unit, as their calculations indicated the additional capacitance of a 300 kVAr unit would be unnecessary to meet current and future electrical demands. The actual price to complete the purchase and installation was $9,800.

Figure 1: Installed Capacitor

3 Background

3.1 Community Profile

The City of London currently provides Blue Box recycling to 172,000 households, including 53,500 households (31%) in multi-residential buildings (2014 WDO Datacall). Collection services are provided under a contract service with 19 trucks for curbside and two trucks for multi-residential. The City owned two-stream Regional Materials Recovery Facility (MRF) was opened in August 2011 and its operation is contracted to Miller Waste Systems.

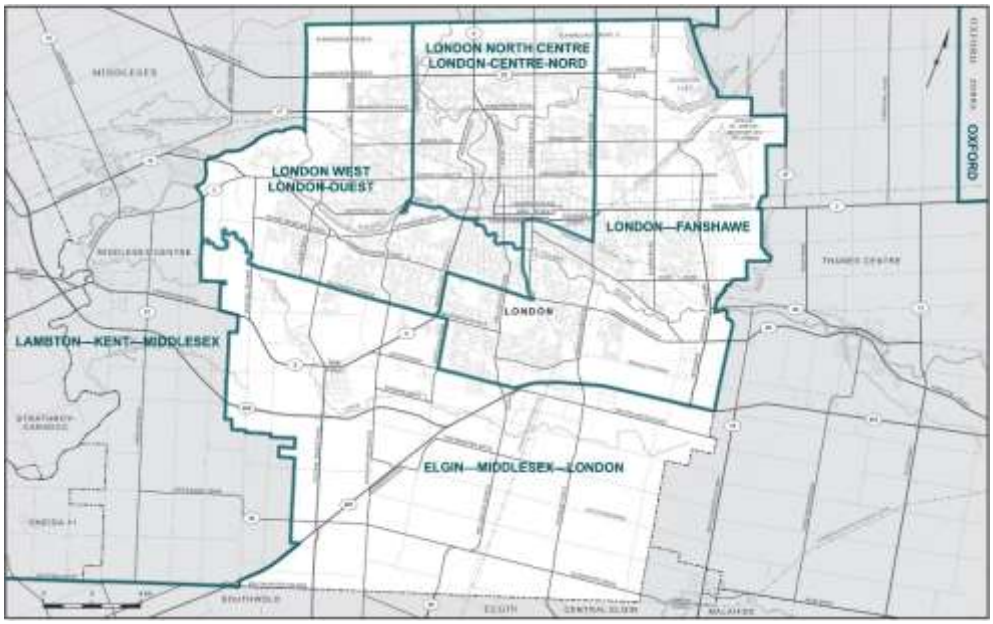

Figure 2: Image retrieved from www.redecoupage-federal-redistribution.ca/ April 13, 2016.

3.2 Waste Management System

The City provides residents with the following waste management services:

- Single-family recycling: Curbside collection every sixth (6) day of Blue Box materials using a two stream box program
- Multi-family recycling: Weekly collection of Blue Box materials using two stream cart & front end loading bin collection
- Single-family yard material collection: Curbside collection six times per year of yard materials and fall leaves
- Garbage collection system for SF and MF (collection and disposal)
- Drop-off Depots: Drop-off depots for various recyclable materials including Blue Box recyclables, yard materials, electronics, scrap metal, appliances, used clothing, etc.

3.3 Current Waste Management Performance

The City currently recycles approximately 25,000 tonnes of material collected from residents through the residential Blue Box program (2014 WDO Datacall). The amount of material recycled from each household within the City is approximately 160 kg/household (2014 WDO Datacall).

3.4 Program Challenges

The London MRF has a recurring power factor below the 90% monthly threshold. This low power factor results in increased electricity charges of approximately $10,000 per year. Installation of capacitors would result in the power factor consistently being above the 90% threshold yielding an initially anticipated 3 to 4 year payback on the investment in a 300 kVAr scalable capacitor.

3.5 Approach

The MRF operator, Miller Waste, received a letter from London Hydro Energy Management department indicating the facility had received recurring power factor penalties for performance below a 90% power factor threshold. London Hydro suggested that installation of corrective capacitors within the MRF's electric distribution system would alleviate this issue. Further, London Hydro identified capacitors may increase the capacity of the distribution system and stabilize voltage levels.

London Hydro suggested installation of a 250 kVAr capacitor would reduce electrical demand charges by approximately $9,910.43 annually based on 2013 usage. City staff solicited estimates for budgetary purposes, for purchase and installation of a 300 kVAr scalable capacitor. As previously noted, the budgetary estimate developed was approximately $30,000.

Equipment and facility construction/renovation requirements

Large capacitors (generally greater than 300kVAr) may cause the power distribution system to have a resonant frequency. To determine if a harmonic filter accessory was required, for the originally planned 300 kVAR scalable capacitor, City of London staff worked with London Hydro to complete a harmonics profile analysis. Ultimately a capacitor of 225kVAR was installed, reducing the risk of resonate harmonic issues, and ultimately it was determined that a capacitive filter to guard against harmonic resonance was not required. A list of the installed equipment is provided below:

- 225 kVAR FPFC (Fixed Power Factor Correction) Bank on Main Switchboard
- Indoor Dustproof NEMA 12 Cabinet
- 400A 600V, 3 Pole, Nema 1, Fusible Style, Single Type Disconnect

Installation and commissioning of equipment and supporting infrastructure;

As noted above, the actual unit purchased and installed was a 225 kVAr non-scalable capacitor. The capacitor bank was installed in the MRF main electrical room, wall mounted above the main switch board. The installation took approximately two days and the commissioning of the installation was co-ordinated with the MRF operator. After installation the equipment was inspected and the installation approved by the Electrical Safety Authority.

3.6 Monitoring and Measurement Methodology

Staff planned to compare six months of baseline versus six months of post installation electrical utility bills. The bills provide power factor data and electrical demand/delivery billing charges. The six months of pre (April – September 2015) vs post (October 2015 – March 2016) electrical utility bills collected will assist staff in summarizing and comparing effectiveness of power factor correction and realized savings on power demand/delivery charges.

3.7 Monitoring Challenges, Limitations and Solutions

Purchase and installation of the capacitor was contracted on May 6th 2015. The installation took two days to complete. Measurement and Monitoring of the project encountered no challenges as the data was provided by London Hydro.

4. Project Results and Analysis

4.1 Project Results

Six months of pre vs post electrical utility bills were collected by staff to assess the effectiveness of power factor correction and realized savings on power demand/delivery charges. The power factor correction and electrical demand/delivery charges for the pre installation period (April – September 2015) vs the post installation period (October 2015 – March 2016) are presented in figure 3 below; Table 1 in section 4.2 provides additional information.

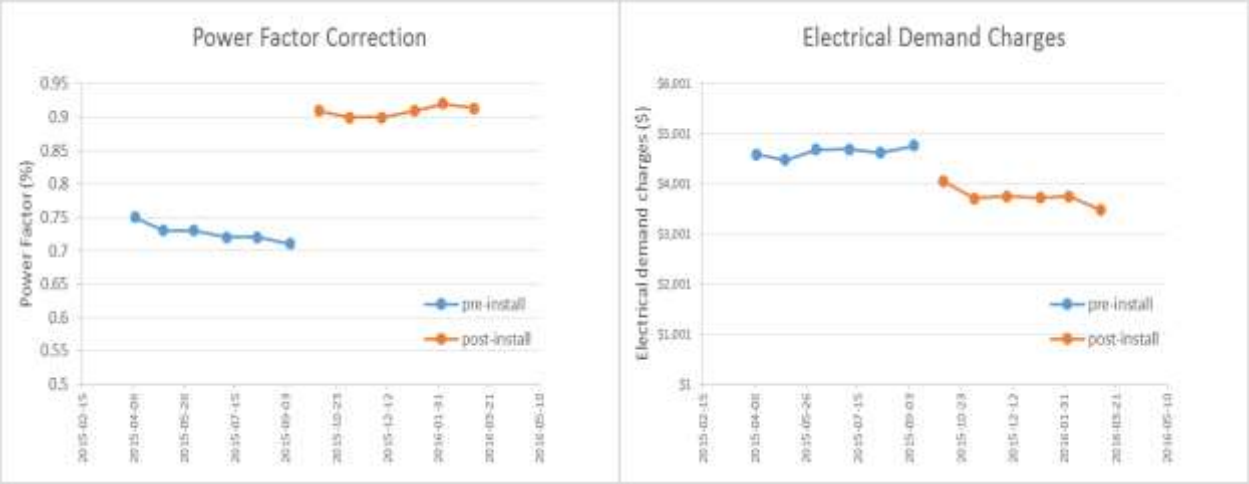

Figure 3: Power factor correction pre vs post installation

The average power factor for the pre installation period was 73% versus 91% following installation of the capacitor. All electrical utility bills received following installation of the capacitor identify the power factor being above 90%. The average electrical demand/delivery charges for the pre installation period was $4,640.98 versus $3,748.77 following installation of the capacitor. This reflects an average monthly savings in electrical demand/delivery charges of approximately $892.91; an estimated $10,700 in annual savings.

4.2 Analysis of Results

Electrical utility bills received following installation of the capacitor indicate the MRF's power factor is now above the critical 90% threshold identified by London Hydro. Adding a capacitor to the electrical system at the London MRF provided a reduction in the apparent power provided to the facility. The reader will note that while KVA decreased after capacitor installation, the actual average energy consumed (kW) between pre vs post periods remained constant.

Meeting the 90% threshold means the charges for electrical demand/delivery charges will be reduced. Convincingly, the average monthly costs of electricity delivery/demand charges for MRF electricity use have dropped nearly 20% following installation of the capacitor.

4.3 Lessons Learned

This initiative was easy to implement and the impact immediate. Once staff became aware of the issue, the identification of a solution to the problem was straightforward.

Table 1: Pre vs post implementation electrical billing information

BILLING DATE	START DATE	END DATE	POWER FACTOR	PEAK (KW)	PEAK (KVA)	Cost
08-Apr-15	21-Feb-15	20-Mar-15	0.75	459.0	613.2	$ 4,597.49
06-May-15	21-Mar-15	21-Apr-15	0.73	436.2	597.6	$ 4,480.53
05-Jun-15	22-Apr-15	21-May-15	0.73	456.6	624.6	$ 4,682.96
07-Jul-15	22-May-15	19-Jun-15	0.72	447.6	625.8	$ 4,691.96
06-Aug-15	20-Jun-15	21-Jul-15	0.72	443.4	616.8	$ 4,624.48
08-Sep-15	22-Jul-15	21-Aug-15	0.71	454.2	636.0	$ 4,768.44
installation of capacitor						
06-Oct-15	22-Aug-15	21-Sep-15	0.91	487.8	537.0	$ 4,063.67
05-Nov-15	22-Sep-15	21-Oct-15	0.90	445.8	496.2	$ 3,713.78
07-Dec-15	22-Oct-15	20-Nov-15	0.90	450.6	498.0	$ 3,753.77
08-Jan-16	21-Nov-15	21-Dec-15	0.91	447.0	489.6	$ 3,723.78
05-Feb-16	22-Dec-15	21-Jan-16	0.92	450.6	491.4	$ 3,753.77
07-Mar-16	22-Jan-16	19-Feb-16	0.91	418.2	457.8	$ 3,483.86
AVERAGE FOR PRE-INSTALLATION			0.73	449.5	619.0	$ 4,640.98
AVERAGE FOR POST-INSTALLATION			0.91	450.0	495.0	$ 3,748.77
DIFFERENCE				0.50	- 124.00	-$ 892.21

5 Project Budget

The budget for completing this work was initially estimated at $30,000 including installation. Staff elected to install a smaller capacitor than originally estimated as it better fit with the needs of the MRF equipment. The unit the City decided on cost $9,800 plus HST for purchase and installation. There were no issues in rolling out this project work and as such the project was completed on schedule.

6 Conclusions

City staff are grateful London Hydro identified and brought forward the issue concerning the low power factor. Once staff were aware of the issue, this became a relatively easy and straight forward problem to solve. The installation of the capacitor yields an anticipated electricity demand/delivery cost savings of more than $10,000 per year and provides a payback on investment in less than one year.