ENERGY SOLUTIONS

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Dear <<Recipient>>:

M&V Plan for Frank's Market

Our Measurement and Verification (M&V) plan for the second Refrigeration System Redesign of Frank's Market is attached for your review.

Please contact the undersigned if you require any additional information.

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1 Introduction

Frank’s Market retained Finn Projects as a consultant to develop a plan for determining the current demand and energy consumption of the walk-in refrigeration system and the consumption reduction achievable by the replacement of the compressors and evaporators.

The objectives of this report include:

- Measure the energy consumption reductions of the existing compressor.
- Calculate electrical demand and consumption for the existing refrigeration and new refrigeration equipment.
- Provide detailed calculations to be submitted to Toronto Hydro for the saveONenergy Retrofit Program incentive application.

2 Scope of Project

Frank's Market is a grocery store located in Toronto, ON. The store carries a large selection of meat, fresh vegetables and frozen food products, as well as dry goods. With a large amount of open and closed refrigerators, freezers and coolers. Refrigeration makes up a significant portion of electricity consumption in the store.

Last year (2011) the grocery store implemented a series of renovations to the refrigeration system to accommodate the changing need of the store, which included taking two compressor units and their related components out of service; converting a walk-in freezer to a set of 36 refrigerator and freezer doors which only takes up a quarter of the space; and disconnected a number of meat coolers. The walk-in freezer on the right side of the store entrance remained.

The compressors and related components for the walk-in freezer which remained are using a lot of energy and need costly maintenance and repairs. To reduce the energy use for refrigeration and the cost for maintenance and repair, the owner of Frank's Market plans to replace the refrigeration equipment for the walk-in freezer. The compressors and condensing fans will be taken out of service, substituted bytwo new semi-hermatic condensing units on the roof. The evaporator's fans will also be replaced with 4 new evaporators. The meat cutting area, which is currently part of the walk-in freezer, will be walled off completely, and will be served by a dedicated refrigeration system consisting of a Keeprite scroll condensing unit and a low profile evaporator.

3 Approach & Methodology

Finn Projects' approach and methodology for the analysis of the energy and demand reduction of the implemented energy efficiency measure is outlined below.

3.1 Data Collection

Frank's Market provided quotes and cut sheets indicating the scope of work , quantity, and model of the equipment to be installed. The equipment to be removed has been metered for demand and energy consumption. The existing equipment, including the compressor, evaporator fans and condensing fans have been recorded through a site visit.

3.2 Development of Measurement and Verification Plan

The M&V Plan is to develop metering of the existing equipment at Frank's. The purpose of the metering is to establish a base case for energy use by the walk-in freezer. Some estimation is required to establish the baseline energy data. The M&V Plan is detailed in section 4 of this report.

3.3 Energy Savings Analysis

The base case compressor's energy consumption is determined by converting the metered readings to hourly data (by summing the 5- or 15-minute consumption data logged, or by averaging 5- or 15-minute demand logged). The hourly data for of the metered equipment is then used to determine average demand, or extrapolated to annual consumption.

Electrical demand and consumption for unmetered and new components have been calculated based on nameplate data and stipulated values, in accordance to IPMVP and the saveONenergy Retrofit Program M&V Procedure. Details for each calculation are in Appendix A.

4 Measurement and Verification Plan

4.1 Purpose

The refrigeration equipment replacement at Frank's Market in 2012 is aimed to reduce energy consumption for refrigeration and costs for maintenance and repairs. The measurement and verification plan will help determine the amount of demand and energy reduction achieved from the project.

4.2 Measurement Boundary

The project savings are determined within a measure boundary that encompasses the equipment removed or disconnected, and the new equipment serving the same area.

Specifically, the equipment to be removed / disconnected (Old Equipment) includes:

- Compressor AA1 which serves the walk-in freezer.
- The remaining four of the twelve condenser fans on the roof.
- Evaporator fans which serve the walk-in freezer.
- Control circuit for the removed walk-in freezer.
- Heat reclaim system for the removed walk-in freezer.

Equipment to be installed (New Equipment) includes:

- Two Hofland WX1 condenser units, serving the walk-in freezer.
- Four new Hofland XX1 evaporator fans, serving the walk-in freezer.
- One Hofland YY1 condensing unit, serving the walled off meat cutting area.
- One Hofland ZZ1 evaporator fan, serving the walled off meat cutting area.

4.3 Interactive Effect

There is no foreseeable interactive effect in this project.

4.4 M&V Standard

The measurement and verification detailed in this plan and the post-project results report follows the International Performance Measurement and Verification Protocol (IPMVP) Option A and the saveONenergy Retrofit Program M&V Procedure for Equipment Replacement- BAsic (ER-B).

IPMVP Option A involves isolation of the energy use of the equipment affected by an energy conservation measure (ECM) from the energy use of the rest of the facility. Measurement equipment is used to physically isolate and measure all relevant energy flows in the pre-retrofit and post-retrofit periods. Only partial measurement is used, with some parameter(s) being stipulated rather than measured. For example, measurements are taken for the compressors and condenser units; whereas the energy has been estimated for some of the associated equipment, such as the heat reclaim system and lighting.

The Retrofit Program ER-B procedure was selected as the Project is estimated to reduce demand by 15 kW, which would yield an estimated Participant Incentive less than $25,000. The ER-B procedure allows the use of stipulated operating hours at 80% of nameplate capacity. Since metered data was available for the compressor of concern, we use the measured data of this equipment. For other equipment with no measured performance data, the default assumptions must be multiplied by 80% of retrofit equipment nameplate rated load.

4.5 Measurement Equipment

PowerX three-phase Power Data Logger PX-250 is used to meter the base case compressor. PowerX Data Logger measures and logs both demand and energy consumption data.

4.6 Measurement Process

Finn Projects installed meter on base case compressor (compressor unit PP-AA1), which is the largest energy user of the base case equipment. The meter recorded voltage, amperage, wattage and consumption on all three phases, for approximately one week. A licensed electrician performed the meter installation and removal.

A similar metering process will occur after the installation, logging the voltage, amperage, wattage and consumption for the new condensing units. The usage of the evaporator fans will be estimated.

4.7 Base Case Energy

The pre-retrofit measurements are based on the one-week measurement data collected by the meter for the old equipment extrapolated for a full-year. Since not all old equipment specified under the Measurement Boundary has been metered, some energy demand and consumption values are calculated. For example, energy for the condenser fans and evaporator fans are calculated by multiplying the quantity of fans, power draw per fan at 80% of nameplate power, minimum NEMA energy efficiency by an assumed hours of operation as per saveONenergy M&V procedure.

4.8 Energy Efficiency Case Energy

The post-retrofit case is calculated based on nameplate data , load requirement based on the same condition as the base case, and estimated hours of operation.

From the base case measurement, we determine the required cooling load by the power draw and an estimated efficiency rating. It is assumed that the cooling load remains the same before and after the retrofit (the base case is measured by using 80% of the base-case nameplate and stipulated hours of operation). The required cooling load is split between the storage area (80%) and the meat cutting area (20%). We then present the cooling load in each area as a percentage of the full capacity of the new condensing units. From the information of specification sheets, we are able to calculate the draw of the condensing units at the cooling load required, which represents the demand.

The energy consumption is calculated by multiplying the demand by the hours of operation. The hours of operation is determined by dividing the annual consumption by the average demand of the old compressor unit. Once again, it is assumed that the hours of operation remains the same before and after retrofit.

When the condensing units are replaced, we will perform an one-week measuremet, as stated in 4.6, to determine the actual power draw and consumption of the condensing units, as well as other components.

4.9 Stipulation

The major energy consuming systems, such as the refrigeration compressors have been metered. There is a large amount of equipment associated with the refrigeration, including condenser fans and evaporator fans drawing power from various electrical disconnects and panels, with various voltages. As such, it would be impractical and time prohibitive to meter each piece of equipment. All assumed values have beennoted in the calculations.

4.10 Analysis Procedure

Electrical demand and consumption reductions will be computed as follows:

Demand Reduction (kW) = Average Demand of Old Equipment – Average Demand of New Equipment

The Average Demand is the arithmetic mean for power demand of all the equipment for the hours between 11 am and 5 pm, as prescribed in the saveONenergy Retrofit Program M&V Procedure.

Annual Consumption Reduction (kWh) = Annual Consumption of Old Equipment – Annual Consumption of New Equipment

Lighting consumption is determined by the wattage multiplied by the stipulated hours of operation.

Condenser fan and evaporator fan, consumption are determined by multiplying the equipment power draw by stipulated hours of operation and by 80% of the nameplate data, as per section 4.5 above.

Compressor and condensing unit consumption have been determined by averaging the metered consumption and data to a daily value, then multiplying the result by 365 days to get an annual consumption.

5 Estimated Demand and Energy Reduction

5.1 Base Case Energy

Table 1 below details the electricity demand and consumption for all components of the refrigeration system that will be removed or disconnected for the project.

Table 1: Summary of baseline period demand and consumption

Item	Demand (kW)	Consumption (kWh)
Compressor AA1	29.9	251,545
Condenser Fans	3.2	9,245
Evaporator Fans	3.3	26,210
Total	**36.4**	**287,000**

Detailed calculations can be found in Appendix A.

5.2 Energy Efficient Energy

Table 2 below details the energy demand and consumption for all components of the refrigeration system that has been installed for the project.

Table 2: Summary of post-retrofit period demand and consumption

Item	Demand (kW)	Consumption (kWh)
Condensing Units WX1	19.4	139,580
Evaporator Fans XX1	3.9	30,464
Condensing Unit YY1	2.2	17,838
Evaporator Fan ZZ1	0.4	2,901
Total	**23.3**	**170,043**

Detailed calculations can be found in Appendix A.

5.3 Electrical Demand and Consumption Reduction

Energy demand and consumption reductions are determined by the difference between the energy calculated for the baseline period and that of the retrofit period. The calculation is shown in Table 3.

Table 3: Summary of demand and consumption reduction

Equipment	Demand (kW)	Consumption (kWh)
Base Case	36.4	287,000
Energy Efficient Case	23.3	170,043
Reduction	**13.1**	**116,956**

Appendix A – Detail Energy Calculations

The calculations below detail the assumptions, and how the energy drawn and consumed by each component of the refrigeration system is determined. The demand and consumption is then summarized and presented in Section 5.1 and 5.2.

Base Case Energy Calculations

Compressor AA1

The compressor AA1 serves the walk-in freezer that is still in operation.
However the compressor is in bad condition and is costly to repair and maintain.
AA1 has been metered for one week in September/October 2011.
AA1 compressor usage (based on metered data of AA1):

Daily Consumption	689	kWh	(metered)
Days of Operation	365	days	
Annual Consumption	251,545	kWh	
Average Demand	29.9	kW	(metered)
EER	7.5		Assumed based on standard old equipment
Cooling Capacity	223,954	BTU/h	kW x 1,000 x EER
Hours of Operation	8,424	hours	Annual Consumption / Load

Condenser Fans

There are 12 x 1 HP fans, 4 of which will be switched off as part of the project

Qty	4	fans	
Motor size	1	HP	
Motor size (in kW)	0.75	kW	Conversion of motor size from HP to kW
Power Draw	0.99	kW	Assume minimum NEMA energy efficiency (75.5%)
Load	80%		As per M&V guidelne
Hours of operation	2920	hours	(assume 4 months in summer)
Demand	3.2	kW	
Consumption	9,245	kWh	

Evaporator Fans

There are 4 evaporators with 12 motors in total. Each motor is 1/3 HP.
Since this equipment was not metered, we have assumed 80% nameplate rated load as per M&V procedure.

Qty	12	fans	
Motor size	0.35	HP	
Motor size (in kW)	0.26	kW	Conversion of motor size from HP to kW
Power Draw	0.35	kW	Assume minimum NEMA energy efficiency (75.5%)
Load	80%		As per M&V guidelne
Hours of operation	7884	hours	(assume 90% of the time, all year around)
Demand	3.3	kW	
Consumption	26,210	kWh	

Energy Efficiency Case Energy Calculations

Condensing Units WX1

Two new semi-hermetic condenser units WX1 will be serving the major bulk or the area in the walk-in freezer. Each condensing unit is equipped with a condensing fan, as well as a 15 HP compressor. Since the walk-in freezer will be separate into the general storage and the meat cutting room, we assume these condensing units will serve 80% of the total area (thus 80% of total load) occupied by the current walk-in freezer.

Compressors

Qty	2	units	(1 compressor per condensing unit)
Compressor nominal HP	15	HP	Specs
Compressor nominal HP (in kW)	11.2	kW	Conversion from HP to kW
Input Power Draw at nominal HP	14.9	kW	at 75% efficiency
Rated Cooling Capacity	177,600	BTU/h	Specs (at 95F ambient temp, 40F suction temp.)
Total Cooling Capacity	355,200	BTU/h	for 2 units
Required Cooling Capacity	179,163	BTU/h	based on old equipment , x 80% area
Load %	50%		Required Cooling / Total Cooling
Average Demand per Unit	7.5	kW	
Average Demand for 2 units	15.1	kW	
Hours of Operation	8,424	hours	
Demand	15.1	kW	
Consumption	126,792	kWh	

Condensing Fans

Qty	2	units	2 condensing units
Total # of condensing Fans	4	fans	(2 condensers, 2 fans each)
Condenser Fans Motor FLA	2.8	A	Specs (per 2 fans)
Voltage	575	V	Specs
Condenser Fan Motor Wattage	2.7	kW	= V x A x 1.7 / 1,000 (per 2 fans)
Diversity Factor	1.0		Assume both condesing units operates at the same time
Load	80%		As per M&V guidelne
Hours of operation	2,920	hours	(assume 4 months in summer)
Demand	4.4	kW	= of units x wattage x diversity factor x load factor
Consumption	12,787	kWh	

Total Average Demand	19.4	kW	sum of compressors and condensing fans
Annual Consumption	139,580	kWh	sum of compressors and condensing fans

Evaporator Fans XX1

Four medium profile evaporators operating at low temperature will be serving the major bulk of the area in the walk-in freezer. Once again, we assume these units will serve 80% of the current walk-in freezer. Evaporators are equipped with 1/3 HP fans each. There will be 4 evaporators with 3 fans each.

Qty	4	evaporators	
Total # of evaporator Fans	3	fans	(4 evaporators, 3 fans each)
Fan Motor size	0.33	HP	each
Full Load Amp	2.10	kW	Specs (for 3 fans)
Voltage	575	V	Specs
Evaporator Fan Motor Wattage	1.2	kW	= V x A x 1.7 / 1,000 (per evaporator)
Diversity Factor	1.0		All fans run at the same time
Load	80%		As per M&V guidelne
Hours of operation	7884	hours	(assume 90% of the time, all year around)
Demand	3.9	kW	
Consumption	30,464	kWh	

Condensing Unit YY1

One new scroll type condenser units YY1 will be serving the meat cutting room, formerly part of the walk-in freezer. We assume the meat cutting room to take 20% of the area, but only 10% of the existing load since the meat cuting room will be at a medium temperature (40°F) instead of the low temperature in the walk-in freezer.

Compressors

Qty	1	unit	
Compressor nominal HP	2.5	HP	Specs
Compressor nominal HP (in kW)	1.9	kW	Conversion from HP to kW
Input Power Draw at nominal HP	2.5	kW	at 75% efficiency
Rated Cooling Capacity	27,200	BTU/h	Specs (at 95F ambient temp, 40F suction temp.)
Total Cooling Capacity	27,200	BTU/h	for 1 unit
Required Cooling Capacity	22,395	BTU/h	based on old equipment , x 20% area x 50% load
Load %	82%		Required Cooling / Total Cooling
Average Demand per Unit	2.0	kW	
Hours of Operation	8,424	hours	
Demand	2.0	kW	
Consumption	17,247	kWh	

Condensing Fans

Qty	1	unit	
Total # of condensing Fan	1	fan	(1 condenser, 1 fan)
Condenser Fan Motor FLA	1.1	A	Specs (per fan)
Voltage	230	V	Specs
Condenser Fan Motor Wattage	0.3	kW	= V x A / 1,000 (per fan)
Diversity Factor	1.0		
Load	80%		As per M&V guidelne
Hours of operation	2,920	hours	(assume 4 months in summer)
Demand	0.2	kW	= of units x wattage x diversity factor x load factor
Consumption	591	kWh	

Total Average Demand	2.2	kW	sum of compressors and condensing fans
Annual Consumption	17,838	kWh	sum of compressors and condensing fans

Evaporator Fan ZZ1

One dedicated low profile evaporator operating at medium temperature will be serving the meat cutting room in the walk-in freezer. Once again, we assume this evaporator will serve 20% of the current walk-in freezer area but only 10% of total existing load. The evaporator is equipped with 4 x 1/15 HP fans.

Qty	1	evaporator	
Total # of evaporator Fans	4	fans	(1 evaporator, 4 fans)
Fan Motor size	0.07	HP	each
Full Load Amp	2.00	kW	Specs (for 3 fans)
Voltage	230	V	Specs
Evaporator Fan Motor Wattage	0.5	kW	= V x A / 1,000 (per evaporator)
Diversity Factor	1.0		All fans run at the same time
Load	80%		As per M&V guidelne
Hours of operation	7884	hours	(assume 90% of the time, all year around)
Demand	0.4	kW	
Consumption	2,901	kWh	