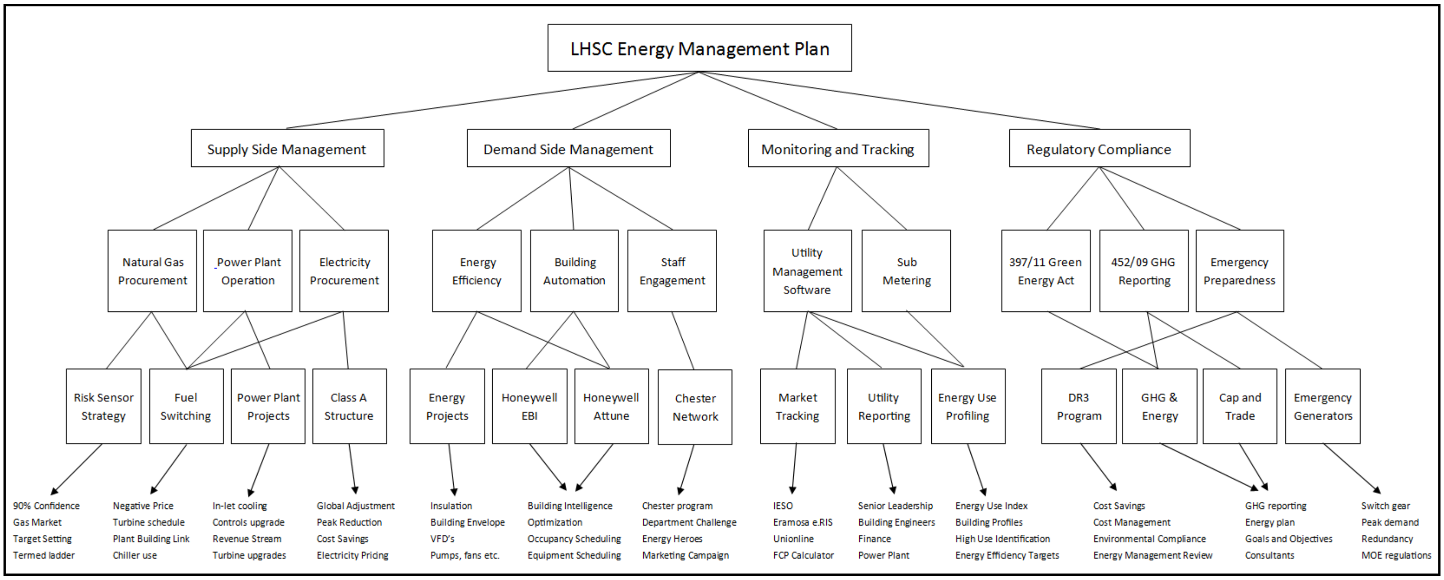
LHSC Energy Management Plan

Facilities Management

Demand Side Management

Energy Management Plan

Demand Side Management



London Health Sciences Centre has a long history of energy management, dating back to the 1970's. In that time, there have been many advancements made toward building intelligence and how it relates to energy management. Equipment and technology has advanced in such a way that buildings can be programmed to optimize their performance for heating, cooling, and lighting and automation has replaced manual tasks. Much has also changed within the energy markets and the prices of natural gas, steam, and electricity have risen and fallen over time. New regulations have been introduced with energy conservation and greenhouse gas emission reduction in mind and there is now more than ever a cost associated with a lack energy efficiency within an organization.

As a hospital there is a financial responsibility toward public tax dollars and an environmental responsibility to minimize our negative impact toward some of the very illnesses we treat. Proper energy management can save significant amounts of money while at the same time, help to reduce its contribution to air pollution, acid rain, carbon emissions etc. Being energy efficient falls under the "first do no harm" motto of the health care sector and LHSC has made great effort to do its part.

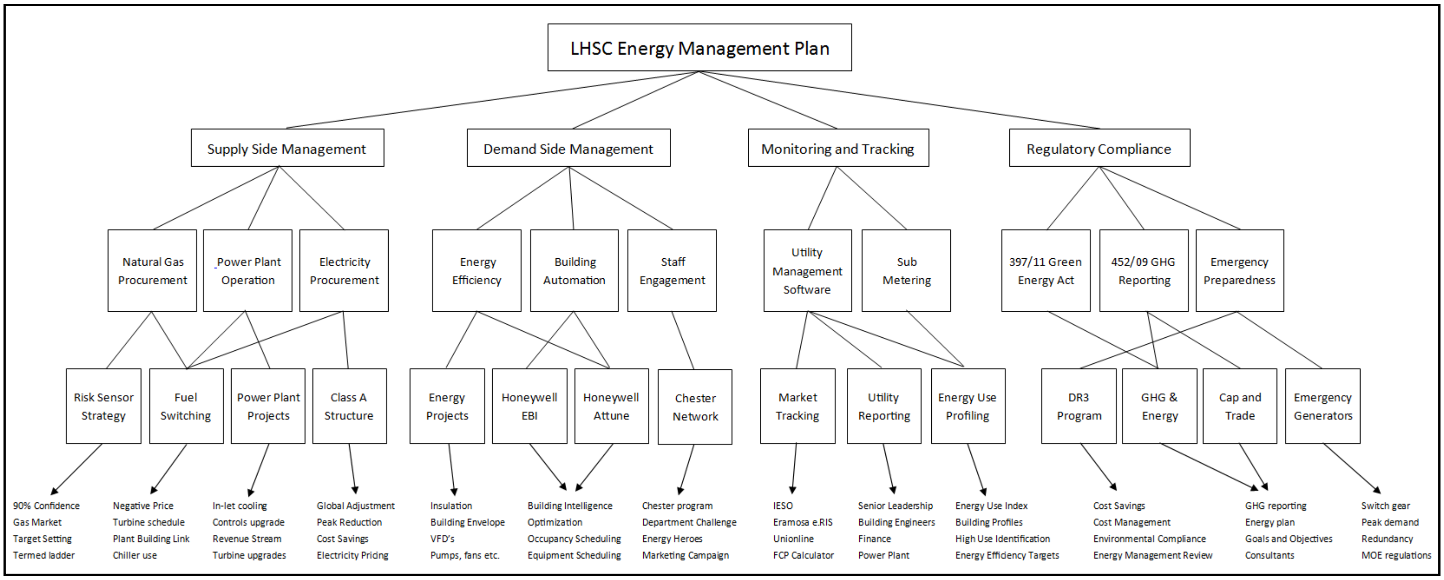
The energy management plan at LHSC has been broken down into four major categories; supply side management, demand side management, monitoring and tracking, and regulatory obligations. This forces the hospital to look at energy streams from the point of purchase to the point of exit and how its being used in between. LHSC has the ability to generate its own electricity at the Victoria Hospital power plant as well as supply steam and electricity to others, like Parkwood Institute.

Deciding how to invest in energy management is one the biggest and most important challenges one faces considering the many different possibilities and opinions that present themselves. Much of the easy work and short payback periods have already been exhausted at LHSC and so Facilities Management is always looking for the next opportunity and weighing the options carefully. Each project is considered for how it impacts the whole and fits together with existing strategies, equipment, and systems.

The following contains a more detailed review of the energy management plan by category until such time that the entire plan is constructed in web format on the Facilities Management website. In particular, this section focuses on demand side management.

Energy Management Plan

Demand Side Management



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What is demand side management?

Demand side management focuses on reducing energy cost and consumption at the point of use instead of at the point of distribution like supply side management. It can mean retrofitting equipment for higher efficiency, scheduling energy use around occupancy and peak cost periods, and engaging the end user in turning things off when possible. Over the past fifteen years, LHSC has invested in several energy efficiency projects. Mechanical systems have been scheduled through a building automation system and employees have been engaged through the implementation of the Chester program. Demand side management Is a never ending process that must be maintained as buildings age, technology changes, and occupancy or space use changes within the facility. LHSC has been recognized often at both the provincial and national level for energy efficiency in the healthcare sector. The hospital has been the recipient of many awards and included in many Canadian healthcare and engineering journals.

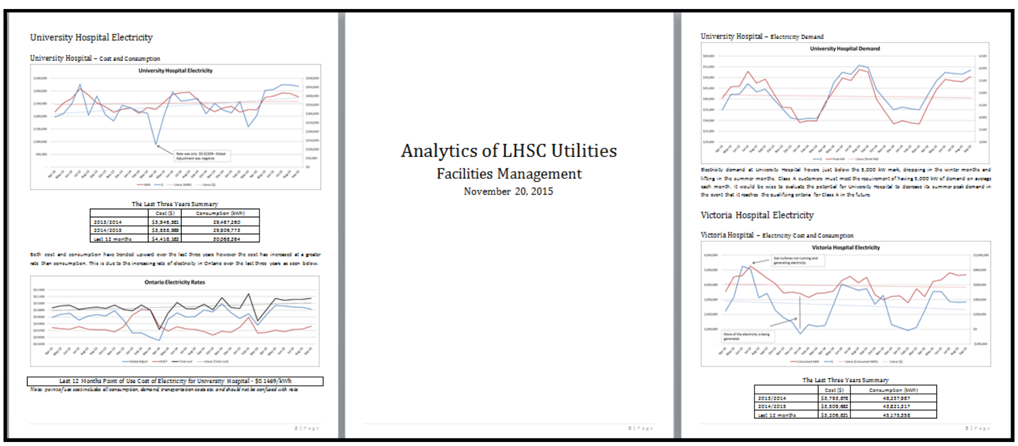






LHSC's energy demand

The healthcare sector has one of the highest energy use indexes in the province because of its hours of operation, energy intensive medical equipment, fresh air requirements etc. Acute care facilities use more energy because of the type of services being provided. At LHSC, fifteen million dollars per year is spent purchasing gas, steam, and electricity so it is prudent to look at demand side management for cost savings. For many organizations, investing in demand side management offers a return on investment that is more attractive than their core business provides, although it is received in the form of cost savings rather than revenue. If LHSC had not invested in demand side management over the last fifteen years, the annual energy cost would be closer to eighteen million dollars. To provide insight into LHSC's energy demand, a complete analytics report was created detailing the different energy streams. Inside you can find cost and consumption for each utility at University and Victoria hospitals along with some explanation for the trends being seen.



Control Click image to view full report

Energy use is everyone's responsibility

LHSC employs over 17,000 staff and each impacts energy use in one way or another. Engaging employees can be a very effective way to capture more energy savings while creating a culture of energy efficiency inside the organization.





Energy Efficiency at LHSC

To date, LHSC has completed five major projects for energy efficiency at the hospitals. These projects were completed in partnership with an Energy Services Company (ESCO) by method of Energy Performance Contracting (EPC). This method is used primarily for financing reasons as the ESCO will design the project and pay for the cost of the project up front. The project is paid back through the guaranteed savings on the utility bills after the project is complete. The payback period is determined by value of the energy savings and once the project has been paid in full, the savings belong to the hospital.

Energy Efficiency Projects

Phase I—Phase I was a retrofit project to Victoria Hospital. It included upgrades to the lighting and building envelope, installation of zone dampers, variable speed drives, condensate heat recovery, heat exchangers, and a building automation system upgrade.

Project	Phase I
Year Implemented	2000
Project Cost	$2,700,000
Guaranteed Savings	$449,000
Guaranteed Payback	6 years
Avg. Actual Annual Savings	$752,748

Phase II—Phase II was a complete replication project of Phase I mentioned above and was implemented at University Hospital. Because of the success of Phase I and the commitment of implementing Phase II, LHSC was awarded a grant from Natural Resources Canada in the amount of $288,000.

Project	Phase II
Year Implemented	2002
Project Cost	$3,100,000
Guaranteed Savings	$625,627
Guaranteed Payback	5 years
Avg. Actual Annual Savings	$869,703

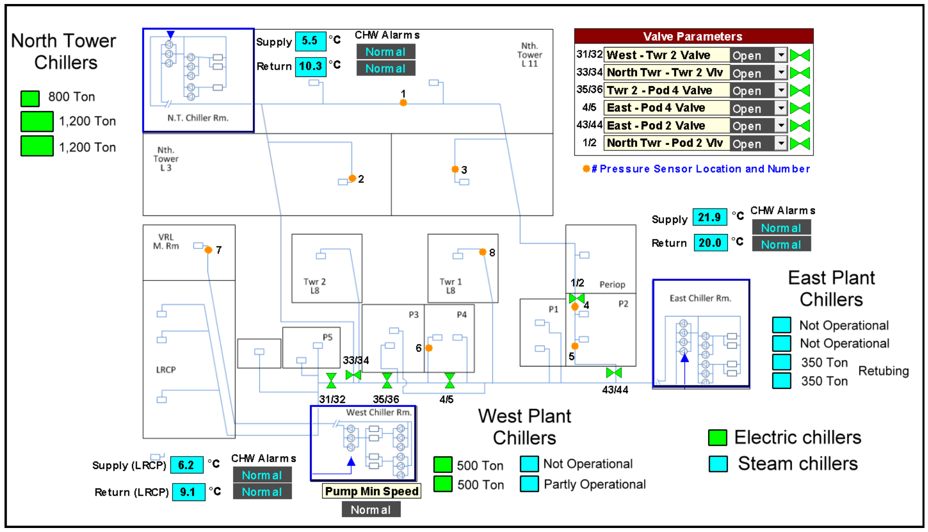
Phase III—In 2006 LHSC commissioned a backpressure turbine in the Victoria Hospital power plant that produces two megawatts of essentially free electricity. It operates in place of a pressure-reducing valve converting 650psi steam (in our main header) to 35psi for distribution to our facility. This project also included the installation of two small boilers that allow our power plant to better "load follow" our steam demand and produce savings through better boiler efficiency.

Phase IV—Phase IV was the installation of the new Chiller Plant at University Hospital. The old Chiller Plant was installed when University Hospital opened in 1971 and was running on CFCs (chlorofluorocarbons) which are not environmentally friendly. The production of our old chiller model (R11) was stopped in 1996 and placed on a 2012 phase out schedule due to its ozone depletion factors.

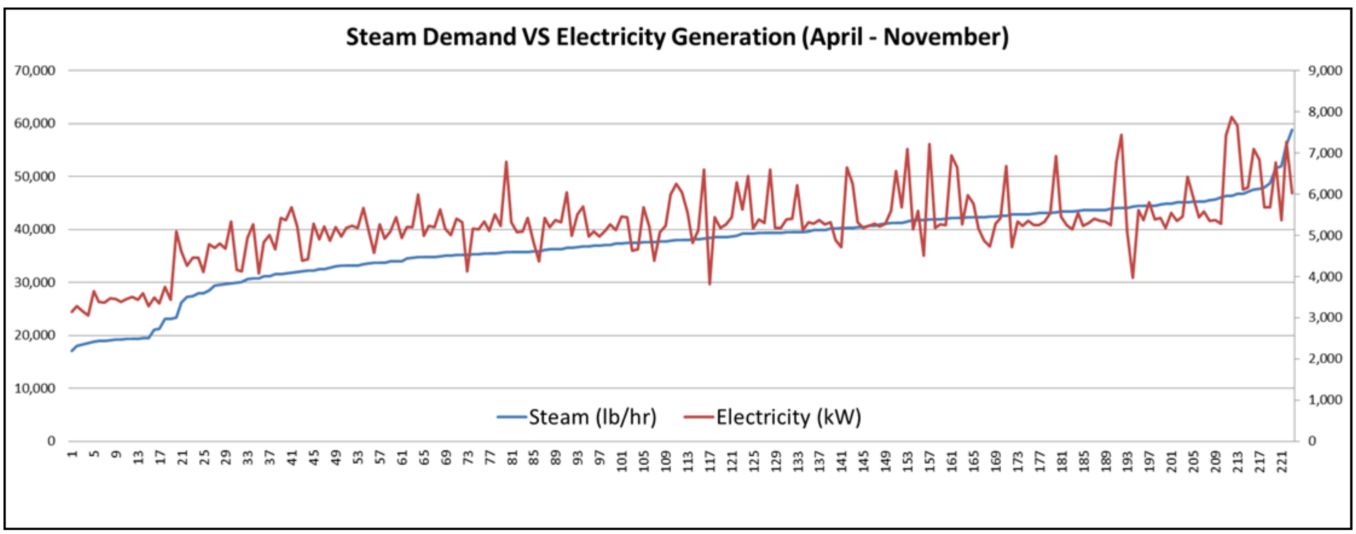
Phase V—The Victoria Hospital power plant was expanded to include a new building that houses an additional 4MW gas fired turbine. In addition, University and Victoria Hospital has been re-combed with upgraded controls, BAS, lighting, plumbing fixtures etc. to capitalize on technological improvements that have been made since the first projects were completed.

Project	Phase V
Year to be Implemented	2011
Project Cost	$16,049,348
Guaranteed Annual Savings	$1,216,194
Guaranteed Payback	14 years

LHSC Chiller project



Victoria Hospital has a very old absorption chiller fleet that has largely become inoperable. Three of the six chillers have completely failed, one is producing only 1-degree Celsius temperature differential and the remaining two require new tube bundles to operate effectively. Steam demand is very important to Victoria Hospital because the power plant turbines need somewhere to put the waste steam when they are generating electricity. If no steam demand exists then no generation occurs. The relationship between steam demand and electricity generation in the summer can be seen below. Replacing the absorption chillers creates the necessary steam demand that the power plant needs in the summer time. In the past, only one of the two gas turbines will run in the summer time because of this lack of steam demand.



Chiller Project Savings

Now that Victoria Hospital has become a Class A customer, the majority of its electricity cost (Global Adjustment) is now being managed by peak electricity demand. The absorption chillers help to reduce the hospital's electricity demand by reducing the amount of electric chilling used during peak demand days in the summer. A project to replace these absorption chillers has a payback tied to increased electricity generation capacity in the summer, reduced Global Adjustment charges, and the ability to switch cooling fuel source so that the hospital can use steam or electricity, depending on which is more economical at any given time. The estimated savings for this project is listed below. These savings could be higher or lower from year to year depending on another group of factors related to targeting peak demand days. In any case the hospital requires more cooling than it had at the end of 2015. This project has moved forward with two, 375 ton west room chillers to be in service May 2016, two east room chillers in service by July 2016, and two east room chillers re-tubed by May 2016.

Global Adjustment Savings	$841,133.00
2. Natural Gas Consumption Cost	-$320,140.19
3. Demand Savings	$175,147.38
Total Annual Savings	**$696,140.19**

Energy Savings and Greenhouse Gas Reduction

The energy savings from these projects have been significant and with them the reduction in associated greenhouse gas and air polluting emissions. The financial benefit to the hospital for completing this work is over three million dollars per year. The carbon dioxide emissions have been reduced by over eight thousand tons, which will present savings when Cap and Trade comes into play.

Project	Electricity (kWh)	Steam (mlbs.)	Water (m3)	Total ($)
London Health Sciences Centre				
Phase I - Victoria (2001-2002)	2,450,704	46,751	2,653	$752,748
Phase II - University (2002-2003)	6,301,729	22,730	51,795	$869,703
Phase III - Power Plant (2005-2006)	4,998,246			$282,822
Phase IV – Chiller Plant (2009)	1,172,642			$49,242
Phase V – Both Sites (2011)	1,561,672	20,006	124,010	$1,072,919
Total Savings Per Year - All Sites	**16,484,993**	**89,487**	**178,458**	**$3,027,434**

London Health Sciences Centre - Annual Emission Reduction			
Emission Type	**Electricity**	**Steam**	**Total**
Total Annual CO_2 Reduction (kg)	1,846,320	6,229,889	8,076,209
Total Annual SO_2 Reduction (kg)	48,501		48,501
Total Annual NO_2 Reduction (kg)	18,953		18,953
Total Annual CH_4 Reduction (kg)		123	123
Total Annual N_20 Reduction (kg)		116	116
Total Annual GHG Equivalent (kg)			**8,114,752**

Awards and Recognition

The work that LHSC has done toward energy efficiency has resulted in many awards over the years. In addition, LHSC has been featured in many magazines and news articles as a means of encouraging others in the health sector to become energy efficient.

2003 Voluntary Challenge & Registry Incorporated Gold Award

2003 Overall Leadership Award, Ontario Hospital Association

2004 National Energy Efficiency Award, Canadian College of Health Service Executives

2004 Project Retrofit Award Honourable Mention (2nd/42), Natural Resources Canada

2005 Environmental Business Achievement Award, London Chamber of Commerce

2007 Award of Excellence, Canadian Healthcare Engineering Society Award

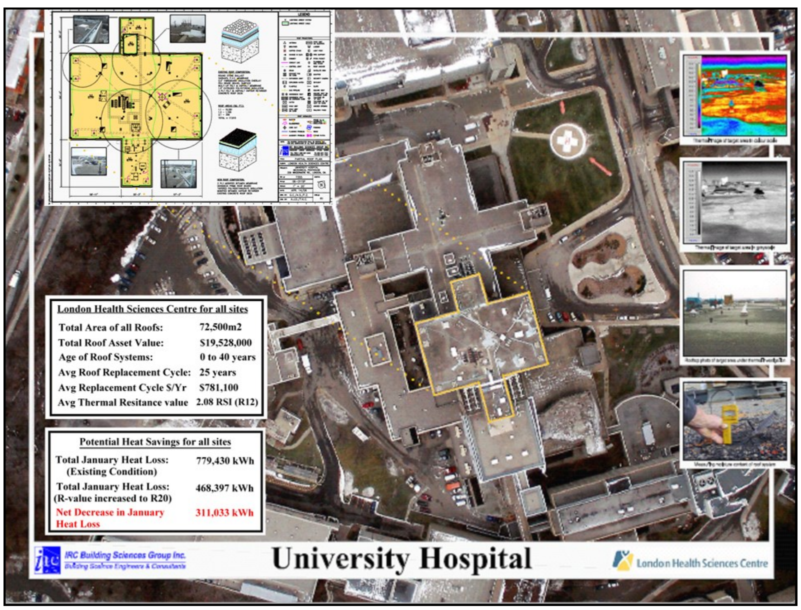
2008 Energy and Environmental Stewardship Award, Canadian College of Health Service Executives

2011 Energy Efficiency Award, Ontario Hospital Association

Building Envelope

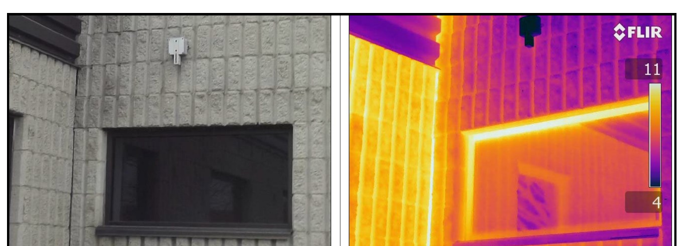
In Canada, we have both a heating and cooling season that can span about sixty degrees Celsius. The building envelope—the boundary between the conditioned interior of the building and the outdoors—is essential for both comfort and energy efficiency. Therefore, a proper roof, highly insulated windows and walls, and well sealed structures will save great amounts of money in the long term. Advanced building envelope technologies contain efficiencies for both the heating and cooling season in the same product. For instance, using proper windows can maximize the benefit of passive heat and natural light from the sun during the winter heating season while incorporating efficient glazing and shading to reduce the cooling load in the summer. Simple and inexpensive solutions also exist, like sealing air leaks throughout the building to the outside. Fresh air can be controlled through dampers and building automation so creating a tight building envelope will cut down on unnecessary energy wastes.

One of the most important components of a good building envelope is a solid roof structure. A roof is important for keeping out moisture however it also important for keeping in the heat and cooling that has been provided to the building. Roofs can be huge sources of wasted energy, especially in the winter when the hot conditioned air is rising and escaping. Thermal scans can be completed to show the heat that is being exhausted through a building roof, like the one below at University Hospital. These thermal scans can estimate the additional energy cost due to the escaped heat and project an energy savings associated with roof replacement. LHSC has created a plan for roof replacement, shown in the project schedule to follow.



University Hospital thermal scan determined how much heat was escaping through the building roof. It was determined that over 300,000 kWh of annual energy consumption could be saved by increasing the R-value of the roof to 20. Thermal scans can also be completed on wall assemblies like the image below of Southwestern Ontario Regional Dialysis Building on Baseline road. The steel and aluminum door and window frames in this case were not insulated and a great deal of heat was escaping. Many of these issues can be remedied with simple insulation and sealing however the savings can be quite significant. IRC Roofing was the company that did the thermal testing on these buildings.

Photograph 1 | Photograph 2 – Thermal bridging occurring through the uninsulated steel door frames.

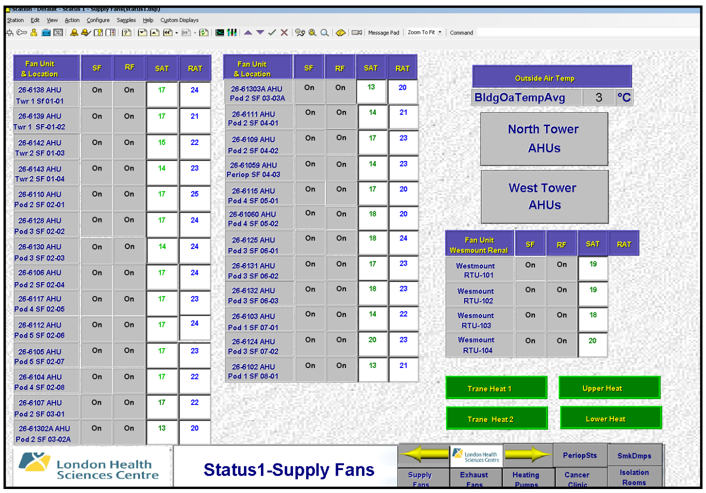


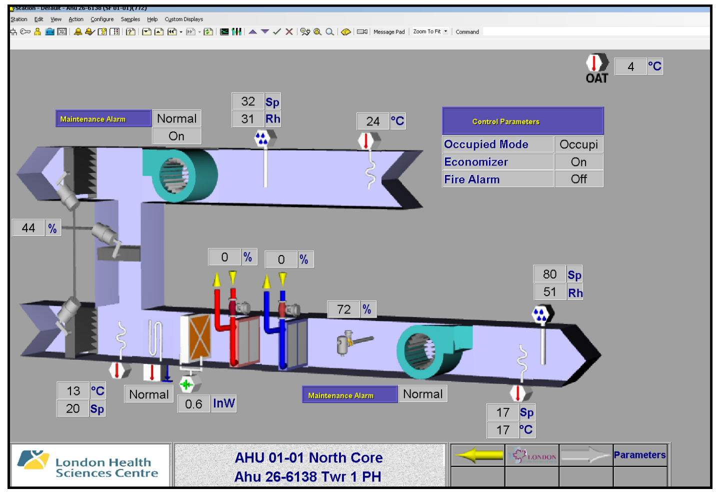
Photograph 5 | Photograph 6 – Heat loss through the non-thermally broken aluminum frames and steel lintel header.

Insulation and air barrier protection may have been compliant with building codes at the time of construction however they do not meet the current minimum building code standards in the older facilities. There is no requirement to upgrade them however improvements would result in increased comfort levels and a reduction in energy cost and consumption.

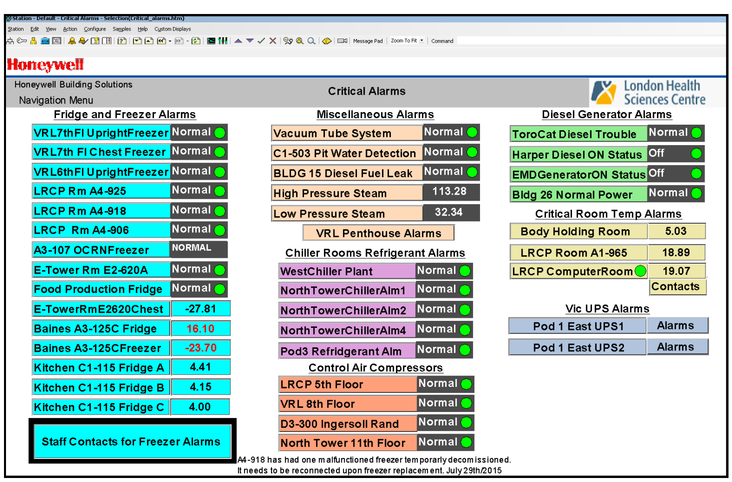
Building Intelligence and Optimization

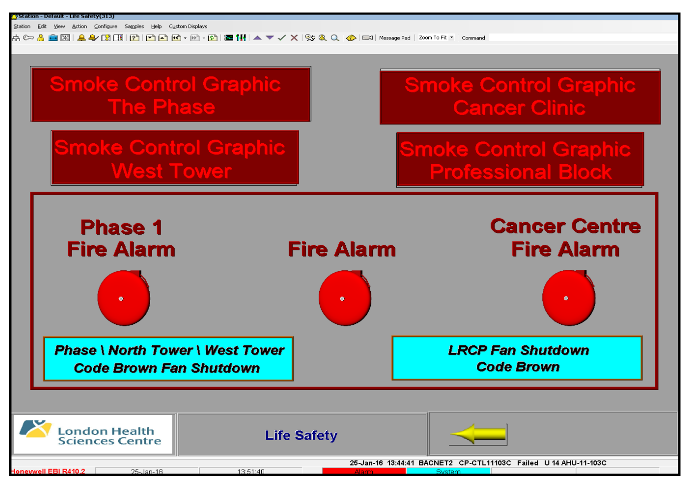
Building intelligence and optimization is accomplished through a building automation system (BAS). LHSC uses the Honeywell Enterprise Building Integrator (EBI) to manage the automation of fans, motors, pumps, chillers, lights, temperature, humidity, fresh air etc. It is a form of building intelligence that allows the building to decide how best to run equipment within the parameters set by the controls personnel. The building automation system is run primarily by LHSC building engineers and controls staff with support from Honeywell. Below are sample screens from the EBI containing a group of air supply fans. From here building engineers can quickly see both the supply and return air temperatures to particular areas and be alerted to issues in real time. Adjustments can be made right on the system, which saves the employees a lot of travel time during busy shifts.





A hospital has many different types of space used for different purposes and these spaces contain microclimates that require special needs. For example, isolation rooms must be in a state of negative pressure so that any illness or disease can be contained within the room. Many medicines and research materials must be held in refrigerated areas with dedicated cooling systems attached to them. An extended period of warm temperatures could contaminate hundreds of thousands of dollars of material. The EBI has critical alarm monitoring that will notify the building engineers and sometimes a department pager of any breeches to the set parameters. There are also life safety protocols that are programmed into the building automation system to use in the case of emergency. For example, if there is a code brown or a fire, the direction of air flow becomes very important. It would take too long to respond manually to situations like this so the EBI allows all necessary changes to made automatically by the click of a button.





Along with maintaining critical systems and various microclimates throughout the facility, building automation systems can be used to reduce energy wastes. Minor adjustments to building equipment could be made twenty four hours per day to optimize the building performance from an energy use perspective. These adjustments would only be possible through an automated system.

Improving the Honeywell EBI building automation system

Now that the building automation system is programmed and running with its major functions in tact, it can be taken to the next level where optimization and energy efficiency can be the focus. The Honeywell Attune system can be a vehicle for collecting data from the building and filtering it through a series of algorithms managed by professional energy analysts and automation experts. The data is pulled from the thousands of control points in the building that feed the EBI. The results can then be presented as a list of improvements and recommendations to deliver the greatest return on investment. Each recommendation would come complete with expected investment costs and energy saving estimations. As measures are taken, the equipment and systems performance can be monitored to verify the savings. Customers receive this information via monthly reports. Common recommendations include operation sequencing, scheduling changes, set point changes, controls reprogramming, mechanical servicing, equipment replacement etc.

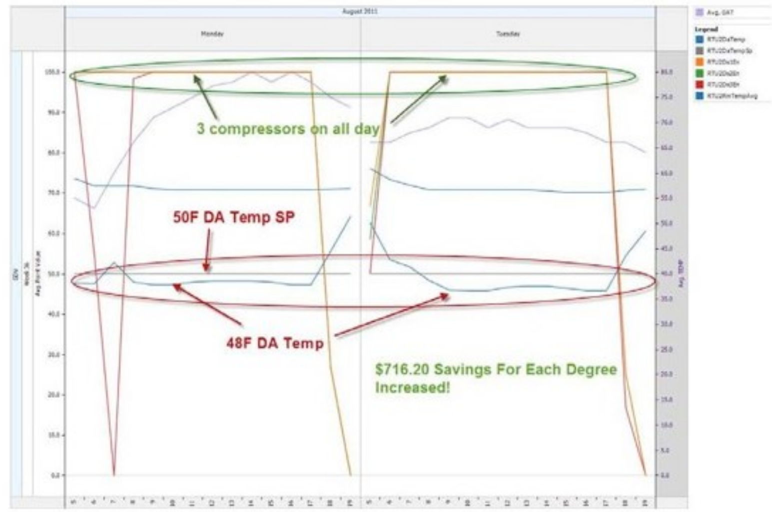
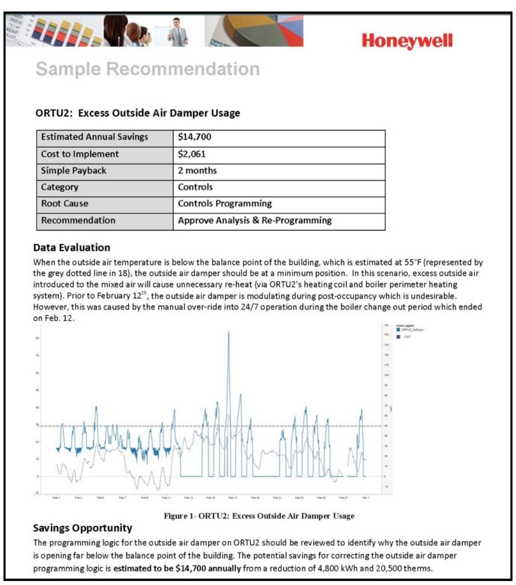


Figure 1 - RTU2 DAT, DAT-SP, RTU Compressor Status

Including 3rd party expertise when needed

Attune Advisory Services also off an energy dashboard that provides real-time information about the building energy use. Analytics are provided in a graphically intuitive, web-based interface, making them easy to understand. The dashboard can be tailored to provide the information that is important to the viewer and also be used as an employee engagement tool for a more general population. The process of collecting real-time data from a facility like the hospital with thousands of control points and then analyzing the data for operational and efficiency improvements is too complex and time consuming for LHSC staff. It is an ongoing process that must be given ongoing attention. Having these improvements and optimizations however could result in substantial savings. By leveraging the expertise, resources, and continuous attention of a third party, LHSC will be able to increase its building intelligence and optimize both the effectiveness of the building and the building control staff. The energy reduction and optimization from this process will tie in very nicely to LHSC's energy project work and staff engagement to provide a full demand side management plan.


Honeywell

Sample Recommendation

ORTU2: Excess Outside Air Damper Usage

Estimated Annual Savings	$14,700
Cost to Implement	$2,061
Simple Payback	2 months
Category	Controls
Root Cause	Controls Programming
Recommendation	Approve Analysis & Re-Programming

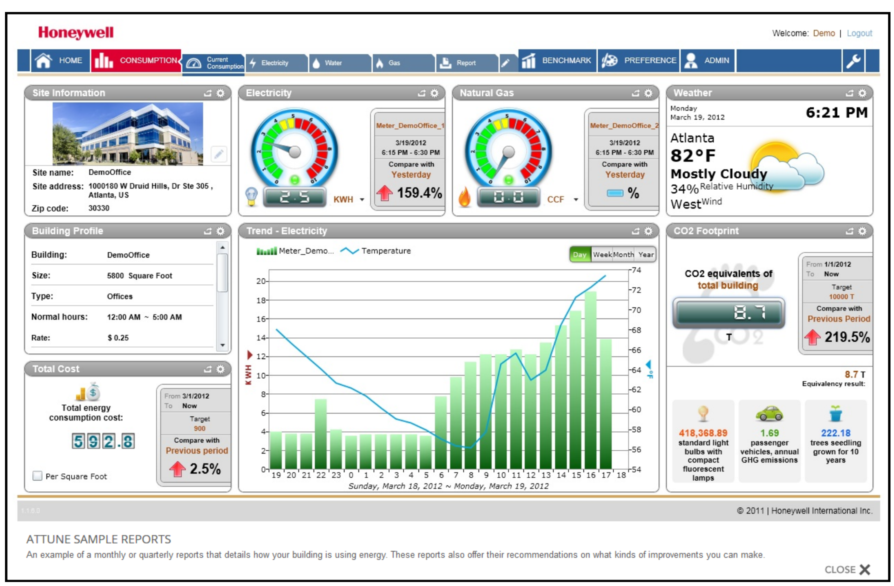
Data Evaluation

When the outside air temperature is below the balance point of the building, which is estimated at 55°F (represented by the grey dotted line in 18), the outside air damper should be at a minimum position. In this scenario, excess outside air introduced to the mixed air will cause unnecessary re-heat (via ORTU2's heating coil and boiler perimeter heating system). Prior to February 12th, the outside air damper is modulating during post-occupancy which is undesirable. However, this was caused by the manual over-ride into 24/7 operation during the boiler change out period which ended on Feb. 12.

Figure 1- ORTU2: Excess Outside Air Damper Usage

Savings Opportunity

The programming logic for the outside air damper on ORTU2 should be reviewed to identify why the outside air damper is opening far below the balance point of the building. The potential savings for correcting the outside air damper programming logic is **estimated to be $14,700 annually** from a reduction of 4,800 kWh and 20,500 therms.

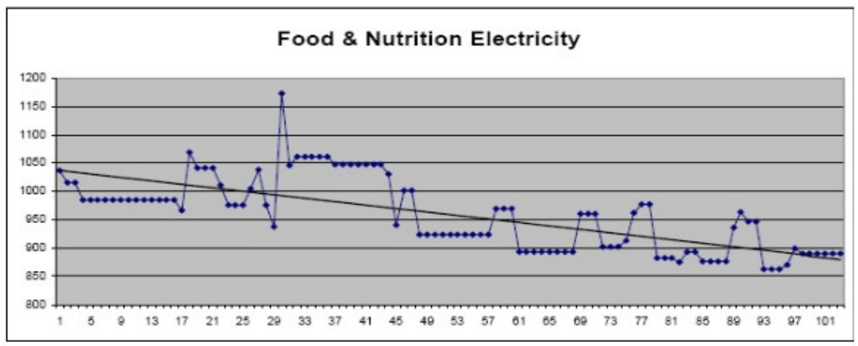


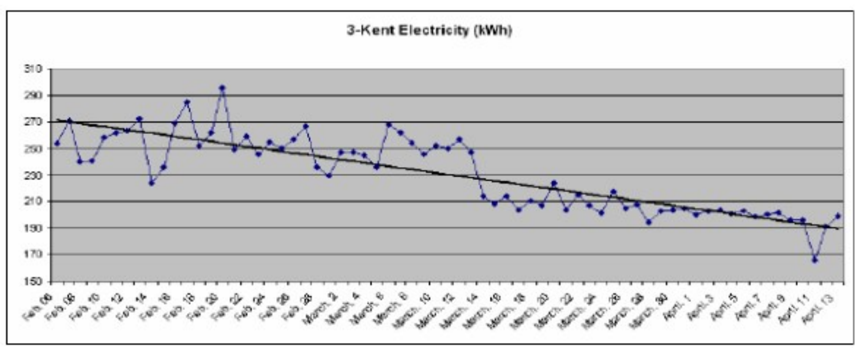
Chester and employee engagement

LHSC has been running an employee engagement program for energy efficiency since 2003. The program inspires active participation toward helping the hospital save energy and is hosted by the energy mascot CHESTER to keep the program fun and friendly. The program incorporates behaviour change strategies and activities that help to get staff involved while increasing their awareness around energy issues. This in turn creates a direct energy related savings from shutting off lights and unused equipment and also helps to create a "culture" of energy efficiency at the hospital that aids to elevate the importance of energy related projects. Overall, it has been shown that successful programs can save approximately 10% of electricity costs.

Department energy challenges

One of the best activities run through the Chester program is the department energy challenge. Using a portable power analyzer, the electricity used by departments is measured before and after employees are challenged to reduce. The challenges are run for five weeks at a time and daily savings are a presented on a "game board" inside the department area. It is a great team building and engagement activity with respect to energy saving and provides staff with immediate feedback as to how their actions help to save electricity. Typically, there will be between a ten to fifteen percent reduction of electricity use once the challenge begins. The meter is also placed on the department at a later date to see if the behaviour has been maintained.



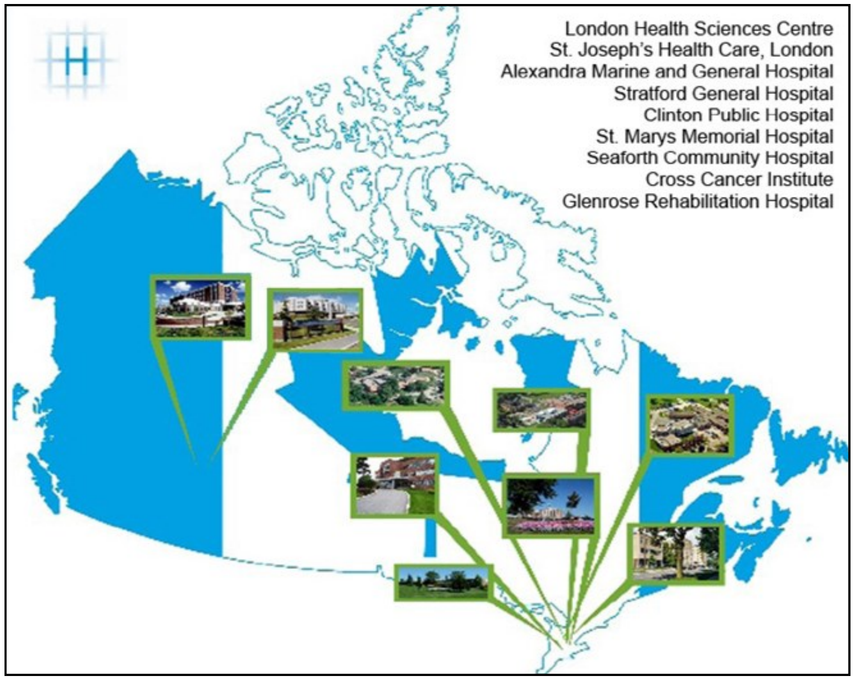


Energy heroes

Employees that are making an extra effort toward energy saving at the hospital are rewarded and recognized as energy heroes. Their story and picture is circulated through the hospital and placed on the energy website where they can be recognized by colleagues and friends as champions in their area.

The Chester Network

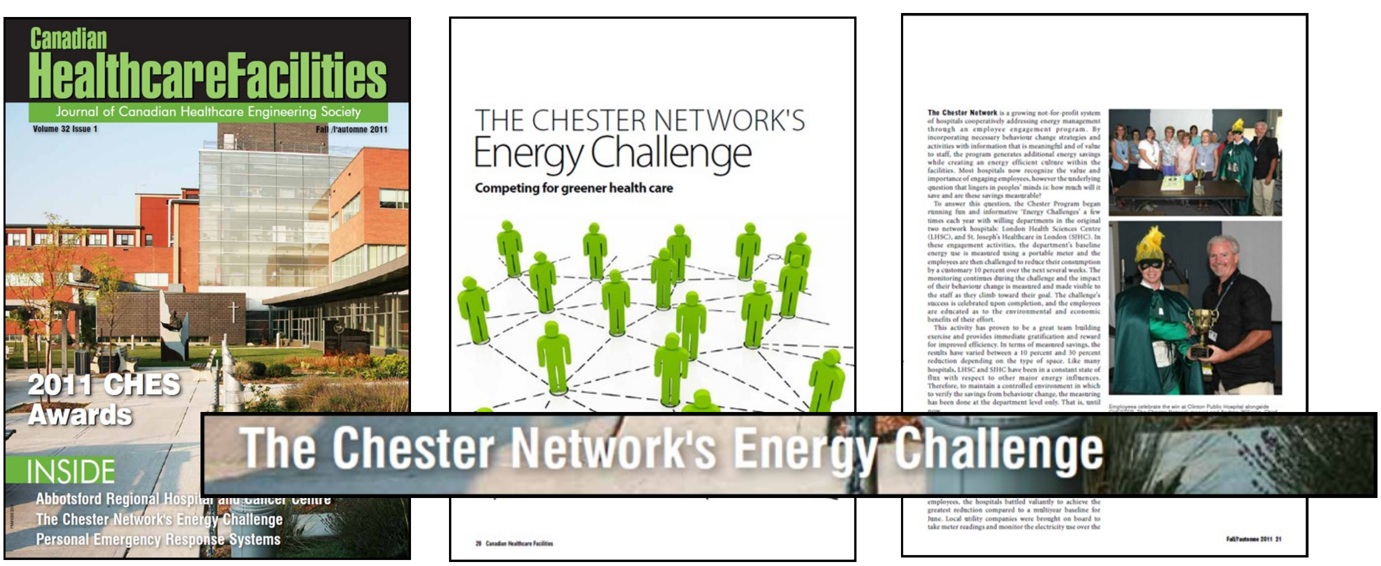
With the increasing interest of other hospitals to create their own energy engagement program, LHSC founded The Chester Network, a not for profit entity that would provide the means for interested hospitals to incorporate their own program under the mentorship of LHSC. The Chester Network has seen the program implementation in nine hospitals across Canada and has engaged over 25,000 hospital employees.



Hospital-wide energy challenge

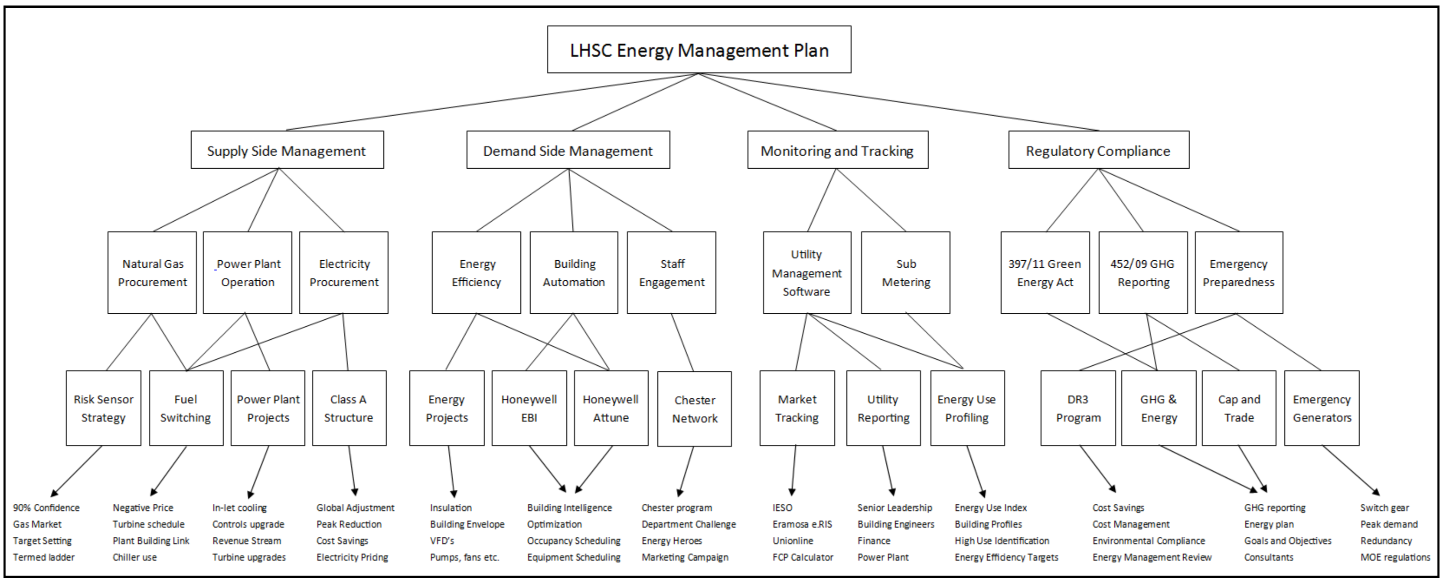
In June 2011, Alexandra Marine and General Hospital, St. Marys Memorial Hospital, Seaforth Community Hospital, Clinton Public Hospital and Stratford General Hospital did something very unique and special; they each monitored their hospital's electricity consumption as a whole and together turned Chester's department Energy Challenge into a five hospital event. Following a promotional campaign designed to gear up employees, the hospitals battled valiantly to achieve the greatest reduction compared to a multiyear baseline for the month of June. Local utility companies were brought on board to take meter readings and monitor the electricity use over the four weeks and results were presented weekly to employees. Each year the winning hospital held a day of celebration with Chester and became the new holder of the energy challenge trophy. The challenge ran each year for several years and produced electricity savings of over fifteen percent. The challenge became a big hit and was featured in the Canadian Healthcare Engineering Society (CHES) fall magazine.

"Many employees took the challenge to heart; so much so that in some cases the effort became visibly noticeable throughout the hospital.", **Joanne Hayter, Clinton Public Hospital**



Investing in Demand Side Management is much simpler than investing in Supply Side Management because external factors like government regulations and energy market volatility do not factor in the same way. Energy savings can be calculated based on equipment specifications and in most cases the results are consistent from year to year.

As new opportunities present themselves they are added to a list with other projects that support the direction the hospital is taking toward energy management. Projects pertaining to demand side management have been slated into a five year schedule below. Some items have been completed and some are ongoing. Many of the projects have been slated according to forecasted HIRF money. For some projects, there is a much larger factor than energy savings that must be considered. For others, they can be rated by the positive impact they have on the Energy Management Plan as a whole. Timing of projects may also change do to unforeseen circumstances or equipment failures.



Demand Side Management - Project Schedule

	Apr-15	Jul-15	Oct-15	Jan-16	Apr-16	Jul-16	Oct-16	Jan-17	Apr-17	Jul-17	Oct-17	Jan-18	Apr-18	Jul-18	Oct-18	Jan-19	Apr-19	Jul-19	Oct-19	Jan-20	Apr-20	Jul-20	Oct-20	Jan-21	Project Cost
Building 6 Roof			■																						?
C & D Tower Roof					■																				$1,150,000
Peak Demand Shutdown exercises						■				■				■				■				■			Negligible
Victoria Hospital Chiller Retubing 3&4								■																	$400,000
Victoria Hospital Chiller Replacement 1&2									■	■															$3,400,000
Victoria Hospital Chiller Replacement 5&6									■	■															$3,400,000
Honeywell Attune									■	■															?
VH Rooftop HVAC Unit 13								■	■	■	■														$340,000
VH Basement Window Replacement								■	■	■	■														$550,000
Power Plant Roof Replacement								■	■	■	■														$300,000
UH Window Replacement & Caulking								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		$750,000/YR
VH Window Replacement 14, 16												■	■	■	■										$650,000
Power Plant Turbine Roof Replacement												■	■	■	■										$120,000
Power Plant Boilers												■	■	■	■	■	■	■	■						$350,000/YR
Byron Family Medical Centre Roof Replacement												■	■	■	■	■	■	■	■						$350,000
UH Rooftop HVAC Unit Replacement												■	■	■	■	■	■	■	■	■	■	■	■		$100,000/YR
VH Windown Replacement 16, 12																■	■	■	■	■	■	■	■		$950,000
54 Riverview HVAC Replacement																■	■	■	■	■	■	■	■		$100,000/YR
UH Rooftop Replacement 9.1,9.3,9.5,9.6																■	■	■	■						$1,000,000
UH Rooftop Replacement 10.1,11.1,11.2,11.3,11.4,11.5,11.6,11.7																				■	■	■	■		$500,000