Comprehensive Energy Audit
City of Creve Coeur

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1. Executive Summary

FDH Engineering (FDH) was requested by the City of Creve Coeur to conduct a comprehensive energy audit of three City owned buildings.

Building Name	Size
Government Center	49,594 sf
Dielmann Recreation Complex	46,470 sf
Public Works Garage	10,204 sf

Table 1 - Building List

The primary goal was to identify sustainable strategies for each facility which save energy and reduce greenhouse gas emissions. All efficiency measures included in this report use proven and existing technologies to cut energy usage, improve comfort, reduce greenhouse gases, and/or reduce maintenance costs.

Table 2 summarizes the Energy Efficiency Measures (EEMs) which were analyzed and recommended for further action. A more detailed EEM summary table is provided in section 5 which includes; kWh, kBTU, estimated savings, GHG reductions, probable construction costs, payback and potential incentives. The costs used in the analysis are engineering estimates and are +/- 15%-20% values. A re-estimate of the savings and costs should be done once a preliminary design (35%-50%) has been completed.

EEM #	Description	kWh	Therms	GHG (Mtons)	Savings ($)	Cost	Payback w/ Incentive
EEM-1	Lighting - Interior	89,801	-	64.59	9,161.05	$30,543	2.6
EEM-2	Lighting - Exterior (1)	49,336	-	35.48	4,616.77	$51,246	10.4
EEM-3	DDC Upgrade	103,350	1,670.00	83.20	10,794.00	$179,394	15.8
EEM-4	Reto- Commissioning (RCx)	297,136	5,105.00	240.82	25,538.00	$57,263	1.2
EEM-5	System Rebalancing	111,260	900.00	84.80	8,945.00	$21,200	1.4
EEM-6	Solar PV	32,274	-	23.21	2,179.88	$105,000	7.9
EEM-7	Heat Recovery	346,499	-	249.21	30,734.43	$18,000	0.0
EEM-8	Building Envelope	69,646	2,810.00	65.01	7,681.52	$26,408	2.6
EEM-9	VFD - Pump(s)	148,788	1,540.00	115.19	11,633.40	$54,780	3.7
EEM-10	New Meeting Room HVAC	36,691	-	26.39	2,623.42	$20,500	6.8
EEM-11	Ice Rink Bleacher Heaters (2)	(97,945)	-	(70.44)	(8,687.69)	$15,200	None
EEM-12	Ice Rink Operational Changes	54,018	458.40	41.29	4,204.80	$8,000	1.8

(1) The cost does not include a reduction in maintenance costs over the life of the new fixture which would occur 2-3 times in the life of the LED fixtures

(2) These values are not savings but additional usage "negative savings"

Table 2 - EEM Summary

Note: A total line was not put at the end of the table above due to the effects of EEM interactions. Since any single EEM can be implemented individually, without respect to other EEMs being done, interaction between EEMs is expected and may reduce the amount of savings by the interacting EEMs. The Phase 2 process outlined in the original RFP from the City would include this additional analysis to capture the effects of EEM interactions.

During the course of performing this energy audit, FDH observed a number of positive sustainable strategies which the City has already implemented to improve energy efficiency and reduce greenhouse gas emissions. Below are a few of the items which were observed:

1. High efficiency condensing boilers have been installed at the government center
2. "Tankless" domestic water heaters are being used at the government center for domestic water usage.
3. T8 light fixtures with electronic ballast have replaced T12 at all three facilities.
4. Munters heat recovery and dehumidification AHU is used for conditioning the ice rink.
5. Direct digital control system (DDC) for over 90% of the connected equipment at the recreation center.
6. New ceiling mounted Infrared (IR) heaters were installed to heat the staff when in the garage bays
7. Increased levels of insulation were added to the doors and ceiling to reduce heat loss and heat gain in the garage bays

We recommend the following items, with financial details summarized in Table 2, be implemented soon to allow the City to benefit from the savings and reductions associated with each. These are discussed in greater detail later in this report:

1. EEM-1: Interior lighting upgrades for the Ice Rink
2. EEM-4: RCx study and related activities at Dielmann Recreation Complex
3. EEM-8: Building Envelope study and corrections.
4. EEM-9: VFD installation at the Government Center
5. EEM-11: Heat Recovery addition to the Ice Rink compressor(s)
6. EEM-11: Ice Rink heaters for spectator comfort (this can be done is phases if desired)

FDH is very excited to continue to work with the City on implementing the above items and can assist with engineering documents, construction activities, and Ameren and Laclede Gas rebate/incentive applications. With our current knowledge of the facilities and relationships with the staff we can have most of the items listed above engineered, ready for contractor pricing, and implementation this summer.

2. Building Background and Systems Operation

The audit described by this report covered three buildings owned by the City of Creve Coeur: The buildings are: Government Center, Recreation Center, and Public Works building.

Photo 1 - Government Center

Photo 2 - Dielmann Rec. Center

Photo 3 - Public Works Garage

2.1. Overview of Systems

The following table represents the assumed construction values used during our analyses. These values were determined from a combination of site survey, original construction drawing review, and City staff interviews.

Load Construction Values			
	Government Center	**Dielmann Recreation Complex**	**Public Works Garage**
Roof (R-Value)	~ R-30 & R-20	~ R-30 & R-20	~ R-30
Window (U- Value/SHGC)	0.55 / .40	0.55 / .40	0.55 / .40
Walls (R-Value)	Masonry R11	Masonry R11	Masonry R13
Plug loads	.5 watts/sf	.5 watts/sf	.5 watts/sf
Misc. Load	.25 watts/sf	.25 watts/sf	.25 watts/sf
Lighting	1.0 watts/sf	1.5 watts/sf	1.0 watts/sf
Infiltration Rate	Neutral	Neutral	Neutral
Ventilation Rates	IMC 2012	IMC 2012	IMC 2012
Usage	Office / Police HQ	Recreation	Office / Garage

Table 3 - Assumed Construction Values

Government Center

Building Construction: The building is located at *300 N. New Ballas Road* and is a two-story repurposed 1940's elementary school multi-use building of approximately 49,600 SF. This building includes spaces occupied by city administrative and financial offices, the police department, and the community center. The spaces within are primarily used as offices or for storage, though the building does feature a 4,000 SF gymnasium (community center), 1,600 SF of exercise & locker rooms (police), and a 2,200 SF council chambers (city administration).

HVAC: Heating and cooling at the Government Center is provided by 39+ horizontal water source heat pumps primarily located above the drop ceilings throughout the building. Ventilation air is supplied to each heat pump by two AHU's located in a dedicated mechanical room on the lower level. These AHU's have heating and cooling coils to partially pre-condition the ventilation air prior to being sent to the heat pumps for final distribution. Heat is added or extracted from a closed loop condenser system with a 20% glycol/water mixture and the use of a heat exchanger or cooling tower respectively. During cooling season, the condenser loop utilizes a 95-ton BAC cooling tower (installed in 2010) to reject heat to the outdoors. During the heating season, four 1,300 MBH (input) Lochinvar "Sync" condensing boilers (installed in 2012) provide a heat source for the condenser loop if the water temperature falls below the set-points. This heating system also provides hot water for the various unit heaters, baseboard heaters, and make-up air pre-heat coils installed at various locations throughout the building.

Control System: Throughout the building, there are a number of thermostat types in use. Most are non-programmable thermostats (McQuay, Honeywell, White-Rodgers), though a few programmable thermostats (Honeywell) do exist. There is a building DDC system which was not accessible or viewable at the time of this audit. No access was possible due to lack of training for the staff on how to operate the systems front-end.

Domestic Water System: The building's domestic water is heated by two natural gas fired Rheem instantaneous "tankless" water heaters with supplemental storage of 6 gallons to reduce system cycling. This system appears to have been installed in 2012 or 2011 and is operating without any reported issues.

Dielmann Recreation Center

Building Construction: The building is located at *11400 Olde Cabin Road* and is a one-story building of approximately 46,500 SF. The primary spaces of use within the complex are the NHL-sized ice rink (23,800 SF, including bleachers) and the golf pro shop (1,800 SF).

The Ice complex shares a warming room "building's main lobby" for skaters and visitors, four ice rink accessible locker rooms, bleachers for spectators, facilities admin offices, snack shop, and restrooms. An administrative section of the building is adjacent to the main lobby and hosts a few offices and a multi-purpose/conference room for staff and public use. The Golf pro shop is connected to the main lobby through an oversized corridor which doubles as a snack dining area. The Golf pro-shop contains a small retail space, green fee desk, large multi-purpose room, and dedicated administrative office(s). Golf cart garage is located directly below the golf pro shop and the large connecting corridor.

HVAC: The ice rink is conditioned by a Munters "DH "heat recovery AHU located in the mechanical space adjacent to the resurfacer room. This AHU has the following features: Supply fan, reactivation fan, reactivation heater, desiccant wheel, DX cooling coil and auxiliary heater. During the heating season the 400 MBTU auxiliary heating coil is the only source of heat to the ice rink area and has the design capabilities of a 33°F temperature rise at winter design conditions. During warmer (cooling) months, the desiccant wheel and regenerative process are used to dehumidify the supply air and keep ice rink humidity within acceptable tolerances. Due to the amount of ice surface being present, no comfort cooling is required in the ice rink space other than to help keep the ice skating surface frozen by the R22 compressor system. This ice rink compressor system is discussed in more detail in the following section. The team "locker" rooms, located on the North side of the ice rink, have no direct cooling provided to them. Instead, the exhaust air taken from the locker rooms is made up from the ice rink which is inherently cool. Electric resistance baseboard heaters provide heating to the locker room when the temperature drops below the set-point(s).

The warming room "main lobby", multi-purpose room, and administrative areas are conditioned by AHU-1 which is located in the basement mechanical space adjacent to the golf cart storage area. Cooling is provided by the AHU from a 25 ton DX cooling coil and associated condensing unit. Primary space heating is provided by the AHU from hot water coils. In addition to the heat from the AHU the spaces which have large exterior surfaces have supplemental hot water baseboard heat below the windows to reduce drafts. The golf pro shop and connecting corridor are conditioned by AHU-2 in a similar manner as AHU-1. This unit is located in the same mechanical room as AHU-1.

Hot water is produced for use by the AHU's, unit heaters, and baseboard heat by two natural gas fired boilers located in the main mechanical room. Each boiler is 2-stage 300 MBH input "multipulse" non-condensing boiler. These boilers operate in a lead/lag relationship with one boiler meeting the heating demands of the building. Annual efficiency is estimated at 75%.

Control System: The ice rink is monitored and controlled through a web-based "Delta" DDC system. This system has a very nice user interface and provides adequate interface and historical trends for the facility's maintenance staff's use and review. The rest of the building is controlled through a web-based "JCI Metasys" DDC system. This system does not make use of graphics for the user interface like the Delta system does. As a result, this system is not as user friendly and system trends are much harder to set up and review.

Domestic Water System: The building's domestic water is heated by two groups of natural gas fired tank style heaters. The first group is a 50 gallon water heater located in the golf shop basement mechanical room and serves the snack and restrooms sinks in the main building. The second group is located in the ice resurfacer storage bay. This grouping has three 100 gallon water heaters and serves the flood water needs, showers, and ice rink restrooms. This system does use a hot water recirculating pump to maintain elevated water temperatures in the hot water piping.

Overview of Ice Making Process Mechanical Systems

In order to keep the ice rink operational year round, the Recreation Center uses three 100-ton compressors with R-22 refrigerant to produce a cold water/glycol mixture to make ice. The following items are part of the ice rink services and/or ice making process:

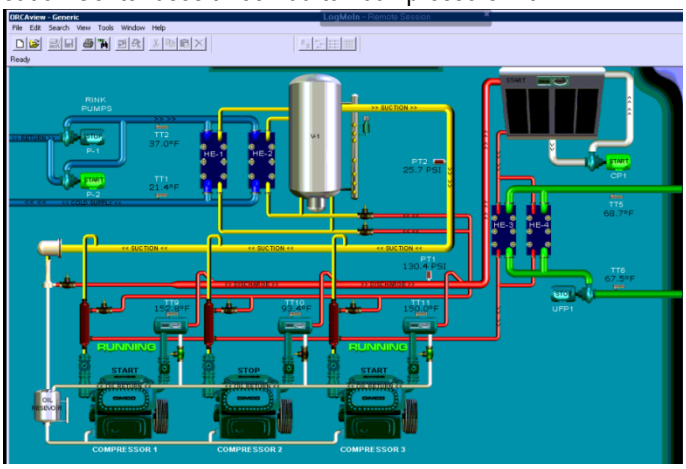

Figure 1 - DDC Screen Capture

1. Slab thickness is set to 1 ½"
2. Slab cooling system (20°F ice surface set-point)
3. Under slab heating system (42°F set-point using recovered heat from the ice making process)
4. Cooling tower (used to reject heat from the ice making process to the outdoors)
5. Waste ice melting system (two 9.5 kW electric heaters with 100 gallon tanks)
6. Flood water system is connected to three natural gas fired domestic water system (140°F set-point)
7. Domestic water heaters for locker room and restroom use(140°F with three natural gas 100 gallon tank heaters)

Refer to Appendix B for a copy of the P & ID drawing for the ice making process.

Public Works

Building Construction: The building is located at *996 Rue de la Banque East* and is a one-story hi-bay building of approximately 10,200 SF. The large parking lot adjacent to the building hosts city-owned trucks while they are not in use or down for maintenance, truck staging/storage, and a salt storage structure. The building itself consists of a smaller conditioned section (3,100 SF) attached to a heated only maintenance garage (6,100 SF).

HVAC: The fully conditioned section of the building is served by a roof top unit (RTU) and includes offices, a meeting room, and a kitchen/dining areas. The RTU is a 7 ½ -ton DX *Goodman* unit, installed within the last year. During the winter, the RTU uses a 210,000 BTU/H natural gas fired heater to heat the building. Cooling is achieved by two compressors totaling 7 ½ tons. A programmable thermostat is used for space set-point control and for night setback/ups (if used) to 73°F.

Control System: The temperature within the garage is regulated only during the winter season. This is done through the use of radiant, natural gas heaters, hung from the ceiling. Large post mounted fans help to circulate air within the garage during the summer months, since there is no actual mechanical cooling for the garage bays. The bay doors have been recently insulated with spray foam help to minimize the effects of outside weather conditions on the garage space. The feedback from the staff was extremely positive for the added insulation.

2.2. Lighting Systems

Government Center

The lighting in the Government Center was reported to have been retrofitted in 2012. Many areas that once hosted T12 fixtures were converted to utilize T8 fixtures with electronic ballasts and 32 watt lamps. These fixtures are almost exclusively 4-lamp fixtures, though a few 2-lamp fixtures do exist in the facility. Also, as a result of the upgrade, five of the building's conference rooms now use motion sensors to automatically shut off lights when not in use. The 250W metal halide fixtures in the gymnasium were not included in the retrofit and are still in use. Parabolic fluorescent and incandescent lighting also still exists sporadically throughout the building but at a very low quantity.

Recreation Center

Most of the lighting at the Recreation Center was retrofitted in 2012. In many areas, including the offices and conference room, the existing T12 fixtures were replaced with 4-lamp, T8 fixtures with 32 watt lamps. There are 54 lights over the ice rink which were not included in this retrofit and remain as 400 watt metal halide. Additionally, there are 24 12" canned light fixtures in the lobby area which are 50 watt metal halide lamps. The decorative cove lighting in the lobby is T8 fixtures with two 32 watt lamps per fixture.

Public Works

As with the other buildings, the lighting at the Public Works building was also retrofitted in 2012. The existing T12 fluorescent lights in the garage bays were replaced with 2-lamp, T5 high bay fixtures. These fixtures utilize rapid-start, 54 watt high output lamps. Inside the office section of the building, the existing T12 lights were replaced with 4-lamp, T8 fixtures with 32 watt lamps.

2.3. Occupancy Schedules

It is assumed most if not all of the lighting and HVAC equipment operates around the below schedules.

Building Schedules			
	Government Center (1)	Dielmann Recreation Complex (2)	Public Works Garage
M-F	8:00am-5:00pm	6:00am-11:00pm	7:00am-3:30pm
Sat	Closed	6:00am-11:00pm	Closed
Sun	Closed	6:00am-11:00pm	Closed
Weekly Hours	45	119	42.5

(1) Police areas are 24 hours per day 7 days per week (168 hours per week)
(2) Golf pro shop hours are 9am-5pm during the winter and 6am-7pm during the summer

Government Center

Being a multipurpose building, the Government Center has a number different occupancy profiles. Most of the building, including the Administrative, Financial, and Public Works sections, operates in accordance with the hours of a typical office. While the official hours range between 8:00 a.m. and 5:00 p.m. Monday through Friday, the occupied hours likely range as early as 7:00 a.m. and as late as 6:00 p.m on any of those days, depending on the employees duties and deadlines. For

obvious reasons, the police station operates 24 hours a day, 365 days of the year. The Community Center operates on less of a fixed schedule as it is open to the general public when requested. The gymnasium is utilized sporadically throughout these hours, and may even be used outside of them (e.g. at night and on weekends). This is also true of the Council Chambers, located in the Administrative section of the building. The unassigned offices in the NE corner of the upper floor currently serve as storage space only and have no occupancy.

Recreation Center

Despite the golf course closing/reduced hours and usage during the winter months, all parts of the Recreation Center operate and are occupied year-round. The administrative section of the building operates weekdays (M-F) during typical business hours. This includes the meeting rooms, which are rented out to groups when requested. The ice rink, team rooms, and warming room are all open (to the public) 7 days a week.

Public Works

The Public Works building operates on weekdays (M-F) during normal business hours (7:00 a.m. to 3:30 p.m.), with a typical occupancy of 3-5 people. Frequently, the occupants are in the garage working on vehicles, and the conditioned part of the building is left nearly unoccupied. Around noon, other city employees return from the field, and the conditioned section is used as a hub for lunch, with a total occupancy of close to a dozen people. Over the weekends, this building is typically unoccupied with the exception of work orders for special events

3. Energy Usage

The energy required to heat and cool a facility depends in large part on the outdoor air temperature. Because weather intensity can vary by as much as 20% from year to year, it is difficult to predict annual energy use by just looking at a previous year's bill. For example, last winter was unseasonably mild in St. Louis and the resulting energy used to heat during last year was less much than what would be required during a "normal" year. To better account for annual weather differences, FDH regresses energy usage with respect to weather to create a comprehensive energy consumption profile for the building. This yields equations and additional insight which are used to calculate annual natural gas and electric consumption, allowing FDH to:

- Identify weather independent energy usage (baseload)
- Quickly recognize any usage that is out of the norm

The following graphs represent the calculated utilization of electricity and natural gas for each building included in this Energy Audit.

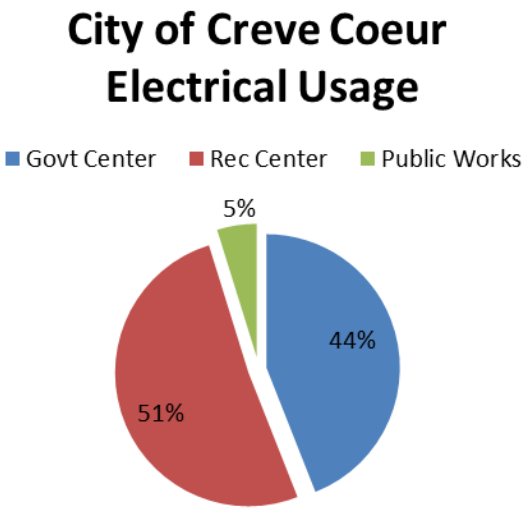

Figure 2 - Electrical Usage Graph

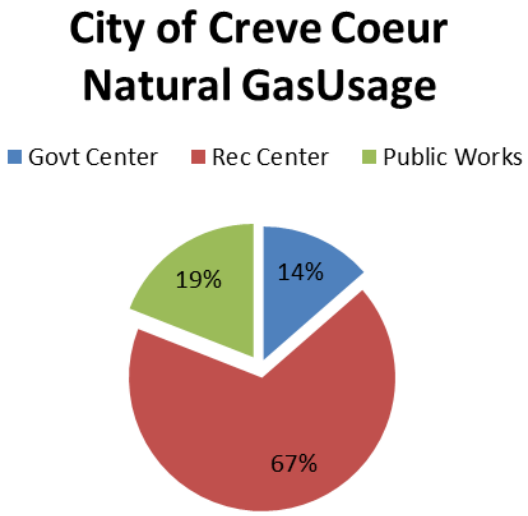

Figure 3 - Natural Gas Usage Graph

The data used to populate the graphs above are given below in Table 4. One item to note from this data is the amount of electrical usage at the Government Center and the natural gas usage at the Recreation Center. Both of these are higher than we would expect given the current usage. As a general point of guidance the Government Center should be closer to $1.00 per sf and the Recreation Center "could" be below $0.50 per SF with heat recovery. We have listed some causes for this and outlined a path to reduce these densities to a more traditional value later in the report.

City Electric Usage					
	kWh	% of Total	Density per SF		
Govt Center	981,200	44%	$	1.34	per Sf
Rec Center	1,140,900	51%	$	1.82	per Sf
Public Works	107,100	5%	$	0.92	per Sf
	2,229,200				
City Natural Gas Usage					
	therms	% of Total	Density per SF		
Govt Center	7,700	14%	$	0.16	per Sf
Rec Center	38,200	67%	$	0.64	per Sf
Public Works	10,800	19%	$	1.03	per Sf
	56,700				

Table 4 - City's Typical Year Utility Usage

City's Utility Rates

The utility rates used for the analysis are outlined below. These rates are listed as "averages" and not intended to be used to predict "actual" energy consumption or actual EEM reductions but, rather provide estimates and magnitude predictions. Additional analysis will be needed if a more precise prediction on energy consumption is desired beyond what has been provided as part of the scope of this Energy Audit. For the purposes of evaluating EEM's benefit this method is deemed acceptable.

Utility Rates (1)			
	Government Center	Dielmann Recreation Complex	Public Works Garage
Electric Schedule	3M	3M	2M
Electric	$0.067	$0.089	$0.072
Nat Gas	$1.05	$0.78	$0.97

(1) Utility rates are the average rates

Table 5 - Average Utility Rates

Government Center

Electricity and natural gas data for the City of Creve Coeur's Government Center was analyzed from November 2009 to December 2012.

Electricity Use

Figure 4 displays the electricity usage (kWh per day) against the average daily temperature for each month. The line containing the red/blue points reflects usage between November 2009 and December 2012. The red and blue shaded triangles represent the weather-related heating and cooling consumption (respectively) of the overall electric consumption. In figure 4 (and all subsequent figures relating to utility data), these heating and cooling triangles are placed on the most recent data trend. The gray shaded area represents the component of the electric use that is weather-independent, which is referred to as the "baseload". The baseload includes things such as lights, computers, electric hot water heaters, condenser water pumpas well as any other year-round loads not impacted significantly by the outdoor temperature.

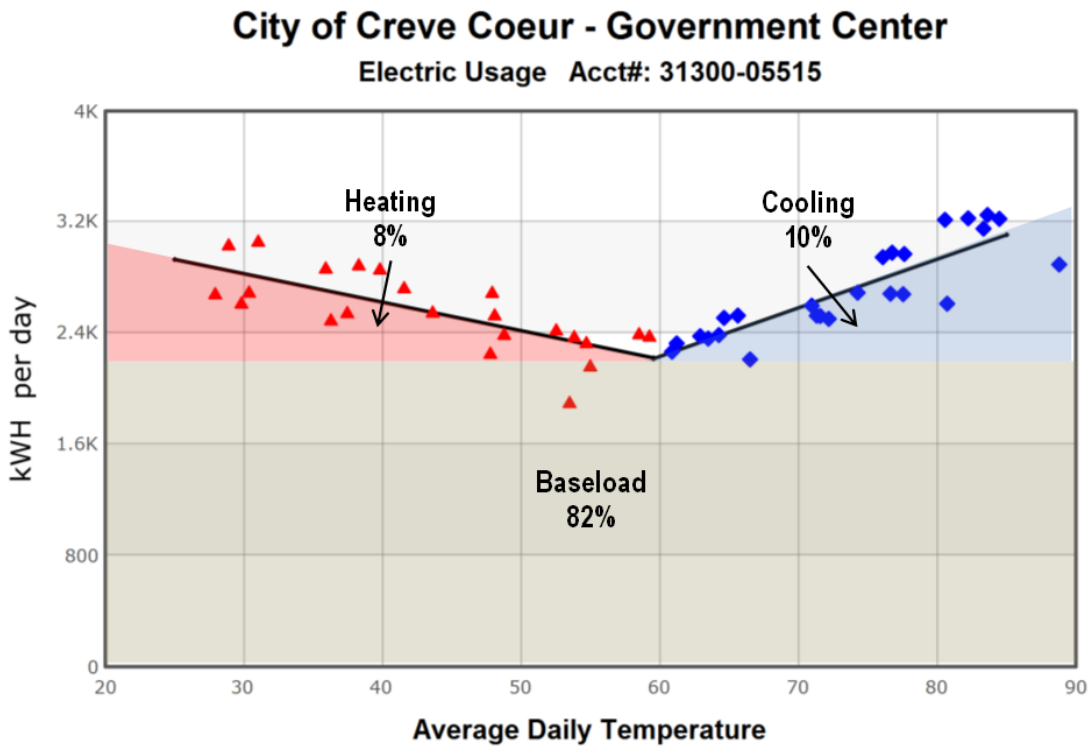

Figure 4 - Gov. Center Normalized Electrical Usage

Table 6 displays the annual electricity usage (kWh and dollars) of the Government Center for each of the components discussed above. The values included in the table represent the most recent 12months of trend in data.

Electricity Use									
Building	Account #	Baseload		Cooling		Heating		Annual Use	
		$	kWh	$	kWh	$	kWh	$	kWh
Govt. Center	31300-05515	$ 53,700	805,200	$ 8,200	94,500	$ 4,500	81,500	$ 66,400	981,200

Table 6- Annual Electrical Usage (Normalized)

Natural Gas Use

Figure 5 displays the natural gas usage (Therms per day) against the average daily temperature for each month. The line containing the red/blue points reflects usage between November 2009 and late Spring/Summer 2011. Since then (Summer 2011 until present), a newer trend has presented itself, represented by the light and dark green points. The exact transition from one trend to the other is difficult to pinpoint during warm weather as the gas usage is almost negligible during these months. The black dots in Figure 5 each represent a month of uncharacteristically high or low gas usage and were not used in determining the buildings weather dependency. As the purpose of the utility analysis is to establish usage rates during "typical" operating conditions, these points were omitted from analysis. The red shaded triangle represents the weather-related heating part of the overall natural gas consumption. In Figure 5, this heating triangle is placed on the most recent data trend (green data points). The gray shaded rectangle (very small) represents the component of the natural gas use that is weather-independent, which, as in the electricity section, is referred to as the "baseload". The baseload for natural gas includes anything that would be a year-round load, such as a gas-fired hot water heater for domestic water use. Natural gas is not used for cooling at the Government Center, and thus the utility data on days above 65/70°F (i.e. blue and light green points) does not form a strong trend, either upwards or downwards.

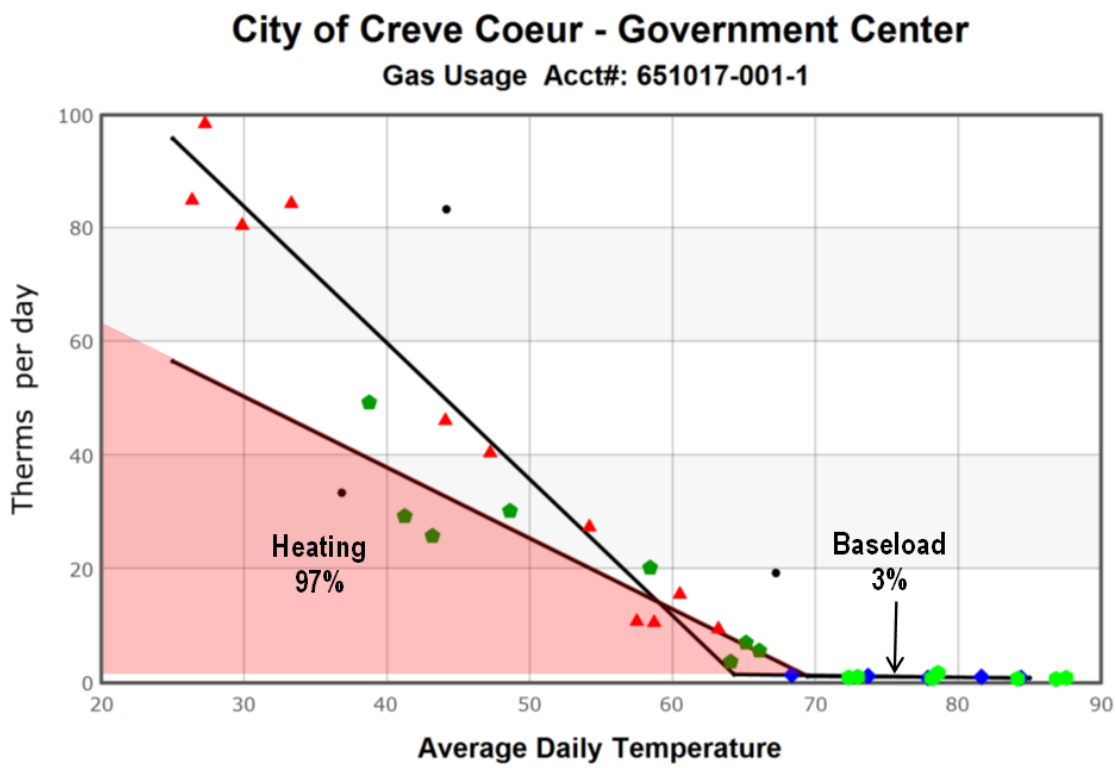

Figure 5 - Gov. Center Normalized Nat Gas Usage

Table 7displays the annual natural gas usage (therms and dollars) of the Government Center for each of the components discussed above. The values included in the table represent the most recent trend in data (green points in Figure 5).

Natural Gas Use									
Building	Account #	Baseload		Cooling		Heating		Annual Use	
		$	Therms	$	Therms	$	Therms	$	Therms
Govt. Center	651017-001-1	$ 400	400	$ -	-	$ 7,700	7,400	$ 8,100	7,700

Table 7 - Annual Nat. Gas Usage (Normalized)

When compared to the old trend in usage (red and blue points), the newer usage trend (green points) has significantly lower natural gas consumption. This can be seen visually in Figure 5 as the dark green points are generally lower than the red.

Numerically, the decrease in usage was calculated to be approximately 4,000 therms per year, translating to a monetary savings of $4,200 annually. Moreover, this decrease in usage represents a 34% drop in overall natural gas usage based on a June 2011 split in usage.

Dielmann Recreation Center

Electricity and natural gas data for the City of Creve Coeur's Recreation Center (Ice Rink/Golf Pro Shop) was analyzed from November 2009 to present (November/December 2012).

Electricity Use

Within the Recreation Center, Ameren has in operation two separate electric meters: one serves the Ice Rink and support spaces and one for the Golf Shop, main lobby, and multi-purpose room.

Ice Rink

Figure 6 displays the electricity usage (kWh per day) for the Recreation Center's Ice Rink against the average daily temperature for each month. The line containing the blue points reflects usage between September 2010 and present (November 2012). The slight increase in electrical consumption is primarily due to the increases compressor and cooling tower load when the outdoor air temperature rises above 60ºF. For the majority of the year the electrical load is very consistent as we would expect with a dominate process load like making ice 24/7. The blue shaded triangle represents the weather-related cooling part (1-3%) of the overall electric consumption. The gray rectangle represents the component of the electric use that is weather-independent, or "baseload". As stated before, the baseload includes things such as lights, computers, electric hot water heaters, ice making usage, and as well as any other year-round loads. Due to the large cooling effect the ice has on the actual ice rink, the use of electric heaters in the locker rooms is a year round need. In this heating case, since the use of the heat is independent of the outdoor weather, it would be identified as part of the baseload and included in the 97% value.

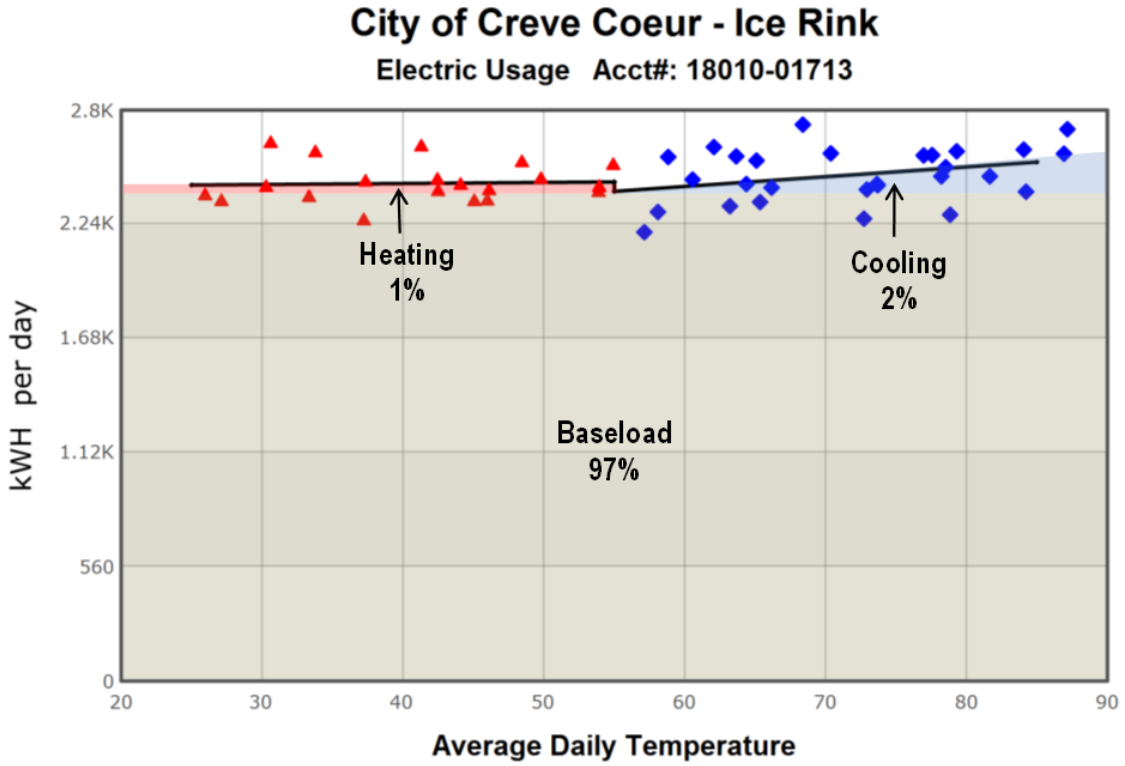

Figure 6 - Ice Rink Normalized Electrical Usage

Table 8 displays the annual electricity usage (kWh and dollars) of the Ice Rink for each of the components discussed above.

Electricity Use									
Building	Account #	Baseload		Cooling		Heating		Annual Use	
		$	kWh	$	kWh	$	kWh	$	kWh
Ice Rink	18010-01713	$ 62,400	878,400	$ 1,500	17,100	$ 400	5,900	$ 64,300	901,400

Table 8 - Annual Electrical Usage (Normalized)

A detailed review and audit of the baseload could identify more usage which is not know at this time. This could be done through a RCx program. Additional sensors and data logging equipment will be needed to isolate systems and identify more baseload items.

Golf Shop

Figure 7 displays the electricity usage (kWh per day) for the Recreation Center's Golf Shop against the average daily temperature for each month. The line containing the red/blue points reflects usage between December 2009 and June 2010. Since then (July 2011 until present), a newer trend has presented itself, represented by the light and dark green points. The blue shaded triangle represents the weather-related cooling part of the overall electric consumption for the most recent cooling period. The gray rectangle represents the component of the electric use that is weather-independent, or "baseload". As stated before, the baseload includes things such as lights, computers, electric hot water heaters, as well as any other year-round loads. Due to the relatively large size of the baseload for the building type, as well as the slight cold-weather correlation (slight downward slope of line as OATs got colder), it was predicted that the equipment was cooling unnecessarily at certain periods during colder weather. This behavior would also lead to a falsely higher heating load, though this is difficult to corroborate in the gas data as both the Golf Shop and Ice Rink are on the same meter. Additional metering trough RCx could identify these loads allowing for additional savings from revised schedules.

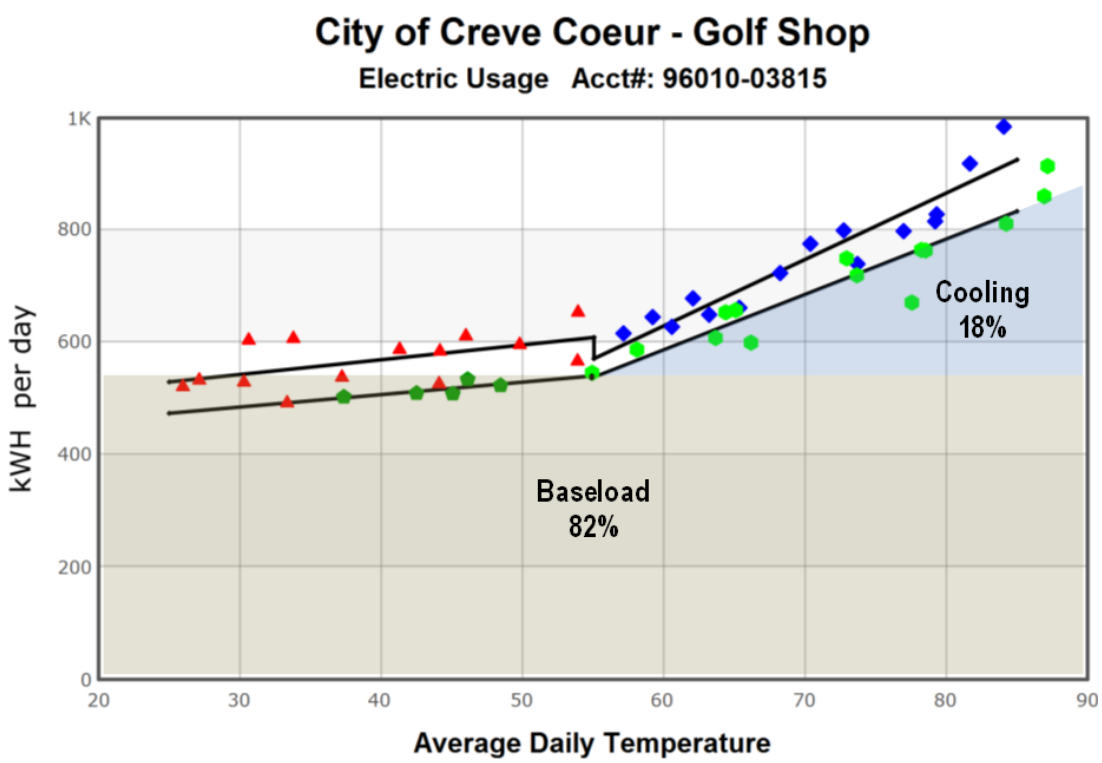

Figure 7 - Golf Shop Normalized Electrical USage

Table 9 displays the annual electricity usage (kWh and dollars) of the Golf Shop for each of the components discussed above.

Electricity Use									
Building	Account #	Baseload		Cooling		Heating		Annual Use	
		$	kWh	$	kWh	$	kWh	$	kWh
Golf Shop	96010-03815	$ 15,700	182,300	$ 4,400	42,900	$ -	-	$ 20,100	225,200

Table 9 - Annual Electrical Usage (Normalized)

When compared to the old trend in usage (red and blue points), the newer usage trend (green points) has lower overall electricity consumption. This can be seen visually in Figure 7 as the points of the newer trend are lower than the points of the older trend. Numerically, the total decrease in usage was calculated to be approximately 22,600 kWh per year, translating to a monetary savings of $2,100 annually. This decrease in usage represents a 10% drop in overall electricity usage for the building from a split date of June 2011.

Natural Gas Use (Ice Rink and Golf Shop)

While two electric meters exist for the Recreation Center, Laclede only has a single gas meter which is shared by both the Ice Rink and the Golf Shop spaces. Figure 8 displays the natural gas usage (therms per day) for this meter against the average daily temperature for each month. The line containing the red/blue points reflects usage between September 2010 and November 2011. Since November 2011 until present, a newer trend has presented itself, represented by the light and dark green points. The black dots represent a separate gas usage trend, dating prior to September 2010, and thus are omitted from analysis. The red shaded triangle represents the weather-related heating part of the overall natural gas consumption. In Figure 8, this heating triangle is placed on the most recent data trend. The gray rectangle represents the component of the natural gas use that is weather-independent, or "baseload". In an ice rink, the baseload for natural gas includes anything that would be a year-round load in an office building, such as a gas-fired domestic hot water heater, boilers, and gas fired heaters in AHU-001. Natural gas is used by the heat recovery process in AHU-001. This regenerative process uses natural gas fired heater to increase the outdoor air to a temperature to aid in removing moisture from the outside air. This can be seen by the slight slopes of the data on days above 65/70°F (i.e. blue and light green points).

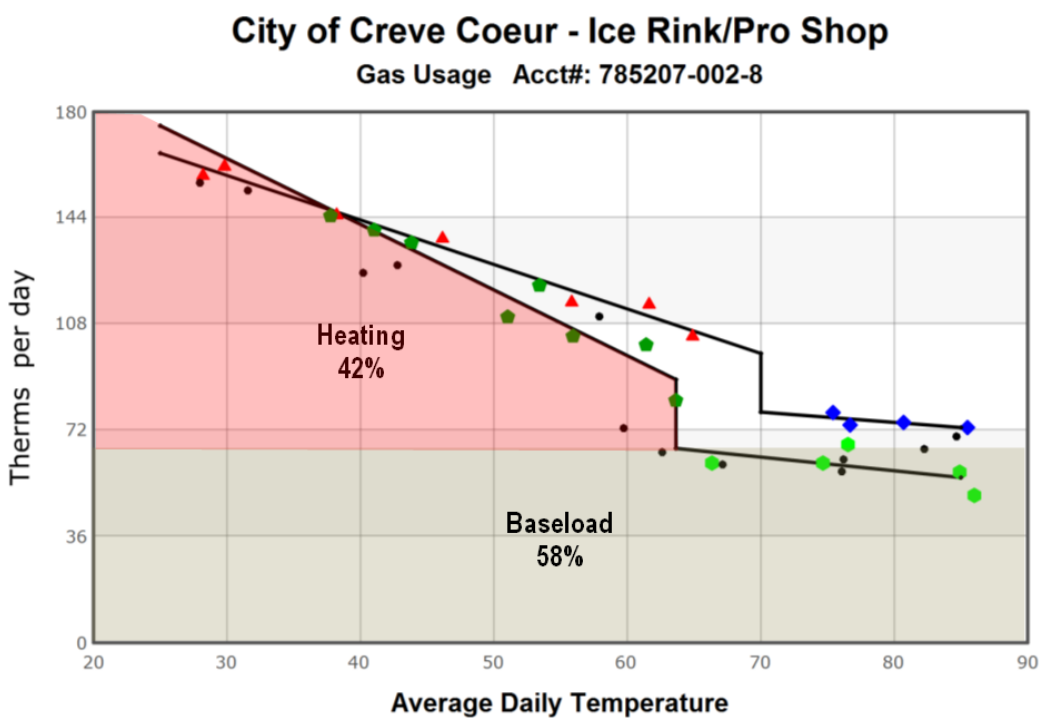

Figure 8 - Golf/Ice Rink Normalized Nat. Gas Usage

Table 10 displays the annual natural gas usage (Therms and dollars) of the Recreation Center for each of the components discussed above. The values included in the table represent the most recent trend in data (green points in **Error! eference source not found.**).

Natural Gas Use									
Building	Account #	Baseload		Cooling		Heating		Annual Use	
		$	Therms	$	Therms	$	Therms	$	Therms
Ice Rink/Pro Shop	785207-002-8	$ 17,300	22,100	$ -	-	$ 12,600	16,100	$ 29,900	38,200

Table 10- Annual Nat. Gas Usage (Normalized)

When compared to the old trend in usage (red and blue points), the newer usage trend (green points) has lower overall natural gas consumption. This can be seen visually in Figure 10 as the baseload of the newer trend is lower than the (not plotted) baseload of the older trend. Numerically, the total decrease in usage was calculated to be approximately 4,000 Therms per year, translating to a monetary savings of $3,200 annually. This decrease in usage represents a 10% drop in overall natural gas usage for the building from a split date of November 2011.

It should be noted that these savings were primarily a result of a decreased baseload. While the appearance in Figure 10 may suggest otherwise, the heating usage in the new trend actually consumes 1,400 more Therms than in the old one, costing the City approximately $1,100. However, this slight increase in usage during the heating season is overcome by the decrease in the baseload, such that the net savings is the $3,200 mentioned above.
Note: Only winter for comparison was very mild (no points below 35F on new trend). This data could be update with 2012-2013 winter data to provide a more complete range in temperatures and associated usages.

Public Works Facility

Electricity and natural gas data for the City of Creve Coeur's Public Works Facility was analyzed from November 2009 to present (November/December 2012).

Electricity Use

Figure 9 displays the electricity usage (kWh per day) against the average daily temperature for each month. The line containing the red/blue points reflects usage between October 2010 and December 2011. Since then (January 2012 until present), a newer trend has presented itself, represented by the light and dark green points. The black dots represent a separate electric usage trend, dating prior to October 2010, and thus are omitted from analysis.
The red and blue shaded triangles represent the weather-related heating and cooling parts (respectively) of the overall electric consumption. The gray rectangle represents the component of the electric use that is weather-independent, or "baseload". As stated before, the baseload includes things such as lights, computers, electric hot water heaters, as well as any other year-round loads. In the Public Works building, this can also be expanded to include air compressors and tools.

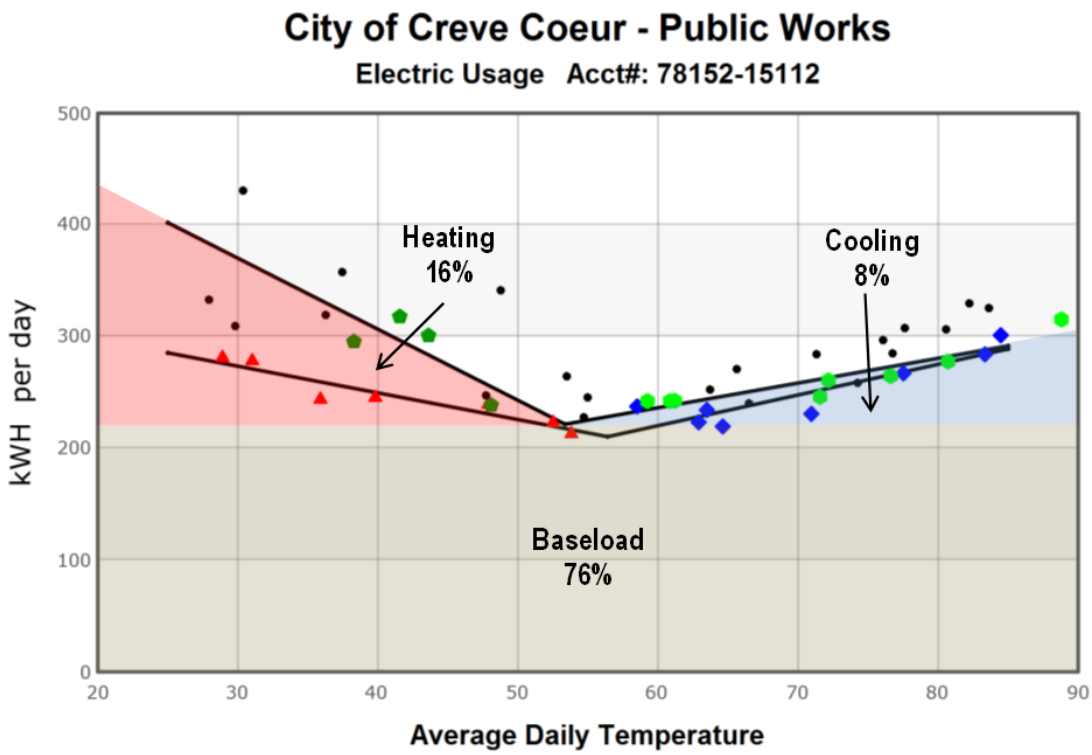

Figure 9 - Public Works Normalized Electrical Usage

Table 11 displays the annual electricity usage (kWh and dollars) of the Public Works Facility for each of the components discussed above. The values included in the table represent the most recent trend in data (green points in Figure 11).

Electricity Use									
Building	Account #	Baseload		Cooling		Heating		Annual Use	
		$	kWh	$	kWh	$	kWh	$	kWh
Public Works	78152-15112	$ 7,200	81,100	$ 900	8,500	$ 1,300	17,500	$ 9,400	107,100

Table 11 - Annual Electric Usage (Normalized)

When compared to the old trend in usage (red and blue points), the newer usage trend (green points) has higher overall electric consumption. This can be seen visually in Figure 11 as the green points are generally higher than the red/blue points. Numerically, the total increase in usage was calculated to be approximately 13,100 kWh per year, translating to a $1,100 increase in the annual electric bill. This added usage represents a 10% increase in overall electricity usage for the building. It should be noted this most recent increase was primarily due to an increased heating load. The heating in the current trend consumes 9,700 kWh ($800) more than the old one. However, since the transition between the old and current electricity usage trends in the Public Works Facility occurred in January 2011, and since the 2011/2012 winter was so mild, there are only 3 points in the heating regime available in the current trend. As such, the current heating trend is subject to change as new, and especially colder-weather, data becomes available. Another partial cause may be added winter load of using crankcase heaters for the street maintenance fleet. Perhaps an additional study or inventory analysis on this usage could identify a possibility for small solar stations to heat the trucks.

Natural Gas Use

Figure 10 displays the natural gas usage (therms per day) against the average daily temperature for each month. The line containing the red points reflects usage attributed to heating between September 2010 and present (November 2012). The black dots represent a separate electric usage trend, dating prior to September 2010, and thus are omitted from analysis. (It

is possible that the current trend began as early as May 2010; however, due to the low levels of natural gas usage during the summer months, this distinction cannot be made purely from the data.) The lack of a significant upward or downward trend within the blue points suggests that there is no gas-based cooling present in the building. The red shaded triangle represents the weather-related heating part of the overall gas consumption. The gray rectangle represents the component of the natural gas use that is weather-independent, or "baseload". As stated before, the baseload includes things such as domestic gas-fired hot water heaters, as well as any other year-round gas loads.

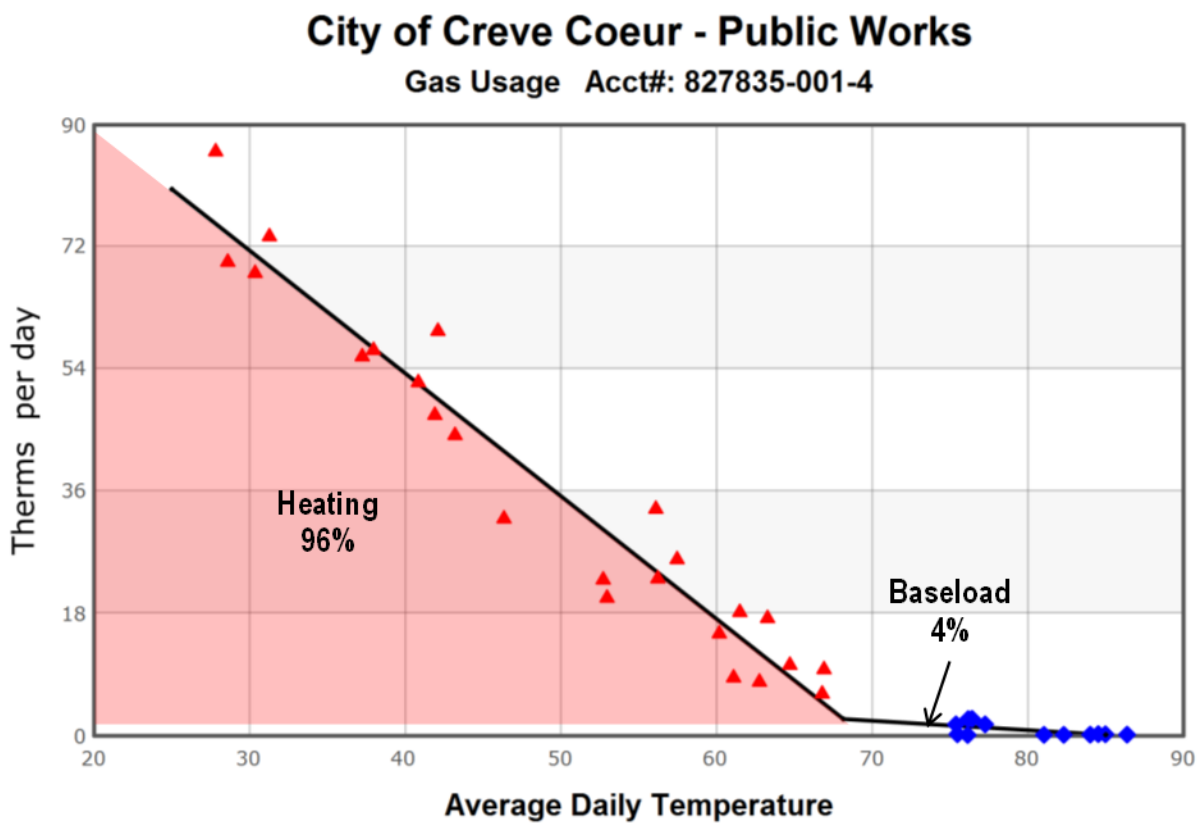

Figure 10 - Public Works Normalized Nat. Gas Usage

Table 12 displays the annual natural gas usage (therms and dollars) of the Public Works Facility for each of the components discussed above.

Natural Gas Use									
Building	Account #	Baseload		Cooling		Heating		Annual Use	
		$	Therms	$	Therms	$	Therms	$	Therms
Public Works	827835-001-4	$ 400	400	$ -	-	$ 10,100	10,400	$ 10,500	10,800

Table 12 - Annual Nat. Gas Usage (Normalized)

The above values do not reflect the recent addition of insulation to the bay doors and bay ceilings. It would be very interesting to do this analysis during the summer of 2013 to capture the impact this insulation had on the natural gas usage. It should be noted based on the data in Figure 10, the usage of natural gas does appear to start earlier then we would have expected. Based on the type of facility the heating of the bays and office heating we would have expected the heating to start close to 60ºF (or slightly below).

4. Heating/Cooling Load Analysis and Equipment Assessment

The goal of this section is to compare the current heating and cooling loads done by computer simulation to the actual installed heating and cooling equipment for each building.

Refer to the assessment section at the end of this report for the assessment tables for each building and major equipment.

Note: We recommended when it is time to repalce any of the current HVAC system, a brief and focused audit be done on the equipment size and actual space usage. It appears much of the installed equipment is oversized beyond a traditional 10% safety factor. This is/may be causing performance issues in spaces which are not loaded as originally intended. This future assessment could reduce the replacement costs and improve performance and life of the equipment. Typically unless this specific item is requested of the design team, a “like-for-like” replacement of the equipment will be done by the designer to reduce liability and design time effort.

5. Recommended Energy Conservation Measures

Energy Efficiency Measures (EEMs) which were determined to reduce utility consumption and greenhouse gases are identified below in Table 13. The associated energy savings, costs of implementation, paybacks, and incentives are included in Table 14. The analysis for each EEM starts on the next page. Please refer to section 2 for a more detailed description of the current conditions as they relate to the EEMs listed below.

EEM #	EEM Description	Government Center	Dielmann Rec Complex	Public Works Garage
EEM-1	Lighting - Interior	✓	✓	
EEM-2	Lighting - Exterior (1)	✓	✓	✓
EEM-3	DDC Upgrade	✓	✓	✓
EEM-4	Reto- Commissioning (RCx)	✓	✓	✓
EEM-5	System Rebalancing	✓	✓	✓
EEM-6	Solar PV	✓	✓	
EEM-7	Heat Recovery		✓	
EEM-8	Building Envelope	✓	✓	✓
EEM-9	VFD - Pump(s)	✓		
EEM-10	New Meeting Room HVAC		✓	
EEM-11	Ice Rink Bleacher Heaters (2)		✓	
EEM-12	Ice Rink Operational Changes		✓	

Table 13 - EEM Matrix

EEM #	Description	Savings					Cost	Simple Payback	Incentive	Payback w/ Incentive
		kWh	Therms	kBtu/year	Greenhouse Gas (Metric Tons)	$				
EEM-1	Lighting - Interior	89,801	-	306,401	64.6	$9,161	$30,543	3.3	$6,286	2.6
EEM-2	Lighting - Exterior (1)	49,336	-	168,336	35.5	$4,617	$51,246	11.1	$3,454	10.4
EEM-3	DDC Upgrade	103,350	1,670	519,630	83.2	$10,794	$179,394	16.6	$8,342	15.8
EEM-4	Reto- Commissioning (RCx)	297,136	5,105	1,524,328	240.8	$25,538	$57,263	2.2	$27,262	1.2
EEM-5	System Rebalancing	111,260	900	469,619	84.8	$8,945	$21,200	2.4	$ 8,361	1.4
EEM-6	Solar PV	32,274	-	110,119	23.2	$2,180	$105,000	48.2	$87,700	7.9
EEM-7	Heat Recovery	346,499	-	1,182,254	249.2	$30,734	$18,000	0.6	$18,000	0.0
EEM-8	Building Envelope	69,646	2,810	518,634	65.0	$7,682	$26,408	3.4	$6,738	2.6
EEM-9	VFD - Pump(s)	148,788	1,540	661,663	115.2	$11,633	$54,780	4.7	$11,436	3.7
EEM-10	New Meeting Room HVAC	36,691	-	125,190	26.4	$2,623	$20,500	7.8	$2,568	6.8
EEM-11	Ice Rink Bleacher Heaters (2)	(97,945)	-	(334,187)	-70.4	$ (8,687.69)	$ 15,200.00	None	None	None
EEM-12	Ice Rink Operational Changes	54,018	458	230,149	41.3	$4,205	$8,000	1.9	$561	1.8

(1) The cost does not include a reduction in maintenance costs over the life of the new fixture which would occur 2-3 times in the life of the LED fixtures

(2) These values are not savings but additional usage "negative savings"

Table 14 - Detailed EEM List

EEM-1: Lighting – Interior

Building lighting typically consumes close to 35% of the electricity used in commercial buildings today. Continual advances in lighting and lighting controls technology offer opportunities to lower the building's lighting load.

Photo 4 - Existing Lighting Fixture

Current Condition:

Recreation Center: The office areas are lit with T8 fixtures with 32 watt lamps. Lobby area has 12" can fixtures with 50 watt metal halide lamps. Ice rink is lit with 400 watt metal halide lamps with manual on/off switching.

Public Works Garage: Office areas are lit with T8 fixtures with 32 watt lamps. The high-bay areas are lit with T5 fixtures. Lighting levels appear to be appropriate for the usage

Government Center: Most lighting interior has been upgraded to T8 fixtures with 32 watt lamps with manual on/off operation. Some spaces appear to be over lit and could benefit from a FC study to determine if de-lamping is acceptable.

Recommended Action:

FDH recommends the lighting retrofits and upgrades in the following locations:

Recreation Center:

- Ice rink lighting to be T5-4 lamp fixtures
- De-lamp lobby cove lighting by 50%
- Install occupancy sensors for restroom, corridors, and vending machines

Public Works Garage:

- Occupancy sensors

Government Center:

- Occupancy sensors
- Multi-purpose room lighting to be T5-4 lamp fixtures
- Lighting foot-candle analysis and utilization survey.

Photo 5 - Ice Rink Fixture

Analysis:

Electric Usage Reduction	89,801	kWh/year
Natural Gas Usage Reduction	NA	therms/year
Total Annual Savings	$9,161	per year
Estimated Implementation Cost:	$30,543	
Simple Payback:	3.3	Years
Incentive/Rebates:	$6,286	
Payback with Incentive/Rebates:	2.6	Years

Assumptions/Notes:

- A complete space by space lighting audit was not completed with this energy audit and should be done to provide accurate fixture and lamp counts.
- Installing occupancy sensors in 62 additional spaces were used to calculate the savings.

EEM-2: Lighting – Exterior

Photo 6 - Typical LED Fixture

EEM-1 stated that lighting consumes close to 35% of the electricity a building uses, this includes both interior and exterior lighting. Exterior light offers a good opportunity for energy savings with longer run time hours and tremendous advances in lighting technologies that lend themselves to exterior lighting.

Current Condition:
The current exterior lighting is metal halide lighting technologies. These lights are used to illuminate the surface parking lot and the building entries. All the exterior fixtures are controlled by a combination of lighting schedules located in the BAS, building specific time clocks, and/or building specific photocells.

Note: The exterior lighting at the Recreation Center is not connected to the buildings electric utility meter or maintained by the Cities staff.

Recommended Action:
FDH recommends replacing all current exterior light fixtures with LED lamps to reduce energy and maintenance costs. The LED lamps last 3 times as long as the current lamps and this reduces maintenance costs significantly.

Analysis:

Electric Usage Reduction	49,336	kWh/year
Natural Gas Usage Reduction	NA	therms/year
Total Annual Savings	$4,617	per year
Estimated Implementation Cost:	$51,246	
Simple Payback:	11.1	years
Incentive/Rebates:	$3,454	
Payback with Incentive/Rebates:	10.4	years

Assumptions/Notes:
- The LED fixture life is estimated to be 100,000 hours which is 3+ times as long as the current fixtures.
- The cost does not include a reduction in maintenance and replacement costs over the life of the new fixture.
- Additional lifetime savings could approach $20,000 depending on actual material and labor replacement costs.

EEM-3: Direct Digital Control (DDC) Upgrade

Upgrade and retrofit the current building control system(s) to a more robust direct digital control (DDC) system. A modern DDC or BAS system can be web based and accessible on any PC authorized to be have access (Similar to the DDC used at the Recreation Center). The system can include wireless thermostats, improved graphical interface for all equipment, improved trending capabilities, improved scheduling, and increased ability to control equipment set-points.

Current Condition:
The current building control system is a mixture of electro-pneumatic and direct digital control. The DDC system is primarily a tool for trending and user interface for schedules with limited set point adjustments.
Recreation Center:

- JCI Metasys system for the non-Ice rink spaces. System does not have any graphics and is not easily navigated. Several systems could not be viewed and have limited function.
- Delta controls for the ice rink and related processes. System has nice graphics and is easy to navigate.

Public Works Garage:

- Local stand-alone controls. This level of control is adequate for this type of facility.

Government Center:

- Vintage DDC system (Access was not possible)
- Local stand-alone controls

Recommended Action:
FHD recommends the current BAS control system at the Government Center and Dielmann Recreation Center be upgraded to a 100% DDC system. This upgrade should include the integration of all fans, AHU, heat pumps, pumps, and space thermostats connected to the DDC system. This upgrade will provide significant improvement to the facility and how it is operated and maintained. Additional points of monitoring and of control to maximize energy conservation strategies will be possible. In addition to increased savings, the comfort level should be expected to improve as system feedback is now possible from the space and terminal equipment level. This increased level of control will provide faster response time for the maintenance staff when components are out of tolerance and for improved space temperature control with less temperature swings. This EEM includes the installation of the following:

- Updated DDC user interface at the Dielmann Recreation Center
- New DDC user interface and associated control points and devices at the Government Center.
- Training for approved users

Analysis:

Electric Usage Reduction	103,350	kWh/year
Natural Gas Usage Reduction	1,670	therms/year
Total Annual Savings	$10,794	per year
Estimated Implementation Cost:	$179,394	
Simple Payback:	16.6	Years
Incentive/Rebates:	$8,342	
Payback with Incentive/Rebates:	15.8	Years

Assumptions/Notes:

- It is recommended all buildings be on the same DDC platform (vendor) to insure consistency and users are fully trained and versed on how to use the system.

EEM-4: Retro-Commissioning (RCx)

The RCx agent (FDH) conducts a detailed facility assessment to diagnose and identify issues with existing equipment, control sequences, and sensor operation problems by the use of field observations and trending. After the data is analyzed, recommendations are made for minor low-cost adjustments that can be made quickly, as well as recommendations for more substantial improvements. Part of the RCx services is an assessment of cost, savings, rebate/incentives, and payback for each item, or group of items identified. If desired, the RCx agent can work with the City's project management team to fully design, implement, and provide measurement and verification after the recommendations are implemented.

Current Condition:
During the course of the energy audit several items were observed to be out of tolerances or settings. This along with the age and complexity of the HVAC systems make the Government Center and Dielmann Recreation Center ideal candidates for an RCx activity.
This new RCx process would be a holistic process which looks at all the HVAC, control, and lighting systems. During this audit several items were identified and witnessed which could be corrected and validated by an RCx process.

- Potential RCx items identified during the development of this audit:
  - AHU on/off schedule
  - Outdoor air damper operation and set-point
  - Economizer method and set-point
  - Space temperature overides
  - DDC system access and training
  - Hot water and condenser water pump operation
  - Supply heater output capacity
  - Adding VFDs to the pumps
  - Domestic water heating

Recommended Action:
FDH recommends the CIty apply to participate in the 2013 RCx program with Ameren Missouri. This program provides significant incentives and rebates for having the building retro-commissioned and any issues found corrected.

Analysis:

Electric Usage Reduction	297,136	kWh/year
Natural Gas Usage Reduction	5,105	therms/year
Total Annual Savings	$25,538	per year
Estimated Implementation Cost:	$57,263	
Simple Payback:	2.2	Years
Incentive/Rebates:	$27,262	
Payback with Incentive/Rebates:	1.2	Years

Assumptions/Notes:

- Ameren Missouri will reimburse the City up to $0.09/kWh "saved" as part of the RCx program. These incentives can be used toward procurement of material and/or professional engineering fees spent as part of an approved retro-commissioning effort. FDH is in the Ameren Trade Ally Network and can assist the City in completing the application and communicating with Ameren on their behalf when requested.

EEM-5: HVAC System Rebalance

Photo 7 - Typical Air Balancing Activity

Over time and after a recent renovation, the system flow rates (air and water) can become unbalanced. This unbalance can cause a variety of issues ranging from indoor air discomfort for occupants to equipment malfunction(s) and failures.

Current Condition:

Public Works Garage: The air flow associated with the recently replace RTU appears to be unbalanced. A post retrofit balancing report was not able to be found and the current air-flow rates could not be verified. The break room appears to be low on capacity while the front office areas seem to have an excess in capacity.

Government Center: AHU-1 and AHU-2 airflow capacities should be reviewed and verified to current space utilization. Pump flow rates should be verified and recalibrated to what is needed to eliminate any excess.

Recreation Center: The air flow differential between the ice rink and lobby appears to be negative. This is causing infiltration from the ice rink into the lobby. OA CFM and exhaust CFM values should be measured and rebalanced to design values.

Recommended Action:

FDH recommends the RTU system be rebalanced by a certified AABC or NEBB balancing contractor to +/- 10% of the design air flows to each space. The indoor comfort will be greatly improved and the use of the portable A/C unit should no longer be needed.

Analysis:

Electric Usage Reduction	111,260	kWh/year
Natural Gas Usage Reduction	900	therms/year
Total Annual Savings	$8,945	per year
Estimated Implementation Cost:	$21,200	
Simple Payback:	2.4	Years
Incentive/Rebates:	$8,361	
Payback with Incentive/Rebates:	1.4	Years

Assumptions/Notes:

- The existing equipment has adequate capacity to heat and cool the current space utilization

EEM-6: Solar Panels (PV)

Solar (PV) panel systems produce electricity for direct "consumption" by the building it is installed on. The panel system can produce approximately the same number of kW as the panel is rated for. If the building requires additional kW beyond what the panels can produce, the already connected utility company will seamlessly provide the needed kW as it is currently doing now. If the building needs less power than the panel is producing, the excess electricity is sent into the Ameren system and a credit is provided to the building meter charges.

Current Condition:
No solar (PV) panels are currently installed at the buildings.

Recommended Action:
If a renewable and solar presence is desired, FDH recommends that a 25kW array be installed. The current government and utility company incentives coupled with the increased competition in the solar PV market have made the price of solar panel installation drop significantly over the last 2-3 years. This EEM includes the installation of the following:

- Design, installation, and owner training for a 25 kW array (the below analysis can be applied to any building the City wishes to install the arrays on)

Analysis:

Electric Usage Reduction	32,274	kWh/year
Natural Gas Usage Reduction	NA	therms/year
Total Annual Savings	$2,180	per year
Estimated Implementation Cost:	$105,000	
Simple Payback:	48.2	years
Incentive/Rebates/Tax Credits:	$87,700	
Payback with Incentive/Rebates:	7.9	years

Assumptions/Notes:

- The analysis above is based on installing a 25 kW array.
- The above array can be installed on all three buildings. The above analysis will be the same for each building with a possible reduction in the installed costs due to the increased volume purchased, if purchased together.

The cost estimates are order of magnitude estimates. A formal solar study and design will be needed to gauge the actual costs of the solar (PV) system installed on the actual roof system. FDH has working relationships with some local solar equipment vendors and can put the City in contact with these companies. Please let us know if the City would like further assistance with this EEM analysis or if a proposal is desired.

EEM-7: Heat Recovery

There are many hours in the year in most HVAC system when heat is rejected to the outdoors (through air or water) while at the same time heat is needed within the building. Using a "heat recovery" strategy in these types of situations can be very cost effective, save significant energy costs, and help extend the life of the existing HVAC equipment.

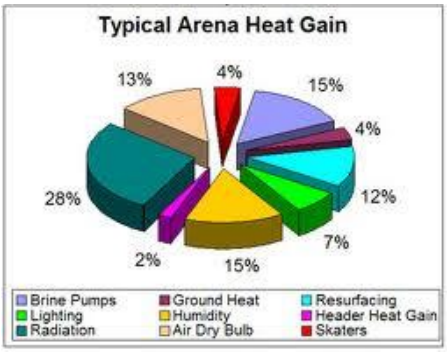

Figure 11 - Ice Rink Energy Usage

Current Condition:

Recreation Center: This facility has a very significant need to heat and cool simultaneously as part of the ice making, dehumidification, and occupant comfort processes. Some examples of this are:

- 9kW of heat is used year round to melt ice shavings from the ice resurfacer.
- Ice making is needed year round and heat is rejected to the outside via the cooling tower.
- Heat is needed to keep the ice rink between 55°F and 62°F.
- Heat is needed to make use of the regenerative process included with the "Munters" AHU.
- Heat is needed to create hot water for "flood water" and locker room uses.

Recommended Action:

FDH recommends heat recovery devices be used to capture and reuse the "waste" heat from the needed processes in the ice rink. The following items will need further investigating and preliminary designs done to obtain more accurate estimate of costs or savings.

- Use the waste heat from the ice making chillers/process to melt the ice shavings, provide supplemental heat to the ice rink, and/or meet other heating needs prior to rejecting the heat with the cooling tower.

Analysis:

Electric Usage Reduction	346,499	kWh/year
Natural Gas Usage Reduction	NA	therms/year
Total Annual Savings	$30,734	per year
Estimated Implementation Cost:	$18,000	
Simple Payback:	< 1.0	Years
Incentive/Rebates:	$18,000	
Payback with Incentive/Rebates:	< 1.0	Years

Assumptions/Notes:

- Ice melting is on 8760hrs per year at 9kW total.
- Adequate refrigerant temps and tonnage are available to be reclaimed
- Assumed compressor run-time was used for calculations.

EEM-8: Building Envelope Improvements

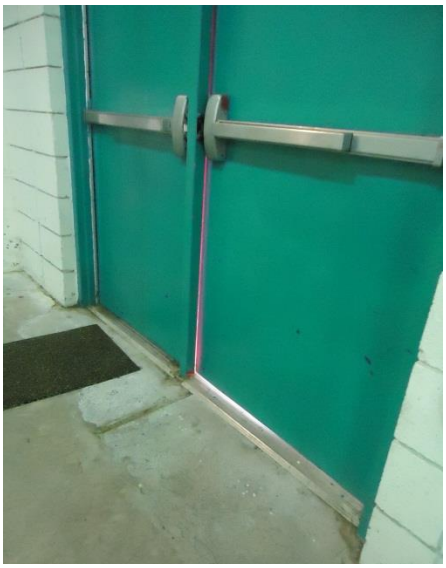

Photo 8 – Major Leakage from bad door seals

Most conventional buildings experience some level of air leakage through the building envelope. The level of leakage greatly depends on building pressurization, construction type, and building orientation. This uncontrolled infiltration (leakage) can affect the thermal comfort of the inhabitants of the building, introduce containments, moisture, and increase utility bills.

Current Condition:
The building envelope does not show signs of any recent improvements or any attempts to seal the common points of infiltration. A comprehensive site survey by a building envelope consultant was not done, but it is recommended, especially at the Recreation Center

Recommended Action:
FDH recommends a building envelope audit be conducted by a specialty contractor to determine the actual needs of the building. We fully expect the need to upgrade the building envelope to minimize the amount of air leakage. This includes sealing cracks and holes with 2-part foam, weather-stripping, caulking, sealing exterior doors, and sealing the window system. This EEM could include the installation of the following:

- Detailed survey of all three buildings for points of infiltration.
- Two part foam at all roof / wall points of connection to seal large gaps
- New door seals and sweeps
- Sealing of penetrations through walls and ceiling planes

Analysis:

Electric Usage Reduction	69,646	kWh/year
Natural Gas Usage Reduction	2,810	therms/year
Total Annual Savings	$7,682	per year
Estimated Implementation Cost:	$26,408	
Simple Payback:	3.4	Years
Incentive/Rebates:	$6,738	
Payback with Incentive/Rebates:	2.6	Years

Assumptions/Notes:

- Building pressurization is corrected and is positive with respect to the outdoors.
- Significant savings should be realized at the Ice Rink due to air leaks and pressure issues witnessed.

The preliminary estimates are order of magnitude estimates. A formal "hands on" envelope assessment should be conducted and measures identified with the appropriate sealing method. FDH has working relationships with an envelope sealing specialist who provides great results with documented success. Please let us know if the City would like further assistance with this EEM analysis or if a proposal is desired.

EEM-9: Addition of VFD's

When energy conservation is desired, all electrical loads should be controlled by a variable operating mode based on demand or load. This type of arrangement is intended to match the impacted equipment's output to the actual real-time needs and not for the "peak" conditions. As the building occupancy changes the impacted equipment should also change.

Current Condition:
The hot water pumps and OA fans operate as constant volume systems. With this type of system the same amount of water/glycol mixture and/or outside air flows regardless of the internal load or outside air temperature.

Recommended Action:
FDH recommends the following items be considered for implementation.

- Install four (4) VFDs for the pump loop. One for each pump
- Install two 2-way control valves to operate as zone valves to open close with occupancy
- Install one (1) VFD's on the outside air system serving the admin portions of the building
- Add DDC points to the new or existing DDC system to control the operation of the pumps and fans based on building load demand.

Analysis:

Electric Usage Reduction	148,788	kWh/year
Natural Gas Usage Reduction	1,540	therms/year
Total Annual Savings	$11,633	per year
Estimated Implementation Cost:	$54,780	
Simple Payback:	4.7	Years
Incentive/Rebates:	$11,436	
Payback with Incentive/Rebates:	3.7	Years

Assumptions/Notes:

- Adequate capacity/space is available in the DDC system for the ice making process to incorporate additional sensors and set-points schedules

EEM-10: New Meeting Room HVAC

Photo 9 – Typical Wall Mounted Ductless FCU

Isolating a large meeting room from the central HVAC system can improve occupant comfort and reduce over heating and cooling during peak usage.

Current Condition:
The meeting room is served by AHU-2 which also heats and cools the main lobby and office areas. Since the main lobby often experiences large fluctuations in heating and cooling requirements the connected spaces are often uncomfortable.

Recommendations:
FDH recommends installing a new dedicated Variable Refrigerant Volume (VRV) system to condition the meeting room. This EEM includes the installation of the following:

- Two (2) 3 ton ductless wall mount FCU's in the meeting room
- Condensing unit mounted outside at grade.
- Rebalancing of AHU-2 with damper installation.
- Two new thermostats
- New Condensate piping routed to outside

This isolation of the meeting room will allow the space to be heated and cooled independently of the main AHU-2 and the needs for the public lobby.

Analysis:

Electric Usage Reduction	36,691	kWh/year
Natural Gas Usage Reduction	NA	therms/year
Total Annual Savings	$2,623	per year
Estimated Implementation Cost:	$20,500	
Simple Payback:	7.8	years
Incentive/Rebates:	$2,568	
Payback with Incentive/Rebates:	6.8	years

Assumptions/Notes:

- Current usage requires 6 tons of cooling.
- Existing AHU system can be rebalanced to reflect the reduction in load.
- Adequate electrical capacity is available

EEM-11: Ice Rink Bleacher Heaters

Adding supplemental heat to the spectator area can be very beneficial to the ice rink. This can increase the number of spectators which can increase the use and revenue from snacks and membership.

Photo 10 – Typical IR Heater

Current Condition:
Currently no supplemental heat is used for the spectator area (bleachers). This area has seen temperatures as low as 45°F and very sporadic spectator usage.

Recommended Action:
FDH recommends three to four (3-4) Infra Red (IR) heaters be installed above the bleachers to provide increased comfort while minimizing heat gain to the ice rink. New thermostats and occupancy sensors can be used to control the IR heaters use efficiently.

Analysis:

Electric Usage Reduction	54,018	kWh/year
Natural Gas Usage Reduction	458	therms/year
Total Annual Savings	$4,205	per year
Estimated Implementation Cost:	$8,000	
Simple Payback:	1.9	Years
Incentive/Rebates:	$561	
Payback with Incentive/Rebates:	1.8	Years

Assumptions/Notes:

- Adequate electrical capacity is available to power the heaters.

Integration into the DDC system is possible with current controllers.

EEM-12: ICE Rink Operational and Control Changes

Controlling and monitoring the ice making process is critical to efficient production of quality ice for the patrons of the ice rink. Often energy is wasted due to the lack of proper monitoring, equipment, and/or operational procedures. By fully investigating the ice make process improvements can be made without the sacrifice of ice quality or occupant comfort.

Current Condition:
Ice temperature is sensed by subsurface temperature sensors. No setbacks are currently utilized for air, ice, or water set-points.

Recommended Action:
FDH recommends the following items be considered for further investigation and implementation.

- Reduction in ice temperature and/or thickness by ½" to ¼" from the current 1 ½" thickness
- Night set back/up for space temperature.
- Installed IR surface sensor to measure ice temperature and adjust for use if acceptable.
- Install occupancy sensors for locker room exhaust on/off operation
- Closing locker rooms during times of low occupancy.
- Adding space temperature control to the Delta or JCI system.

Analysis:

Electric Usage Reduction	54,108	kWh/year
Natural Gas Usage Reduction	458	therms/year
Total Annual Savings	$4,205	per year
Estimated Implementation Cost:	$8,000	
Simple Payback:	1.9	Years
Incentive/Rebates:	$561	
Payback with Incentive/Rebates:	1.8	Years

Assumptions/Notes:

- Adequate capacity/space is available in the DDC system for the ice making process to incorporate additional sensors and set-points schedules

6. Financing Options

Because of our extensive track record in accurately measuring and verifying savings, FDH can provide clients with an investment grade energy audit that is accepted by many financial institutions. In many cases this ability to predict energy savings based on budgeted utility and operation expenses allows clients to arrange for loans or a lease/purchase with little or zero out of pocket costs. Most lenders recognize the increased value of property which results from these types of energy upgrades and feel secure with these lending practices. We have outlined a few possible paths to implementation which could allow some construction to start this spring and be completed most likely by the end of summer.

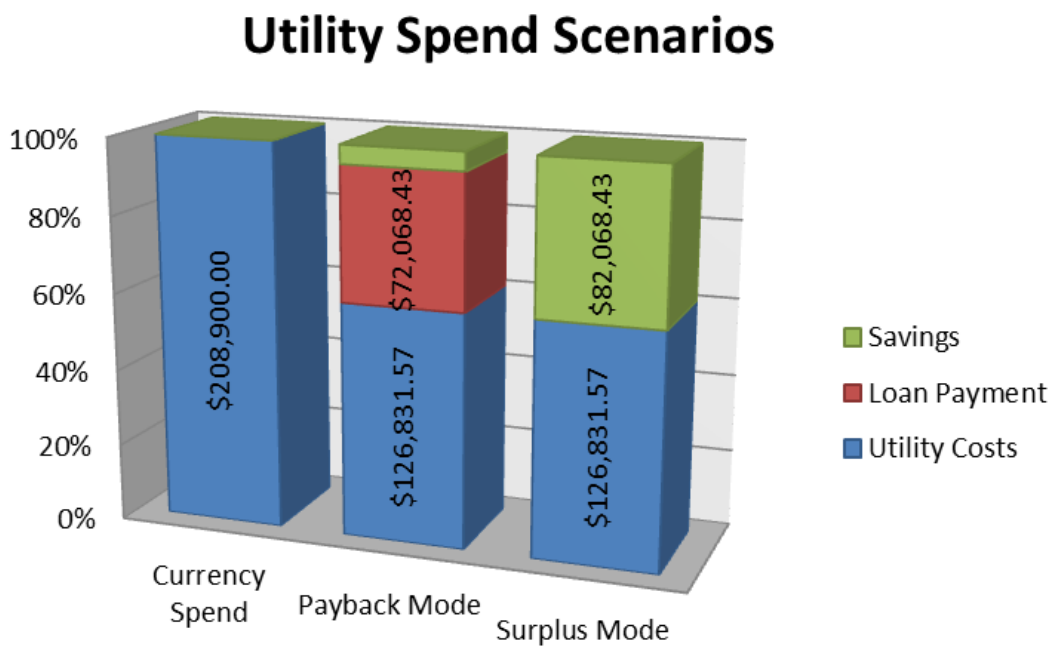

Figure 12 - Savings Funded Option

6.1. Capital Contribution Method

The City may choose to fund the selected EEMs by the use of capital contributions or other internal means. This would be considered the more traditional approach to making facility improvements and does not rely on the generated savings to pay back the loan (if used). Depending on the City's budget making process the savings generated from these EEM implementations could be lost for future use by the facilities. Often times the utility projections become based on the new improved utility spend. This does not allow for real reinvestment into the facilities for future upgrades and enhancements.

6.2. Low interest loans through PNC and FDH relationships

PNC Bank will provide a net-zero financing option which utilizes savings derived from reduced energy utilization to pay down the debt associated with the cost of the project. Our objective is to implement a project which does not require capital investment by the City. The reduction in Client's operating budget, through lower utility bills, along with funding from incentives and rebates, will be used to pay for the project. Ultimately, the energy savings will provide a positive cash-flow over the payback period, that is, the annual utility savings will exceed the annual principal and interest payments to the bank.

6.3. Energy Savings Performance Contract (ESPC)

An Energy Savings Performance Contract (ESPC) offers an alternative way of purchasing capital improvements. (See State of Missouri Energy Savings Contracts for Government Units – RSMO 8.231 & 640.651).

An ESPC is a partnership between a City and an energy service company (ESCO). The ESCO conducts a comprehensive energy audit for the City and identifies improvements to save energy and address any operating issues to further reduce costs. The ESCO designs and constructs a project which meets the City's needs and through third party lenders, arranges the necessary funding with the backing of guaranteed performance. These projects are typically 100% financed through a lease arrangement and aid in securing the reinvestment of energy savings back into the facilities. Therefore, they do not require capital from the City. As a lease, they are not counted as debt. The ESCO also guarantees the improvements will generate annual energy and operational savings sufficient to cover the annual lease payment making the project revenue neutral.

FDH can assist the City in perusing this avenue and take on the role of the owner's representative. This role will utilize FDH's extensive experience with ESPC, energy audits, and the resulting calculations to insure the City's best interests are maintained over the life of the performance contract. With the proper guidance an ESPC can be a very effective and positive experience for all involved.

7. Observation Items

The following items should be looked into further by the maintenance staff. These items were noticed during our audit and felt they should be mentioned.

Government Center:

1. The heat pump which serves the IT/server room should have a ducted return. The current installation is un-ducted and not preforming as it should, partly due to this.
2. DDC control system should be reviewed and made operational to the current staff. Training should be provided along with login and passwords.
3. AHU-1 and AHU-2 do not appear to be operational. During both visits neither of these units was operating.
4. Cooling tower water quality looks bad. A cooling tower water specialist should conduct a water analysis and cooling tower analysis and make recommendations to improve the water quality.
5. Some of the sally port unit heaters were not operational.
6. Verify the number of boilers needed and their sequence.

Dielmann Recreation Center:

1. The heat pump which serves the IT/server room should have a ducted return. The current installation is unducted and not preforming as it should, partly due to this.
2. Additional pump insulation should be added to repair or increases the insulating effectiveness at the base-mounted pumps.

Public Works Garage:

1. RTU roof access is not ideal and should be changed. Plans/design should be done to assess the current access and structural limitations for adding a new point of access for maintenance. One possible solution would be to add a door/hatch from the mezzanine level to the lower roof.

8. Conclusion

As previously stated, The City of Creve Coeur has already done an excellent job of identifying and implementing energy efficiency projects to reduce energy consumption in their facilities. This report should reinforce this since it has validated the previous projects are in fact saving energy.

If the majority of the EEMs listed in Table 14 are implemented, the initial investment would be approximately $500,000 - $600,000 and should provide a payback, after incentives, of less than 7 years. After which the City would have a savings surplus of approximately $82,000 + / year (as noted in Figure 12) which could be further invested into additional improvements to the facilities. As these EEMs are implemented, a second look is recommended at the end of the Design Development stage of the design process where the energy savings and construction cost are re-evaluated to insure the project expectations are still on track and will produce the anticipated savings and timeframes.

FDH is excited to part of this sustainability project and can provide the needed engineering and construction activity services needed, if desired by the City. Our professional engineering team and construction management team can provide a “turn-key” retrofit project for the City. If a traditional design – bid –build approach is desired we can engineer full plans and specifications for bidding and construction and follow through with construction administration and commissioning.

We look forward to working with the City and its staff to assist in implementing the above strategies and identifying more opportunities which coincide with capital improvement projects.

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Appendix A - Equipment Assessment

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Appendix A - Equipment Load Comparison and Assessment

TAG	Description	Location	Cooling Over-Sizing	Heating Over-Sizing	Condition / Comments	Action
Government Center Equipment						
HP-1	Ceiling Mounted Heat Pump	Women's Locker (PD214) & Men's Locker (PD215)	-68%	-72%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-2	Ceiling Mounted Heat Pump	Exercise Room (PD216)	55%	1%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-3	Ceiling Mounted Heat Pump	Interview Room (PD211-213)	83%	143%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-4	Ceiling Mounted Heat Pump	Detectives (PD210)	26%	32%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-7	Ceiling Mounted Heat Pump	Chief (PD206), Conference (PD207), and Lieutenant (PD209)	18%	5%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-8	Ceiling Mounted Heat Pump	Waiting (PD202), Secretary (PD203) & Photo Lab (PD208)	138%	173%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-9	Ceiling Mounted Heat Pump	Corridor (PD201), Electrical (PD218), Mechanical (PD219), Janitor (PD221) & Women's Bathroom (PD222)	-1%	-8%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-12	Ceiling Mounted Heat Pump	Corridor (AL201)	32%	-13%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-13	Ceiling Mounted Heat Pump	Council Chambers (AL206)	62%	214%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-14	Ceiling Mounted Heat Pump	Corridor (AL202), Conference (AL203) & Judge (AL204)	37%	41%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-16	Ceiling Mounted Heat Pump	Conference Rooms (AL205, AL208 & AL209) & Storage (AL212)	40%	8%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-18	Ceiling Mounted Heat Pump	Toilet (AL214) & Mayor (AL215)	15%	1%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-19	Ceiling Mounted Heat Pump	City Clerk (AL217), Office Machines (AL217A) & Secretaries (AL218)	21%	26%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-21	Ceiling Mounted Heat Pump	City Administrator (AL220)	29%	27%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-22	Ceiling Mounted Heat Pump	Vault (AL216), Assistant Admin (AL219) Corridor (AL222) & Office Mach (F202)	32%	65%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-23	Ceiling Mounted Heat Pump	Supervisor (F205)	20%	-20%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-24	Ceiling Mounted Heat Pump	Offices (F203 & F204)	-5%	18%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-25	Ceiling Mounted Heat Pump	Finance/General (F201)	70%	34%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-26	Ceiling Mounted Heat Pump	Vestibule (PL201) & Lobby (PL202)	44%	262%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-27	Ceiling Mounted Heat Pump	Corridor (PW201), Secretary/Reception (PW208), Electrical (PW217)	26%	11%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-28	Ceiling Mounted Heat Pump	Toilets (PW202 & PW203) & Janitor (PW204)	-70%	-74%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-29	Ceiling Mounted Heat Pump	Lounge (PW206) & Conference (PW207)	51%	123%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-31	Ceiling Mounted Heat Pump	Current Events (PW205), Office Machines (PW209) & Secretary (PW227)	26%	40%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-32	Ceiling Mounted Heat Pump	Corridor (PW214), Mud Room (PW212), Archives (PW213), Storage (PW218), Zoning Admin (PW220) Planning Admin (PW221) & Corridor (PW222)	50%	52%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-33	Ceiling Mounted Heat Pump	Corridor (PW210), Director (PW223) & City Engineer (PW224)	25%	4%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-34	Ceiling Mounted Heat Pump	Drafting Area (PW226) (serving half the room)	85%	79%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years

Appendix A - Equipment Load Comparison and Assessment

TAG	Description	Location	Cooling Over-Sizing	Heating Over-Sizing	Condition / Comments	Action
HP-35	Ceiling Mounted Heat Pump	Drafting Area (PW226) (serving half the room)	85%	79%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-36	Ceiling Mounted Heat Pump	Cell Entry (PD123A) & Men's & Women's Cells (PD127 - 133)	-70%	-71%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-37	Ceiling Mounted Heat Pump	Holding (PD123), Prints (PD124) & DWI (PD125)	84%	506%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-38	Ceiling Mounted Heat Pump	Booking (PD121)	-3%	74%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-39	Ceiling Mounted Heat Pump	Corridor (PD114), Armory (PD118), Corridor (PD119), Interview (PD120) & Juvenile (PD126)	83%	189%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-40	Ceiling Mounted Heat Pump	Reports & Lineup (PD117), Briefing (PD112), Elevator Lobby & Elevator (PD143) & Evidence Storage (PD148)	54%	73%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-41	Ceiling Mounted Heat Pump	Radio (PD107), Patrol Div (PD115), Watch Commander (PD116) & Evidence (PD121B)	51%	36%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-44	Ceiling Mounted Heat Pump	Corridor (PD101), Records (PD102), Closets (PD103, PD108 & PD109) & Service Div. Commander (PD110)	61%	19%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-45	Ceiling Mounted Heat Pump	Communications (PD104), Closet (PD105) & Toilet (PD106)	32%	90%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-46	Ceiling Mounted Heat Pump	Lobby (CC101) & Corridors (CC102 & CC117) & Gym Storage (CC118)	95%	284%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-47	Ceiling Mounted Heat Pump	Meeting Room (CC103) & Electrical (CC127)	88%	21%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-49	Ceiling Mounted Heat Pump	Parks & Rec Director (CC104), Conference (CC105) & Staff (CC107)	44%	109%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-50	Ceiling Mounted Heat Pump	Meeting Room (CC106)	135%	39%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-52	Ceiling Mounted Heat Pump	Gymnasium (CC112) & Mech. Equip. Room (CC113)	184%	162%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-53	Ceiling Mounted Heat Pump	Offices (CC114 & CC115) & Vestibule (CC116)	3%	155%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
HP-54	Ceiling Mounted Heat Pump	Gym/Multipurpose Bathrooms (CC120/121), Multipurpose (CC122), Kitchen (CC123), Storage (CC124) & Mech Room (CC125)	46%	150%	Actual condition was not reviewed.	Monitor/Replace as failures occur < 5 years
AHU-1	Ventilation AHU	Serves Police	Rcx	Rcx	Unit was not operating at the times of our field surveys. This unit is original and replacements should be done within the next 2-3 years.	RCx and then replace < 3 years with a unit which fully conditions all outside air.
AHU-2	Ventilation AHU	Serves Gov. Building	Rcx	Rcx	Unit was not operating at the times of our field surveys. This unit is original and replacements should be done within the next 2-3 years.	RCx and then replace < 3 years with a unit which fully conditions all outside air.
Boilers	Four Natural Gas Boilers	All spaces	-	-	Replaced in 2012 with 4 condensing boilers. Only two boilers are needed based on anticipated loads.	Verify led/lag sequence and OA temp reset is active for the leaving water temperature.
CWP-1	Condenser Pump	All spaces	-	-	Original CV flow system	Monitor/Replace < 5 years
CWP-2	Condenser Pump	All spaces	-	-	Original CV flow system	Monitor/Replace < 5 years
HWP-1	Hot Water Distrabution Pump	All spaces	-	-	Recently replaced (2012?) but operates as a CV system	Monitor and service as normal
HWP-2	Hot Water Distrabution Pump	All spaces	-	-	Not original but operates as a CV system	Monitor/Replace < 10 years
CT-1	Cooling Tower	All spaces	-	-	Scale and metal build-up	Measure quality, clean, and treat water/cooling tower system
DDC	Direct Digital Control	All spaces	-	-	Not used by staff. Additional training and upgrade is recommended to improve performance and reliability	New training and upgrade to web-based system < 5 years
Dielmann Recreation Center						
AHU-001 "Ice"	Heat Recovery AHU	Ice Rink & Bleachers	Rcx	Rcx	Unit was new in 2003. Unit is not adequately maintaining temperature within the ice rink. No temperature control exists at the bleachers and the space is very cold at times (low 50's high 40's)	RCx < 1 year to restore performance or determine limits of AHU

Appendix A - Equipment Load Comparison and Assessment

TAG	Description	Location	Cooling Over-Sizing	Heating Over-Sizing	Condition / Comments	Action
AHU-1	Part of AHU-1	Party Room, Ice Pro Shop	-	-	Space temperature is reported to be very difficult to control. Thermostat is located in the main lobby.	Remove space from AHU-1 < 3 years
Electric Heat	Electtric Baseboard	Team Rooms & Bathrooms	-	-	Covers were added to prevent burns and damage to equipment. Thermostats are not part of the DDC system	Monitor and service as normal
AHU-1	Main AHU	Warming Room, Offices, Meeting Room, Concessions, Lounge	27%	Unknown	AHU is original to the building/major renovation. No major issues appear to exist.	Clean unit and rebalance, replace < 8 years
AHU-2	Main AHU	Golf Pro Shop, Golf Pro bathrooms	35%	Unknown	AHU is original to the building/major renovation. No major issues appear to exist.	Clean unit and rebalance, replace < 8 years
B-1	Natural Gas Boiler	AHU-1 and AHU-2 Spaces	-	-	Boiler is operating properlly.	Monitor/Replace < 5 years with condensing boiler with high turndown. Can possibly use one of the Gov Center Boilers if needed
B-2	Natural Gas Boiler	AHU-1 and AHU-2 Spaces	-	-	New boiler and is operating properlly.	Monitor and service as normal
Comp-1	R22 Compressor	Ice Making Process	-	-	R22 compressor appear to be in good shape and operating within tolerances.	Verify units are cycle based on runtime hours
Comp-2	R22 Compressor	Ice Making Process	-	-	R22 compressor appear to be in good shape and operating within tolerances.	Verify units are cycle based on runtime hours
Comp-3	R22 Compressor	Ice Making Process	-	-	R22 compressor appear to be in good shape and operating within tolerances.	Verify units are cycle based on runtime hours
CT-1	Cooling Tower	Ice Making Process	-	-	Cooling tower appears to be operating acceptable and maintaining R22 temps/pressures within tolerances.	Monitor and service as normal
DDC	Direct Digital Control	All spaces	-	-	Web-based and two distinct systems are used and appear to be used daily by the staff. Very critical to the operation and maintenance activities.	Upgrade the JCI system to include graphics and trending of systems.
Public Works Garage						
RTU-1	Roof Top Unit	Garage office, lobby, and break room	13%	114%	Replaced in 2012. There is operational issues with air flow to the break room. This is possibly contributed to an imbalance of air flow. A portable AC unit is used in the summer to keep the space cool. This unit should not be needed.	Rebalance air flow < 1 year
IRH-1	Infrared Celling Mounted Heater	Garage Bay	-	Unknown	New in 2012 and appear to be operating as designed	Monitor and service as normal
IRH-2	Infrared Celling Mounted Heater	Garage Bay	-	Unknown	New in 2012 and appear to be operating as designed	Monitor and service as normal
IRH-3	Infrared Celling Mounted Heater	Garage Bay	-	Unknown	New in 2012 and appear to be operating as designed	Monitor and service as normal

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Appendix B - Ice Rink Ice Making Diagram

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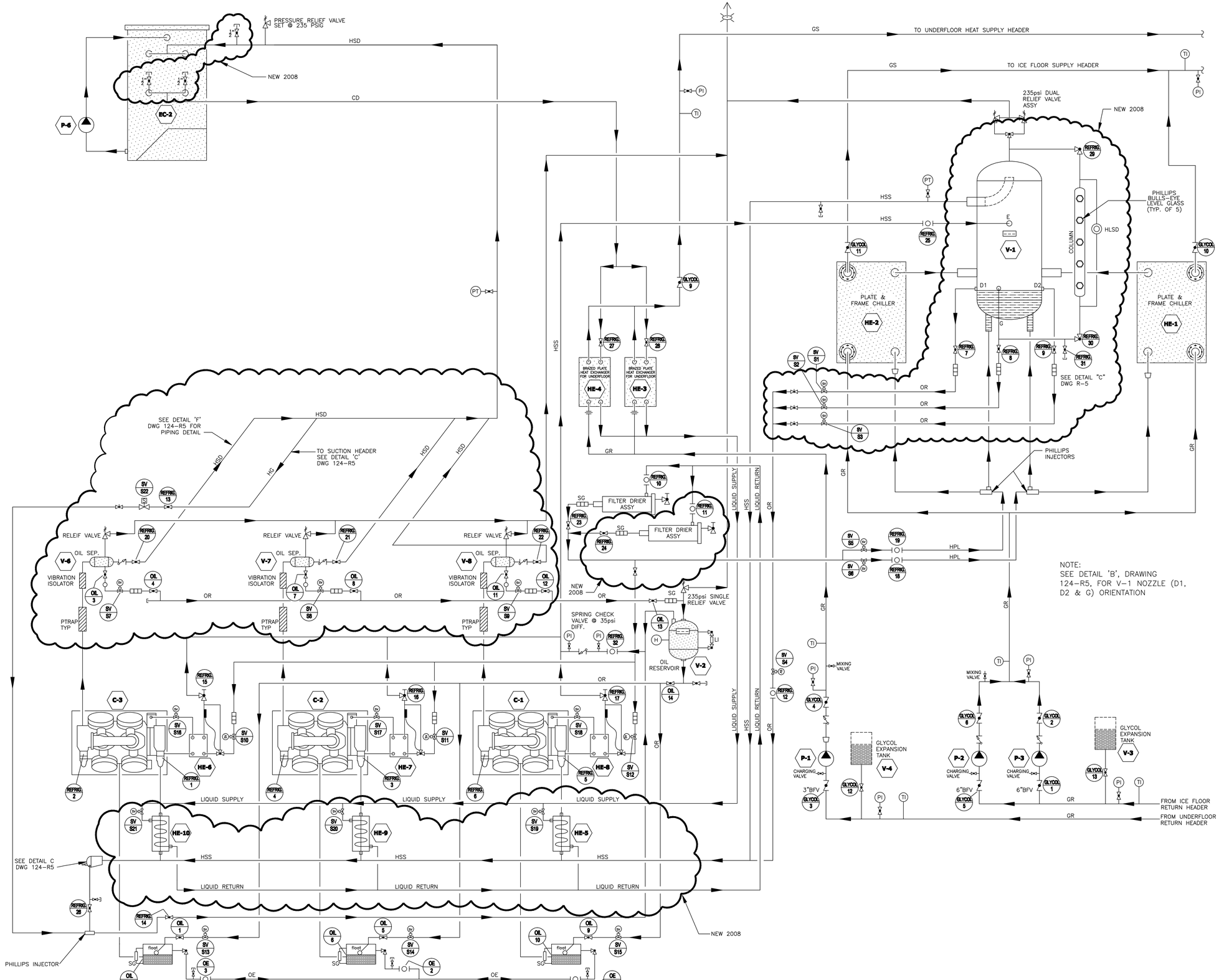

NOTE:
#7 GLYCOL SHUT-OFF, MAIN CHILLED WATER RETURN SHUT-OFF(BUTTERFLY VALVE) & #6 GLYCOL SHUT-OFF, MAIN CHILLED WATER SUPPLY SHUT-OFF (BUTTERFLY VALVE) ARE NOT SHOWN ON THIS DRAWING.

revision		
4		
3	10-03-22	AS-BUILT, BY CIMCO REFRIGERATION
2	08-03-31	ADD ISOLATION VALVES HPL
1	08-03-31	ISSUED FOR RFQ
no.	date	remarks

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Dielman Recreation Complex Renovations

City of Creve Coeur, Mo.

P. & I. D.
2008 RETROFIT AS-BUILT DRAWING

drawn	PDM	checked	RHS
date	MAR 4/08	scale	NTS
issued	–	project	124
drawing number	124-R4	revision	3