Final ESPC Pre-Qualification Report For Select State Properties

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Delaware Sustainable Energy Utility

Prepared by:

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2 BACKGROUND

The Delaware Office of Management and Budget (OMB) is responsible for the operations and maintenance of dozens of State owned properties. OMB has used Energy Savings Performance Contracting (ESPC) as a vehicle to make improvements in several properties in its portfolio in the recent past, and asked Celtic Energy, Inc. (CEI) to help them 'pre-qualify' a select number of properties that would be good candidates for another round of successful ESPC projects. CEI is under contract to the Delaware Sustainable Energy Utility (DESEU) who provides the tax exempt financing for ESPC and many other energy initiatives across the state, and was hired to assist OMB in this effort. This document lists key technical and operational aspects of each facility which may support an ESPC, provide insight to single energy conservation measures (ECMs), or mark this particular facility for future upgrades.

The facilities involved in this study include:

1. Carvel State Building – 820 N. French Street, Wilmington
2. 900 King Street – 900 King Street, Wilmington
3. New Castle County Courthouse – 500 N. King Street, Wilmington
4. DEMA – 165 Brick Store Landing, Smyrna
5. TMC – 169 Brick Store Landing, Smyrna
6. William Penn – 801 Silver Lake Blvd, Dover
7. Absalom Jones – 310 Kiamensi Road, Wilmington
8. Biggs at Herman Holloway – 1901 N. DuPont Hwy, New Castle

3 SUMMARY

The goal of an ESPC is to provide financing for energy efficiency upgrades of existing equipment either through equipment replacement or retrofits, commissioning, and maintenance. Typical comprehensive ESPC projects can yield an energy cost savings of 20%-40%; typical finance terms range from 15 to 20 years. The current total energy costs for the eight facilities in this portfolio is approximately $3,700,000. These initial projections estimate a 20% cost savings to be $740,000 and a 20-year term performance contract value of $14,800,000.

To narrow down these initial estimates, CEI conducted site visits and operational interviews with building staff to develop refined savings and cost estimates. The measures identified for all buildings in this portfolio are estimated to be approximately $4,660,000 and have an estimated savings of $550,000. Comparing these costs and savings to the projected cost and savings capacity of the ESPC ($14,800,000/$740,000) show that there is room for additional measures or other capital intensive improvements.

Based on our initial analysis, CEI believes that there are enough opportunities between the eight facilities in this pre-qualification phase to for the OMB to pursue an ESPC. There appears to be a robust opportunity of $5-$15 million, which can leverage the innovative mechanism to make significant building improvements.

The tables below illustrate cost, savings, and payback for ECMs at each facility. Technical facility profiles and detailed descriptions of key findings and ECMs are outlined later in this report.

Table of abbreviations
HP – Heat pump
LED – Light emitting diode (solid state illumination)
PEPCO – District chilled and hot water Company
CHW – Chilled water
HW – Hot water
CT – Cooling Tower
ECM – Energy conservation measure
VFD – Variable frequency drive (motor speed controller)
DEMA – Delaware Emergency Management Agency
TMC – Transportation Management Center
EUL – Effective useful life
BMS – building management system i.e. central building controls
RCx – Retrocommissioning
EOL – End of Life (equipment)

3.1 CARVEL STATE BUILDING:

	Measures	Core HP Replacement	PEPCO CHW Conversion	PEPCO District HW Conversion	Condensing Boiler	Cooling Tower Replacement
Carvel State Building	Savings %	2%	25%	50%	20%	0%
	Savings kWh	54,384	391,044			0
	Savings CCF			16,600	6,669	
	Savings $	$4,878	$35,074	$16,500	$6,614	$0
	Cost	$1,500,000	$ 200,000	$150,000	$600,000	$650,000
	Payback (yrs)	Capital Outlay	5.7	9.1	90.7	Capital Outlay

Notes:

- The selected ESCO shall make an independent analysis on whether to connect to the PEPCO chilled and hot water loop (Option 1) or replace/upgrade existing equipment (Option 2).
    - Option 1
        - PEPCO heating will eliminate all gas usage, due to the fuel switch
        - PEPCO cooling will eliminate CT need
        - PEPCO option (Option 1) will eliminate EOL CT and Boiler equipment replacement
    - Option 2
        - Detailed field audit will need to be performed to determine replacement equipment sizes
        - Will require a capital outlay
            - CT replacement at EOL, no energy savings will be realized due to the energy efficiency upgrades performed during the recent AMERESCO ESPC
            - Boiler replacement at EOL, potential 20% savings with condensing boilers
            - Boiler circulation pumps and associated piping need to be replaced as soon as possible (evidence of leaking observed during audit)
- Recent ESPC addressed CW loop pumps & VFDs, CTs upgrades/optimization, T12 to T8 conversion, heat pump replacement, & other small ECMs.
- Core Air Handling/Heat Pump units at end of EUL, need replacement regardless of PEPCO decision.
    - Preliminary count of 144 units throughout the building
    - May require engineering and significant to optimize unit size and count, this should be evaluated under an ESPC.
    - Reengineering will depend on PEPCO loop tie-in analysis. Units will be CHW/HW with PEPCO or water source HPs if simply replaced.
- Some recent LED upgrades.
- Lighting occupancy sensors being installed by in-house electricians; partially complete.
- BMS Control maintenance 2x per week.

3.2 900 KING STREET

	Measures	HP Upgrades	New LED Fixtures Occ. Sensors	Project Summary (% savings in $)
900 King Street	Savings %	5%	45%	35%
	Savings kWh	204,789	130,867	335,656
	Savings CCF			
	Savings $	$19,756	$12,625	$32,380
	Cost	$250,000	$185,000	$435,000
	Payback (yrs)	12.7	14.7	13.4

Notes:

- May be a candidate for integration to PEPCO district chilled and hot water loops, however the cooling tower is newer and there is a contract for new boiler.
- Boilers at end of EUL, went down during a 20F week, need new pump/drive; under contract for a new boiler.
- HPs continuously being replaced w/ std. eff. units, some HPs are very old.
- Comfort issues related to equipment failure.
- 2nd floor has simultaneous hot/cold complaints.
- CTs newer, but observed water saturated insulation in one section.
- Rooftop AHU has energy recovery and appears to be operating well.
- Mix of T12/T8 lighting, 4th floor soffit lighting replaced with LED panels.
- Stairwell fixtures in poor condition (T12).
- HP filters maintained semi-annually.

3.3 NEW CASTLE COUNTY COURTHOUSE

	Measures	Retrofit LED Occ. Sensors RCx Daylighting	HVAC RCx & Equipment Upgrades	Project Summary (% savings in $)
New Castle Courthouse	Savings %	40%	10%	12%
	Savings kWh	853,632	252,088	1,105,720
	Savings CHW (kBTU)		2,230,806	2,230,806
	Savings HW (kBTU)		1,812,059	1,812,059
	Savings $	$75,707	$211,196	$286,903
	Cost	$770,000	$500,000	$1,270,000
	Payback (yrs.)	10.2	2.4	4.4

Notes:

- District HW/CHW from PEPCO.
- Lighting on until 12AM for custodial staff.
- Significant glazing, daylighting recommended by building Engineer.
- Slowly upgrading to LED.
- Frequent light fixture maintenance.
- Occ. sensors receive complaints, perhaps not commissioned or poor application.
- Too bright in some places; perhaps de-lamp when upgraded to LED.
- Original design used excessive OA, economizer added after construction.
- Existing dampers make it difficult to economize limited flow.
- Courtrooms make up majority of core spaces and are cooling dominated.
- Courtrooms have low set points to keep occupants awake.
- Older BMS, no optimal start/stop options.
- PEPCO HX may be undersized (1,500 GPM max), cannot satisfy design day load.
- AHUs said to be approaching end of EUL, appeared well maintained, drives upgraded recently.
- No humidity control in BMS.
- All stairwells restricted and seldom used, heated with unit heaters.
- Unoccupied set points 80F/60F clg/htg.
- In setback mode, some AHUs do not turn off T-stat in bad location and VAVs call for air.
- New VAVs proven to reduce drive speed by 10%.
- Rebalanced three times, still having air flow issues.
- Renegotiate PEPCO monthly capacity charge.

3.4 DELAWARE EMERGENCY MANAGEMENT AGENCY (DEMA) AND TRANSPORTATION MANAGEMENT CENTER (TMC)

	Measures	Data Center Process Optimization	Data Center Cooling Optimization	Retrofit LED	CT Replacement & Drives Fresh Air upgrades/RCx	Electric Boiler Replacement	Solar	Summary
DEMA	Savings %	5%	5%	25%	33%	30%		29%
	Savings kWh	8,262	5,508	62,681	57,990	71,177	151,618	357,236
	Savings $	$756	$504	$5,734	$5,304	$6,511	$10,613	$29,422
	Cost	$1,000	$1,000	$40,000	$47,500	$35,000	$386,197	$510,697
	Payback (yrs)	1.3	2.0	7.0	9.0	5.4	36.4	17.4
TMC	Savings %	5%	5%	25%	33%	30%		28%
	Savings kWh	7,790	5,194	49,079	55,031	60,889	151,618	329,601
	Savings $	$719	$479	$4,531	$5,081	$5,621	$10,613	$27,045
	Cost	$1,000	$1,000	$36,000	$95,000	$35,000	$386,197	$554,197
	Payback (yrs)	1.4	2.1	7.9	18.7	6.2	36.4	20.5

Notes:

- Some of lighting on 24/7 unless on occ. sensor.
- HVAC assumed to be 24/7 for most/all areas.
- Some areas are manned 24/7 (emergency dispatch).
- 100% fresh air into plenum causes humidity issues and increased cooling.
- No drives on FA units, bldg. mgr. requested drives.
- Heat pumps failing, replacement with like units.
- CTs approaching end of EUL, no drives.
- No CT redundancy for TMC.
- HID exterior lighting, photocell or timeclock.
- Two (2) data centers, may contribute to significantly more electric usage.
- Building is all electric, including boilers, fuel conversion possible.
- New BMS, possible RCx opportunity (OA reduction).
- Zoning issues in DEMA training area when occupied.
- Building manager requesting more privileges for troubleshooting.
- One (1) Emergency generators sized to power TMC building, two (2) emergency generators for DEMA, emergency systems only.
- Opportunity for Solar.
- Many perforated floor tiles are not under server racks for raised floor air distribution.
- Solar can be installed as roof mount or ground mount in open space. Roof area supports appx. 950 panels, at 270W/panel expected electric offset is 303,000kWh annually. An offset rate of $0.07/kWh was used in this analysis. System was split between both buildings. Cost estimated at $3/watt.

3.5 WILLIAM PENN

	Measures	Data Center Process Optimization	Data Center Cooling Optimization	Retrofit LED Occupancy Sensors	CT Replacement AHU Replacement CT Drives Recommissioning	Hi Eff Boiler Upgrade	Summary (% savings in $)
William Penn	Savings %	5%	5%	40%	10%	15%	14%
	Savings kWh	149,700	28,352	68,272	404,871		651,196
	Savings CCF					1,439	1,439
	Savings $	$13,375	$2,533	$6,100	$36,175	$1,620	$59,804
	Cost	$1,000	$1,000	$67,000	$332,500	$60,000	$461,500
	Payback (yrs)	0.1	0.4	11.0	9.2	37.0	7.7

Notes:

- Cooling towers approaching end of EUL.
- HPs replaced as they fail.
- Upgraded BMS, Bldg. mgr. has limited control; requests more privileges for troubleshooting Temp sensors unreliable and not calibrated.
- No Cx said to be performed on recent BMS upgrade.
- Server rooms low set points 70°F.
- Light fixtures approximately 5 years old.
- Many areas w/ occ. sensors.
- Preference for less light output.
- 100% load backup generators.
- AHUs approaching end of EUL.
- Floor panel diffusers are not necessarily under server racks for raised floor air distribution.

3.6 ABSALOM JONES

	Measures	Gym Ventilators	HP Upgrades	New and Retrofit LED Daylighting Controls	New Windows	Summary (% savings in $)
Absalom Jones Center	Savings %		5%	40%	15%	26%
	Savings kWh		11,761	95,397	83,988	191,147
	Savings $		$1,228	$9,958	$13,463	$24,648
	Cost	$50,000	$25,000	$145,000	$201,000	$421,000
	Payback (yrs.)		20.4	14.6	14.9	17.1

Notes:

- New boilers, domestic water heater, and cooling tower.
- No zones for perimeter heating, some areas over heat.
- Needs gym ventilators.
- T12/T8 Mix, Exterior LEDs.
- Single pane windows in poor condition.

- Adding RTUs to Art & Sr. center wings.
- Several original old HPs remain.
- Controls appear to be working well but possible RCx.
- Skylights in updated area, no daylighting control.

3.7 BIGGS AT HERMAN HOLLOWAY

	Measures	Data Center Temperature Optimization	Data Center Temperature Optimization	CRAC Upgrades	Summary (% savings in $)
Biggs Building	Savings %	5%	5%	10%	21%
	Savings kWh	11,950	11,950	23,900	
	Savings $	$1,195	$1,195	$2,390	$4,780
	Cost	$1,000	$1,000	$100,000	$102,000
	Payback (yrs)	0.8	0.8	41.8	21.3

Notes:

- Building is not sub-metered.
- Billed annually for an unmetered usage at $23,900.
- Some CRAC units at end of EUL or inefficient, one recently replaced.
- 100 tons of cooling total, only 50 tons required, units are cycled.
- Load may decrease by increasing room temp.
- Unknown if any upgrades will reduce bill due to unmetered usage.
- UPS battery backup can operate for about 1 hour.
- Backup generator can satisfy server, serviced by owner.
- Space felt humid, but limited complaints.
- Low occupancy.

4 SITE ENERGY USE

The table below illustrates energy density, costs, and usage for the sites in this portfolio. All of the usage and cost data was extracted from Energy Star Portfolio Manager and is assumed to be accurate.

Facility	Area	kBTU/SF	$/SF	Electric Usage (kWh)	Electric Costs	Gas Usage (CCF)	Gas Costs	CHW Cost	District HW Cost	Total Cost
Carvel State Building	302,250	75	$1.78	5,651,736	$506,916	33,346	$30,304			$537,220
900 King Street	71,700	57	$1.29	843,658	$81,387	11,398	$11,304			$92,691
New Castle Courthouse	570,000	105	$4.16	5,696,293	$505,195			$1,378,513	$509,873	$2,372,340
DEMA	28,700	131	$3.51	1,101,604	$100,767					$100,767
TMC	22,472	158	$4.27	1,038,725	$95,896					$95,896
William Penn	49,900	330	$8.34	4,536,373	$405,317	9,591	$10,802			$416,119
Absalom Jones Center	63,000	82	$1.49	559,923	$58,445	31,306	$35,313			$93,757
Biggs	7,940	103	$3.01	239,000	$23,900					$23,900

In order to estimate savings by measure electric consumption was allocated between six end use categories: Data Center, Data Center Cooling, Lighting, Cooling/Ventilation, Heating/Ventilation, and Plug Load. The allocation was approximated based on industry assumptions, observed conditions, and usage patterns. The table below illustrates the allocation of electricity and other energy used to estimate savings in this report

	Total Electric	Data Center	Data Center Cooling	Lighting	Cooling & Ventilation	Heating & Ventilation	Plug Load	Electric Ltg/Clg /Htg/Plug (kBTU/SF)	Gas Heating (kBTU/SF)	District HW (kBTU/SF)	District CHW (kBTU/SF)
Carvel State Building	5,651,736	-	-	1,357,949	1,564,176	1,155,003	1,574,609	64	11		
		0%	0%	24%	28%	20%	28%				
900 King Street	843,658	-	-	290,815	227,984	193,390	131,468	40	16		
		0%	0%	34%	27%	23%	16%				
New Castle Courthouse	5,696,293	-	-	2,134,080	1,356,495	1,164,382	1,041,336	34		32	39
		0%	0%	37%	24%	20%	18%				
DEMA	1,101,604	165,241	110,160	250,723	175,726	237,258	162,496	98			
		15%	10%	23%	16%	22%	15%				
TMC	1,038,725	155,809	103,873	196,315	166,762	202,962	213,005	93			
		15%	10%	19%	16%	20%	21%				
William Penn	4,536,373	2,994,006	567,047	170,681	243,830	243,830	316,979	67	20		
		66%	13%	4%	5%	5%	7%				
Absalom Jones	559,923	-	-	238,493	126,232	108,988	86,209.87	30	51		
		0%	0%	43%	23%	19%	15%				

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5 TECHNICAL FACILITY PROFILES

Carvel Building – 820 N. King Street

Built: **1977/1998**
Size (SF): **302,250**
Floors/Levels: **11**
Tenant: **State Offices**
Space Type: **Office**
Building Schedule: **M-F: 7:00am - 6:00pm/Guard 6:00am - 10:00pm**
Occupancy: **Office employees and transient civilians**

HVAC Systems

Heating: Console water source heat pumps for perimeter areas and offices, core heat pumps in air handlers. Boilers temper condenser water loop.

Boilers: 2 Bryan boilers in good condition with natural gas Gordon Piatt burners 1,167 to 3,500 MBH modulating. Circulation pumps and associated piping in poor condition from HX to condenser loop (evidence of leaking observed during audit).

Cooling: New console water source heat pumps for perimeter areas and offices, antiquated core heat pumps and air handlers. Cooling towers temper condenser water loop in good condition.

Clg. Towers: 3 Evapco cooling towers, size not determined. Renovated to like-new <5 years prior. Circulation pumps with HX to condenser loop in good condition.

Distribution: 4 condenser water pumps 60HP Aurora Pumps 1,035 GPM / 100 ft., VFD with controls.

Lighting Systems

Open Areas: 32WT8 <5 years old
Hallways: 32WT8 <5 years old
Exterior: MH Recessed Cans

Energy Management System

Type: DDC
Set points: 76F Cooling, 68F Heating
Manufacturer: Not observed, Niagara AX Software, all systems appeared to be operating well
Maintenance: Maintained by Modern Controls 2x/week

Building Envelope

Exterior: Concrete; good condition **Glazing:** Double pane, aluminum in good condition
Roof: Flat rubber membrane gravel ballast; condition not observed
Doors: Revolving doors and vestibules; condition not observed

Comments and Observations

Performance: The building appears to perform well. The facility has a current above-average Energy Star score of 74. The AMERESCO ESPC addressed the majority of issues, including T12 to T8 lighting conversion,

lighting controls in restrooms and offices, cooling tower renovation with fan VFDs, optimized controls, and new motors. Because the lighting has been recently replaced and contracted under an ESPC, LED lighting is not recommended as part of a new ESPC. Condenser water pumps were replaced/reconditioned and VFDs and controls were added. The cooling towers were renovated and equipped with variable speed fans, pumps, and a control system in the recent ESPC under AMERESCO. It was said that the existing cooling towers struggle to meet the building's cooling requirements during design days, but this evaluation was outside the scope of this study.

The State is currently evaluating a connection to the PEPCO district hot and chilled water loops, which will eliminate the need for cooling tower and boilers, and the related maintenance of each. DEDC Engineering performed a study outlining the advantages of the PEPCO tie-in and presented a cash flow analysis favoring the PEPCO connection. However, the existing equipment serving the water source heat pumps appeared to be well maintained and in good operating condition, but the equipment is approaching the end of its useful life. **The decision whether or not to upkeep, replace, or recondition the cooling towers, boilers, and pumping systems versus connection to the PEPCO district hot and chilled water loops is beyond the scope of this study. CEI recommends utilizing an ESCO under ESPC to assist in creating an independent cost and savings analysis to guide the decision.**

Facility Photos

Boilers and Pumps

Cooling Tower Pumps and HX

Rebuilt Condenser Water Pump

Cooling Tower 1 of 3

ESPC Potential Measures

PEPCO CHW/HW Loop Connection(Option 1): The decision to migrate to the PEPCO CHW/HW loop needs to be further investigated. The benefits of the district hot and chilled water connection is that the project will: 1) eliminate boiler and cooling tower maintenance, 2) eliminate replacement of boilers and cooling tower equipment at end of useful life, and 3) keep charges at a flat rate – the State will be charged a flat rate for hot and chilled water and not be charged any more for capacity than they are currently being charged at the Courthouse. Preliminary connection cost estimate provided by DEDC Engineering is $350,000, but may not include capital cost required for tie-in to the PEPCO loop itself. The table to the right shows the cost and savings analysis for the PEPCO conversion. This measure can be performed under an ESPC.

Measures	PEPCO District CHW Conversion	PEPCO District HW Conversion	PEPCO Total
Savings %	25% Cooling Energy	50% Htg. energy	8% Cost
Savings kWh	391,044		391,044
Savings CCF		16,700	5,699
Savings $	$35,074	$16,500	$40,726
Cost	$200,000	$150,000	$350,000
Payback (yrs)	5.7	9.1	6.8

In a January 19, 2016 email from Patrick Towbin, of PEPCO Energy Services, PEPCO stated, "[The Carvel Building] will pay the exact monthly payment for capacity." This is in regards to the $107,682 for cooling and $32,561 for heating. These 'capacity' charges are assumed to be part of a Capital Recovery Fee, imposed on the New Castle County Courthouse for the initial connection. Connection to the PEPCO loops would have the same rates of $0.045/ton-hr and $5.014/mmbtu as the State is paying for the Courthouse.

Alternatively:

New Condensing Boilers/Cooling Towers (Option 2): The decision to migrate to the PEPCO CHW/HW loop needs to be further investigated. CEI believes the boilers have at least a 5 year remaining useful life if well maintained. Replacing these boilers with a premium efficiency condensing boiler system will save approximately 15-20% over the existing system. Cost estimates are beyond the scope of this assessment, however DEDC suggests a replacement cost of $600,000 for the boilers. These costs and savings were used to develop the analysis table.

Measures	Condensing Boiler
Savings %	20%
Savings CCF	6,669
Savings $	$ 6,614
Cost	$ 600,000
Payback (yrs)	90.7

The cooling towers have been reconditioned and retrofitted with pump and fan VFDs and new controls under the recent ESPC. If well maintained, these CTs will have 5-10 years of useful life remaining. An engineering analysis of the existing infrastructure (specifically the existing cooling towers) will be required by the ESCO to verify infrastructure capacity. Cost estimates are beyond the scope of this assessment, however DEDC suggests a replacement cost of $650,000 for the CTs. There will be limited or no savings by replacing these CTs with equivalent or comparable units.

Replacing boilers and cooling towers may be performed under an ESPC, but it would be the responsibility of the selected ESCO to evaluate the PEPCO option with the equipment replacement option.

Core Heat Pump Replacement: The building's existing core Air Handler/Heat Pump Units temper outdoor air for the interior spaces, which were largely open office areas when originally constructed. These units are said to be a maintenance burden and have exceeded useful life. Repurposing of open office space in a 1990s renovation, enclosed a portion of the open offices, requiring additional units be added to the enclosed spaces. Replacing these units will be a capital intensive measure, but is necessary to properly condition the building and supply required outdoor air. Alternatively If the PEPCO integration is selected, the AHUs could be equipped with hydronic heating and cooling elements as opposed to water source heat pumps. An engineering study will be required by the ESCO to optimize the size, count, and layout of the new units to mimic the existing level of zone control. The table to the right shows the cost and savings estimates for the capital improvement. This measure is a costly capital improvement with limited savings, but can be appropriately implemented as a part of an ESPC.

Measure	Core HP Replacement
Savings %	2%
Savings kWh	54,384
Savings $	$4,878
Cost	$1,500,000
Payback (yrs)	Capital Outlay

Measures Evaluated but not Recommended

The lighting measure below is not recommended as it is currently a part of an ESPC under AMERESCO.

LED Retrofit and Occupancy Sensors: The lighting was converted from T12 to T8 and included new fixtures. Replacement of the T8 fixtures may be cost prohibitive, but retrofitting the existing fixtures with LED T8 tubes may offer an attractive payback well within the means of an ESPC. Lighting occupancy-based controls are limited to restrooms and some private offices. It is recommended that additional spaces be controlled to reduce run time. The table to the right shows the estimated cost and savings for both LED retrofits and occupancy sensors.

Measure	Retrofit LED Occ. Sensors
Savings %	40%
Savings kWh	543,180
Savings $	$48,719
Cost	$386,880
Payback (yrs)	7.9

900 King Street

Built: 1981
Size (SF): 71,700
Floors/Levels: 4 + Ground floor
Tenant: State Offices
Space Type: Office
Building Schedule: M-F: 7:00am - 6:00pm
Occupancy: Office employees

HVAC Systems

Heating: Console water source heat pumps for perimeter areas and offices, ceiling mounted HPs. Boiler tempers condenser water loop.

Boilers: 1 Weil McLain boiler at end of useful, under contract to be replaced. Circulation pumps in acceptable condition with HX to condenser loop.

Cooling: Console water source heat pumps are replaced upon failure. Cooling towers temper condenser water loop in good condition.

Clg. Towers: 2 Evapco cooling towers in good condition. CT fans VFD Controlled. Circulation pumps with HX to condenser loop in good condition.

Distribution: 2 Condenser water pumps 20HP Bell and Gossett pumps in excellent condition lead/lag with VFD control.

Lighting Systems

Open Areas: Mix of T12 and T8, fixtures in poor condition.
Hallways: Mix of T12 and T8, fixtures in poor condition.
Exterior: MH Recessed Cans

Energy Management System

Type: DDC
Set points: 76F Cooling, 68F Heating
Manufacturer: Not observed, Niagara AX Software, all systems appeared to be operating well
Maintenance: Maintained by Modern Controls 1x/week

Building Envelope

Exterior: Concrete; good condition **Glazing:** Double pane, aluminum in fair/poor condition
Roof: Flat rubber membrane gravel ballast; condition not observed
Doors: Vestibules; good weather stripping

Comments and Observations

Performance: The building appears to perform well and has the lowest energy usage per area of all the buildings in this assessment. This may be due to low utilization (fewer occupants), tighter control, or other reasons outside the scope of this investigation. The building requires continuous replacement of older heat pumps. Several console heat pumps were observed in the maintenance storage area to soon be installed. Ceiling heat pumps are said to be replaced less frequently and most have exceeded useful life. Lighting appeared to be a mix of T12 and T8, and is only upgraded to T8 once the older equipment has failed. The 4th floor was under renovation during the time of the visit and new LED panels were being installed in the

hallway. The boiler has exceeded useful life and will need a replacement, a new boiler has been approved to be installed. This site may be a candidate for district chilled and hot water through PEPCO, the selected ESCO shall evaluate costs and savings for such project.

Facility Photos

Boiler

New CW Pump (red) Boiler Pump (Blue)

T12/T8 Lamps in Fixture

4th Floor

ESPC Potential Measures

Heat Pump Replacements/Upgrades: The building's heat pumps are said to be a maintenance burden and many have exceeded useful life. Replacing these units will be a capital intensive measure, but selecting high performance units will increase overall system efficiency. The table to the right shows the cost and savings analysis for the capital improvement. This measure can be performed as a part of an ESPC.

Measure	Core HP Replacement
Savings %	5%
Savings kWh	204,789
Savings $	$19,756
Cost	$250,000
Payback (yrs)	12.7

New LED Fixtures and Occupancy Sensors: Some fixtures appeared to have been retrofitted with T8 lamps, but some had T12 and magnetic ballasts. The lighting fixtures are in poor condition with broken diffusers and lenses noted in many cases. Replacing the existing fixtures with new LED fixtures would be the best solution as it appears the facility is undergoing a minor renovation floor by floor. Lighting occupancy-based controls are limited to restrooms and some private offices. It is recommended that additional spaces be controlled to reduce run time. The table to the right shows the estimated cost and savings for both LED retrofits and occupancy sensors.

Measure	New LED Fixtures Occ Sensors
Savings %	45%
Savings kWh	130,867
Savings $	$12,625
Cost	$185,000
Payback (yrs)	14.7

Measures Evaluated but not Recommended

Boiler Replacement: The existing boiler has exceeded its useful life and needs to be replaced. There is no redundancy with this boiler system. A condensing-type boiler replacement is recommended. Having multiple condensing units in a cascading arrangement will allow for redundancy without a backup boiler; however, this claim must be determined by the installing party. This boiler project could be candidate for an ESPC. The table to the right shows the cost and savings estimates for this measure.

Measure	Boiler Replacement
Savings %	20%
Savings CCF	2,280
Savings $	$2,261
Cost	$75,000
Payback (yrs)	33.2

New Castle County Courthouse – 500 N. King St.

Built: **2002**
Size (SF): **570,000**
Floors/Levels: **11**
Tenant: **State Courthouse**
Space Type: **Offices and Court**
Building Schedule: **M-F: 7:00am - 6:00pm**
Occupancy: **State employees and transient civilians**

HVAC Systems

Heating: PEPCO District Hot Water
Cooling: PEPCO District Chilled Water
Distribution: 37 AHUs, VAV

Lighting Systems

Open Areas: T8 and pin-based CFL recessed fixtures; excellent condition.
Hallways: T8 soffit, T8 troffer lighting and pin-base recessed fixtures
Exterior: HID Pole lighting, parking garage lighting not observed

Energy Management System

Type: DDC
Set points: 76F Cooling, 68F Heating
Court Room Stpt: 70F Cooling
Note: Controllers said to be recently upgraded with no Cx.

Building Envelope

Exterior: Metal panel and brick facade; excellent condition
Glazing: Double pane, aluminum in excellent condition
Roof: Flat rubber membrane; condition not observed
Doors: Vestibules; tight weather stripping

Comments and Observations

Performance: The courthouse is in excellent physical condition; most of the mechanical equipment appeared to be well-maintained and in great condition. The courthouse energy costs are two to three times more per square foot compared to the other office/civil use buildings in this portfolio. The higher utility costs appears to be due to the monthly capacity and usage charges for the district hot and chilled water.

The facility Engineer brought forth many control issues, inefficiencies, and common mechanical issues that can be addressed through retro-commissioning and equipment replacement/modification in an ESPC. Some examples include: continuous maintenance of fluorescent lighting fixtures due to the long runtimes, occupancy sensor complaints (perhaps not commissioned correctly or poor application), complaints of being

too bright in places, post-construction ad hoc outdoor air economizer, outdated BMS with limited capabilities, undersized district chilled water heat exchanger, and air balancing issues. There may be opportunities for daylight harvesting for hallway lighting adjacent to the glass curtain walls.

Facility Photos

Trane AHU

Distribution Pump Motor VFDs

Mech. Rm. On-Board

ESPC Potential Measures

HVAC Retro-commissioning & Equipment Upgrades: The majority of the equipment is in good condition; however, the building has experienced significant control issues (or lack of control) since original construction based on building design. Retrocommissioning (RCx) of the courthouse HVAC systems may have the highest returns due to the high cost of district hot and chilled water. If performed correctly, RCx may even reduce chilled water demand, which would solve the alleged capacity issue and perhaps lower capacity charges. Some equipment may need upgrades to facilitate RCx efforts, and some costs are included in the analysis. The table to the right shows the cost and savings estimate for this measure. This measure would be an excellent candidate for an ESPC.

Measure	HVAC RCx & Equipment Upgrades
Savings %	10% Energy
Savings kWh	252,088
Savings CHW (kBTU)	2,230,806
Savings HW (kBTU)	1,812,059
Savings $	$211,196
Cost	$500,000
Payback (yrs)	2.4

New LED Fixtures and Occupancy Sensors: The majority of the lighting fixtures are in great condition and could be retrofitted with LEDs, which would be less costly than a replacement. The glass curtain walls allow for significant sunlight penetration into the adjacent hallways which is a good candidate for daylight harvesting. Daylight harvesting generally has a longer payback than other lighting control strategies, but the light levels observed in some hallways may be great for a simple, lower cost ON/OFF strategy. Lighting occupancy-based controls is said to be a nuisance is some spaces, which may be due to poor initial application or improper initial commissioning. Recommissioning or relocating the existing controls and expanding the use of occupancy sensors can be supported by an ESPC. The table to the right shows the estimated cost and savings for both LED retrofits and occupancy sensors.

Measures	New LED Fixtures Occ Sensors
Savings %	40%
Savings kWh	853,632
Savings $	$75,707
Cost	$770,000
Payback (yrs)	10.2

DEMA/TMC Facility

Built: **DEMA 1998; TMC 2003**
Size (SF): **28,700/22,472**
Floors/Levels: **2**
Tenant: **State Offices**
Space Type: **Office**
Building Schedule: **M-F: 6:00am - 6:00pm; areas 24/7**
Occupancy: **Office employees**

HVAC Systems

Heating: Ceiling mounted heat pumps
Boilers: 2 Precision Parts Corp electric boilers 460 MBH lead/lag
Cooling: Ceiling mounted heat pumps
Clg. Towers: 2 Evapco cooling towers in poor condition for DEMA no fan drives; 1 Evapco CT for TMC no fan drives. Circulation pumps with HX to condenser loop in good condition.
Distribution: 2 Condenser water pumps observed through BMS for both DEMA and TMC CW loops

Lighting Systems

Open Areas: T8, fixtures in good condition
Hallways: Recessed cans CFL
Exterior: MH Pole 175W/250W

Energy Management System

Type: DDC
Set points: 76F Cooling, 68F Heating
Manufacturer: Not Observed, Niagara AX Software, upgrades 12mo prior
Maintenance: Maintained by JCI Controls 1x/week

Building Envelope

Exterior: Concrete; excellent condition **Glazing:** Double pane, aluminum in excellent condition
Roof: Flat white rubber EPDM membrane; condition not observed
Doors: Good weather stripping

Comments and Observations

Performance: This building serves as the main offices for the DE Emergency Management Agency and the Transportation Management Center. The DEMA side has a 24/7 staffed emergency dispatch office area and serves as the Emergency Operations Center during natural disasters. There is a training center in the DEMA side that has variable occupancy and tends to overheat. DEMA has a small server room. The TMC side has standard offices and a large server room.

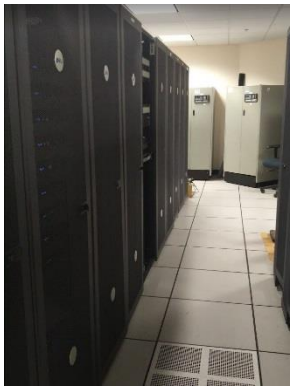
This combined facility has a higher energy use density (kBTU/ft^2) than other office buildings in the portfolio. The excessive usage is likely due to 24/7 operation, electric boilers, aging cooling towers without drives, outdoor air control issues, and data centers.

For the purpose of this pre-qualification, DEMA and TMC are treated as one building as they share the same footprint, mechanical room, outdoor equipment, and controls.

Facility Photos

Electric Boiler 1 of 2

Aging Cooling Towers



Server Room

De-lamped 2x2 T8 Fixture

ESPC Potential Measures

Boiler Replacement: The existing boilers are electric and, while more efficient than a fossil fuel boiler, are significantly more expensive to run and operate. There does not appear to be access to natural gas in the area, but natural gas would be the recommended fuel of choice. Replacement of the electric boilers with a high efficiency, propane-fired condensing boiler may reduce operating costs by 15% due to the fuel switch. However, since the facility uses oil for the emergency generators (oil tanks were not observed during the site visit, and are assumed to exist), a switch to oil-fired boilers may save as much as 25%. Utilizing the existing tanks will save on material and labor as the existing oil tanks may be utilized compared to propane. A condensing-type boiler replacement is recommended, but is not generally available for oil-fired units. This study assumed $2.00/gal propane, $2.00/gal oil, and $0.10/kWh; more precise calculations would be necessary. Costs are estimated for material through RS Means; labor costs can vary significantly. This boiler project could be candidate for an ESPC. The included table shows the cost and savings estimates for this measure.

Measure	Boiler/Fuel Switch (Propane/Oil)
Savings %	15%/30%
Savings $	$6,000/$12,000
Cost	$80,000/$70,000
Payback (yrs.)	13.3/5.8

Data Center and Cooling Optimization: Servers and associated cooling equipment can contribute to a large energy draw at the facility. CEI normalized electric usage to similar offices within the portfolio and found that the servers can be contributing up to 25% of the site energy use (both DEMA and TMC).

	Measures	Data Center Process Optimization	Data Center Cooling Optimization
DEMA	Savings %	5%	5%
	Savings kWh	8,262	5,508
	Savings $	$756	$504
	Cost	$1,000	$1,000
	Payback (yrs)	1.3	2.0
	Measures	Data Center Process Optimization	Data Center Cooling Optimization
TMC	Savings %	5%	5%
	Savings kWh	7,790	5,194
	Savings $	$719	$479
	Cost	$1,000	$1,000
	Payback (yrs)	1.4	2.1

The Department of Energy lists 12 opportunities, adjustments, and strategies that can significantly reduce energy and perhaps improve performance. These include:

IT Opportunities:

1. Server Virtualization
2. Decommissioning of Unused Servers
3. Consolidation of Lightly Utilized Servers
4. Better Management of Data Storage
5. Purchasing More Energy-Efficient Servers, UPSs, and PDUs

Airflow Management Strategies:

6. Hot Aisle/Cold Aisle Layout
7. Containment/Enclosures
8. Variable Speed Fan Drives
9. Properly Deployed Airflow Management Devices

HVAC Adjustments:

10. Server Inlet Temperature and Humidity Adjustments
11. Air-Side Economizer
12. Water-Side Economizer

Many of these measures can be implemented by existing staff or as part of an ESPC. An estimate of 5% savings for server energy and cooling energy is assumed for this study. Costs for implementing any optimization strategy can vary significantly, from no/low cost (temp. adjustments) to capital investments (new more efficient servers). The included table shows the cost and savings estimates for this measure implementing low cost strategies.

Retrofit LED and Occupancy Sensors: The fixtures appear to be in great condition overall. Some areas were de-lamped to reduce light output and some areas were switched off. The majority of the hallway and open office area lighting are on switches and seldom turned OFF. Exterior fixtures were noted to be HID poles and wall packs are said to be on photocells or time clocks. These fixtures should be replaced with new LEDs with similar distribution and light output.

	Measure	Retrofit LED
DEMA	Savings %	25%
	Savings kWh	62,681
	Savings $	$5,734
	Cost	$40,000
	Payback (yrs)	7.0
	Measure	Retrofit LED
TMC	Savings %	25%
	Savings kWh	49,079
	Savings $	$4,531
	Cost	$36,000
	Payback (yrs)	7.9

Occupancy sensors should also be evaluated as part of an ESPC. If installed and commissioned correctly, they will reduce runtime by as much as 20% in active spaces and even more in limited occupancy areas.

The included table shows the estimated cost and savings for new exterior LED fixtures, LED retrofits, and occupancy sensors.

Cooling Tower Replacements and Recommissioning: The existing cooling towers (CTs) are approaching end of useful life and do not have fan drives. Retrofitting these aging units with drives and controls is not recommended. However as part of an ESPC, the capital intensive CT replacement coupled with savings from drives and controls will be a great opportunity. There is no redundancy for the TMC CT, unifying the system to serve both DEMA and TMC may reduce operational and replacement costs.

DEMA	Measures	CT Replacement/Drive Fresh Air upgrades/RCx
	Savings %	33%
	Savings kWh	57,990
	Savings $	$5,304
	Cost	$47,500
	Payback (yrs.)	9.0
TMC	Measures	CT Replacement/Drive Fresh Air upgrades/RCx
	Savings %	33%
	Savings kWh	55,031
	Savings $	$5,081
	Cost	$95,000
	Payback (yrs.)	18.7

The facility manager expressed issues with the fresh air (FA) unit for DEMA. CEI reviewed of the FA control strategies for both DEMA and TMC, and determined there may be a control failure or maintenance needed as the DEMA FA outdoor air damper was open, but the cooling was commanded OFF and the supply fan was commanded to 100%. Conversely the TMC FA unit had an open outdoor air damper, but both stages cooling were enabled, reheat was commanded to 40%, and the supply fan was at 55% speed. DEMA discharge air temp was 76°F and 51% RH (no cooling or reheat), while the TMC discharge temp was 70°F and 65% RH (reheating to these conditions is questionable). Recommissioning the controls can lead to significant savings as the building is 100% electric.

The included table shows the estimated cost and savings for replacing the cooling towers and recommissioning the building control systems. Cost was estimated through RS Means for the cooling towers, but recommissioning costs are more variable.

Ground-Source Heat Pump: As an alternate to replacing the cooling towers and boilers, a ground-source heat pump (GSHP) should be considered. The study can be performed during the assessment phase of a performance contract to determine feasibility. A GSHP can reduce the sizes or eliminate the need of cooling towers and boilers depending on the quantity and depth of the geothermal heat exchanger wells. This can even reduce maintenance and free up floor space (by complete removal of the boilers). Estimating savings for this measure is outside the scope of this study but it should be an option for the ESCO.

Solar Photovoltaic (PV): Solar is a great opportunity to reduce a portion of onsite electric use and may be feasible to supplement the emergency generators for site resiliency. There may be opportunity for ground-mounted or covered parking PV arrays; however, the large, open roof may be the most cost effective option. CEI estimated that the roof is suitable for approximately 250 kW DC or more, depending on panel output. This size system in central DE can offset electric usage by over 300,000 kWh annually. Solar generally offsets electric supply costs, but there can be some demand savings if peak demand is coincident with peak solar production. For this study, CEI estimated the offset electric rate to be $0.07/kWh, which is about 30% lower than the average blended rate for both buildings. Current market conditions support approximately $3.00/Watt for this size system installed; CEI used this figure for the estimation.

DEMA	Measure	Solar
	Savings kWh	151,618
	Savings $	$10,613
	Cost	$386,197
	Payback (yrs.)	36.4
TMC	Measure	Solar
	Savings kWh	151,618
	Savings $	$10,613
	Cost	$386,197
	Payback (yrs)	36.4

The included table shows the estimated cost and savings for solar PV. While the payback may be prohibitive under an ESPC, the opportunity still should be investigated in further detail as there are many different options for financing, power purchase agreements, or leasing that may improve cash flow.

William Penn

Built: 1982
Size (SF): 49,900
Floors/Levels: 2
Tenant: Department of Information and Technology
Space Type: Office/Data Center
Building Schedule: M-F: 7:00am - 6:00pm; Telecommute Policy
Occupancy: Office employees

HVAC Systems

Heating: Heat pumps and rooftop air handlers.
Boilers: 2 Burnham Boilers; good condition. Power Flame modulating natural gas burners 600 - 1000 MBH.
Cooling: Heat pumps and rooftop air handlers; 155 Ton Trane air cooled chiller.
Clg. Towers: 2 cooling towers in end of life condition serve CRAC units and heat pumps.
Distribution: 2 Trane rooftop AHUs no name plates, poor condition.

Lighting Systems

Open Areas: T8, fixtures in good condition.
Hallways: T8, fixtures in good condition
Exterior: MH pole lights for parking area

Energy Management System

Type: DDC
Set points: 76F Cooling, 68F Heating
Manufacturer: Not observed, Niagara AX Software, upgrades 2 weeks prior
Maintenance: Maintained by JCI Controls 1x/week

Building Envelope

Exterior: Brick; excellent condition **Glazing:** Not observed
Roof: Flat membrane gravel ballast; condition good
Doors: Single vestibule entrance good condition

Comments and Observations

Performance: This building serves as the main data center for the State. It hosts over 7,700 ft^2 of server room floor space or 15% of the building. This building has the largest energy density of all facilities in this portfolio, namely due to the server loads and server cooling loads.

The facility has approximately 255 employees, but there is a telecommute policy in effect. Many of the office spaces observed in the walk-through were vacant, but only a portion of the lighting was turned OFF.

The facility Engineer express that he is having difficulty controlling the facility after the recent BMS upgrades. It was mentioned that the controls were not properly commissioned and that limited permissions do not allow for quick adjustments or troubleshooting.

Facility Photos


Boilers


Cooling Towers


Entry Area LED Retrofits


Trane Rooftop AHUs

ESPC Potential Measures

Boiler Replacement: The existing boilers appeared to be in good condition, and may have at least 10 years of useful life if continued to be well-maintained. A condensing-type boiler replacement may be recommended as part of an ESPC to take advantage of increased efficiency and slightly improve reliability. Having multiple condensing units in a cascading arrangement will allow for redundancy without a secondary backup boiler; however, this claim must be determined by the installing party. This boiler project could be candidate for an ESPC, but should be treated as a capital improvement as the payback is longer than the expected useful life. The included table shows the cost and savings estimates for this measure.

Measure	Boiler/Fuel Switch (Propane/Oil)
Savings %	15%
Savings CCF	1,439
Savings $	$1,620
Cost	$60,000
Payback (yrs.)	37.0

Data Center and Cooling Optimization: Servers and associated cooling equipment can contribute to a large energy draw at the facility. CEI normalized electric usage to similar offices within the portfolio and found that the servers can be contributing up to 66% of the site energy use.

Measures	Data Center Process Optimization	Data Center Cooling Optimization
Savings %	5%	5%
Savings kWh	149,700	28,352
Savings $	$13,375	$2,533
Cost	$1,000	$1,000
Payback (yrs)	0.1	0.4

The Department of Energy lists 12 opportunities, adjustments, and strategies that can significantly reduce energy and perhaps improve performance. These include:

IT Opportunities:

1. Server Virtualization
2. Decommissioning of Unused Servers
3. Consolidation of Lightly Utilized Servers
4. Better Management of Data Storage
5. Purchasing More Energy-Efficient Servers, UPSs, and PDUs

Airflow Management Strategies:

6. Hot Aisle/Cold Aisle Layout
7. Containment/Enclosures

8. Variable Speed Fan Drives
9. Properly Deployed Airflow Management Devices

HVAC Adjustments:

10. Server Inlet Temperature and Humidity Adjustments
11. Air-Side Economizer
12. Water-Side Economizer

Many of these measures can be implemented by existing staff or as part of an ESPC. An estimate of 5% savings for server energy and cooling energy is assumed for this study. Costs for implementing any optimization strategy can vary significantly, from no/low cost (temp. adjustments) to capital investments (new more efficient servers). The included table shows the cost and savings estimates for this measure implementing low cost strategies.

Retrofit LED and Occupancy Sensors: The fixtures appear to be in overall good condition. Some areas were switched OFF while occupied to reduce ambient lighting. Occupancy sensors were observed in some spaces; it was observed that some offices had poor sensor placement as the lights would turn on by people passing by in the hallway. Exterior fixtures were noted to be HID poles and wall packs; it was assumed that the exterior fixtures are on photocell or time clocks. Exterior fixtures should be replaced with new LEDs with similar distribution and light output.

Measure	Retrofit LED Occupancy Sensors
Savings %	40%
Savings kWh	68,272
Savings $	$6,100
Cost	$67,000
Payback (yrs)	11.0

Occupancy sensors should be evaluated as part of an ESPC. If installed and commissioned correctly they will reduce runtime by as much as 20% in active spaces and even more in limited occupancy areas. For the spaces with false occupancy issues, recommissioning the sensors or moving them is recommended.

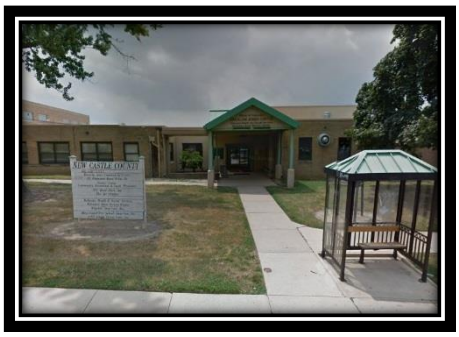
The included table shows the estimated cost and savings for new exterior LED fixtures, LED retrofits, and occupancy sensors.

Cooling Tower/AHU Replacement and Controls Cx: The existing cooling towers (CTs) are approaching end of useful life and drives were not observed. Retrofitting these aging units with drives and upgrading controls is not recommended. The AHUs appear to be reaching end of useful life, but are well maintained. As part of an ESPC, the capital intensive CT and AHU replacement coupled with savings from new drives and controls will be a great opportunity.

Measures	CT Replacement AHU Replacement CT Drives/RCx
Savings %	10%
Savings kWh	404,871
Savings $	$36,175
Cost	$332,500
Payback (yrs.)	9.2

RS Means was used to estimate costs for the 2 CT and 4 AHU replacements; commissioning and additional control points were estimated and can vary significantly. The included table shows the project performance for this set of measures and is recommended as part of an ESPC.

Absalom Jones Center



Built: 1950
Size (SF): 63,000
Floors/Levels: 2
Tenant: Dept. Health & Social Services, Senior Center, Community Center
Space Type: Community Center
Building Schedule: M-F: 9:00am - 2:00pm; Extended use senior center
Occupancy: Civil use

HVAC Systems

Heating: Heat pumps/Hydronic Loop.
Boilers: 2 new Harsco 200 MBH boilers, under construction during site visit. No perimeter heat zoning.
Cooling: Heat pumps, new RTUs being installed for art and senior center wings.
Clg. Towers: 2 CTs, one is new and under construction during site visit.
Distribution: Pumps on VFDs.

Lighting Systems

Open Areas: T8 some T12, fixtures in poor condition. DHSS wing has newer fixtures
Hallways: T8, fixtures in poor condition
Exterior: LED wall packs and poles

Energy Management System

Type: DDC
Set points: 76F Cooling, 68F Heating; 72F for Senior Center
Manufacturer: Not Observed, Niagara AX Software, upgrades 2 weeks prior
Maintenance: Maintained by Radius Controls

Building Envelope

Exterior: Brick; excellent condition **Glazing:** Poor condtion
Roof: Flat membrane gravel ballast; condition good
Doors: Single vestibule entrance good condition

Comments and Observations

Performance: This facility serves mainly as a community center. It has an art center, senior center, early childhood education services, and offices for the Department of Health and Social Services. This building appears to have a higher energy density than expected compared to the low occupancy rates; this may be due to the old equipment, very poor weatherization, and control limitations. The windows have broken seals and some must be screwed shut for safety. The DHSS side was said to overheat during the winter due to lack of zone control of perimeter heating. The piping arrangement was not investigated as part of this study, but an ESPC may provide the opportunity to address this issue.

Many mechanical upgrades are under construction including new boilers, RTUs, domestic water heater, pumps and drives, buts there remains a significant number of opportunities for an ESPC. Energy costs moving forward are expected to slightly reduce with the new equipment.

ESPC Potential Measures

Heat Pump Upgrades: Each classroom area has 1 or 2 heat pumps controlled by thermostat. Occupants have the ability to adjust the temperature by ±2°F. There are approximately ten heat pumps that remain and are 30 years old. Replacing older and failing heat pumps with high efficiency units will slightly improve building efficiency. Upgrading or adding additional controls to the spaces (CO_2 ventilation) will optimize outdoor air and further improve efficiency.

Measure	HP Upgrades
Savings %	5%
Savings kWh	11,761
Savings $	$1,228
Cost	$25,000
Payback (yrs.)	20.4

The included table shows the estimated cost and savings this measure. These units and controls can be incorporated as part of an ESPC.

Gym Ventilators: The existing ventilators for the gym have failed and are no longer operational. These units originally had hydronic heating coils that had been decommissioned. Heating is currently provided by the perimeter radiation, which is the secondary heating source. Although the gym is seldom used, ventilation is required to maintain air quality when occupied. It is recommended that these units be replaced with like units, or removed completely and a dedicated gas-fired RTU installed. A demand control ventilation control strategy based on CO_2 levels will conserve energy during periods of low occupancy. Replacement of this equipment will be capital intensive with limited or no savings. Costs are estimated to be approximately $50,000 using RS Means for a demoing of the existing units, new gas-fired RTU, and gas piping. Costs may vary significantly depending on complexity of bringing gas to the unit, abatement, and any structural upgrades. This can be incorporated as part of an ESPC.

New and Retrofit LED and Occupancy Sensors: The fixtures appear to be in poor condition. Many of the T12 lighting have been replaced with T8 lamps and electronic ballasts; however, as part of a building-wide renovation, new fixtures are recommended. Occupancy sensors were observed in some spaces, but lights remained ON. Additional occupancy sensors are recommended in areas not currently controlled. There may be opportunities for daylight harvesting for hallway lighting adjacent to the windows in the hallways in the DHSS wing and in areas with sky lighting.

Measure	New and Retrofit LED Daylighting Controls
Savings %	40%
Savings kWh	95,397
Savings $	$9,958
Cost	$145,000
Payback (yrs)	14.6

Exterior fixtures have been recently upgraded to LED, but some remained ON during the day due to failed or improperly placed photocells. New time clocks or photocells should be installed to ensure dusk to dawn operation.

The included table shows the estimated cost and savings for new LED fixtures, some occupancy sensors, and daylighting controls. This lighting upgrade has a lengthy payback due to the cost of new fixtures and low cost of electricity, but can be included as part of an ESPC.

New Windows: The existing windows are in very poor condition; replacement of these windows will reduce heat loss and solar gain, increase safety, and improve security. The included table shows estimated costs and savings; however, it should be noted that these are rough estimates, as there are many variables involved in this type of upgrade. This measure is recommended as part of a multi-facility ESPC.

Measures	New Windows
Savings %	15%
Savings (htg/clg) $	$13,436
Cost	$201,000
Payback (yrs.)	14.9

Biggs at Herman Holloway

Built: **Ca. 1980**
Size (SF): **63,000**
Floors/Levels: **1**
Tenant: **Department of Information and Technology**
Space Type: **Data Center and Offices**
Building Schedule: **M-F: 8:00am - 6:00pm; Extended use senior center**
Occupancy: **Office employees**

HVAC Systems

Heating: Not reviewed, building maintained by 3rd party.
Boilers: Not reviewed, building maintained by 3rd party.
Cooling: Data center is cooled by 4 Liebert CRAC, DX split on roof.

Lighting Systems

Open Areas: T8 Lighting in good condition.

Energy Management System

Type: Not reviewed.

Building Envelope

Exterior: Not observed **Glazing:** Not observed
Roof: Flat membrane gravel ballast; condition not observed
Doors: Vestibule, poor weather stripping

Comments and Observations

Performance: This facility hosts several servers for the Department of Information and Technology. The space is not submetered, rather is billed $23,900 based on occupied area and other variables. This cost appears to be a good value for the amount of energy used; however, without submetering no quantitative conclusion can be made. It is not clear if any energy improvements will reduce annual billing.

ESPC Potential Measures

Data Center and Cooling Optimization: Servers and associated cooling equipment can contribute to a large energy draw at the facility. CEI normalized electric usage to similar offices within the portfolio and found that the servers can be contributing up to 66% of the site energy use.

Measures	Data Center Process Optimization	Data Center Cooling Optimization
Savings %	5%	5%
Savings kWh	11,950	11,950
Savings $	$1,195	$1,195
Cost	$1,000	$1,000
Payback (yrs)	0.8	0.8

The Department of Energy lists 12 opportunities, adjustments, and strategies that can significantly reduce energy and perhaps improve performance. These include:
IT Opportunities:

1. Server Virtualization
2. Decommissioning of Unused Servers
3. Consolidation of Lightly Utilized Servers
4. Better Management of Data Storage
5. Purchasing More Energy-Efficient Servers, UPSs, and PDUs

Airflow Management Strategies:

6. Hot Aisle/Cold Aisle Layout
7. Containment/Enclosures
8. Variable Speed Fan Drives
9. Properly Deployed Airflow Management Devices

HVAC Adjustments:

10. Server Inlet Temperature and Humidity Adjustments
11. Air-Side Economizer
12. Water-Side Economizer

Many of these measures can be implemented by existing staff or as part of an ESPC. An estimate of 5% savings for server energy and cooling energy is assumed for this study. Costs for implementing any optimization strategy can vary significantly, from no/low cost (temp. adjustments) to capital investments (new more efficient servers). The included table shows the cost and savings estimates for this measure implementing low cost strategies.

Computer Room Air Conditioning Replacements: Three of the existing CRAC units are approaching end of life and are said to be unreliable. One unit was recently replaced with a 40T unit, which is said to take most of the load. The server room is conditioned to 70°F and 37% RH. Replacing these units will be capital intensive, but can be handled under a multi-building ESPC. Limited savings are expected for a replacement as the new, more efficient unit is handling most of the load currently.