Attachment D
Proposal Scopes and Previous Energy Related Studies

RFP proposals shall be based upon the scopes for Juanita Kidd Stout Center for Criminal Justice (SCCJ), Municipal Services Building (MSB), and Health Center 5.

The measures delineated below shall all be evaluated and addressed as part of any RFP response, however, additional measures may be proposed as alternatives or supplements to the listed measures. Proposers shall base evaluations on technical profiles included in Attachment C along with the site walkthrough(s) and onsite investigations undertaken as part of this RFP response to evaluate the three building scopes. For further reference, previous studies on increasing efficiency of the chiller plant located in SCCJ and feasibility of rooftop PV solar installation at Health Center 5 are provided as part of this Attachment.

Proposers will only be evaluated based upon proposals for these buildings.

Juanita Kidd Stout Center for Criminal Justice – Chiller Plant Optimization

- Replace cooling tower fan motors, install variable frequency drives (VFDs) on cooling tower fans and remaining condenser water pumps, and implement a fixed-approach condenser water temperature reset control sequence.
- Install VFDs on remaining primary chilled water pumps and implement a variable-speed primary pump control sequence.
- Implement air-side economizer on all applicable air-side systems to minimize cool-weather demand for chilled water.
- Install a water-side economizer to meet remaining cool-weather demand for chilled water.
- Replace Alerton control system with Tridium Niagara to facilitate management of guaranteed savings measures and integration with the City's central Tridium Niagara supervisor and monitoring program.

Municipal Services Building – Equipment and Controls Upgrades

- Install VFDs on the active chilled water pumps located in the MSB basement mechanical room and implement speed control coordinated with the chilled water pumps located in SCCJ.
- Replace perimeter induction terminal units with fan-coil units or replace in-kind; integrate units into the existing DDC building automation system.
- Implement air-side economizer on all applicable air-side systems to minimize cool-weather demand for chilled water.
- Upgrade lighting and lighting controls; integrate into the existing building automation system.

Health Center 5 – Whole-Building Energy Performance

- Upgrade lighting and lighting controls; integrate into the existing building automation system.
- Integrate facilities systems into existing building automation system and implement high-efficiency operations sequences.
- Replace multi-zone AHU and chiller with VRF, or reconfigure multi-zone

AHU into a VAV system and replace chiller.

- Replace boiler with high efficiency condensing boiler.
- Implement building envelope improvements.
- Install on-site photovoltaic solar energy generation and energy storage.
- Install a microgrid connected to on-site photovoltaic solar energy and energy storage.

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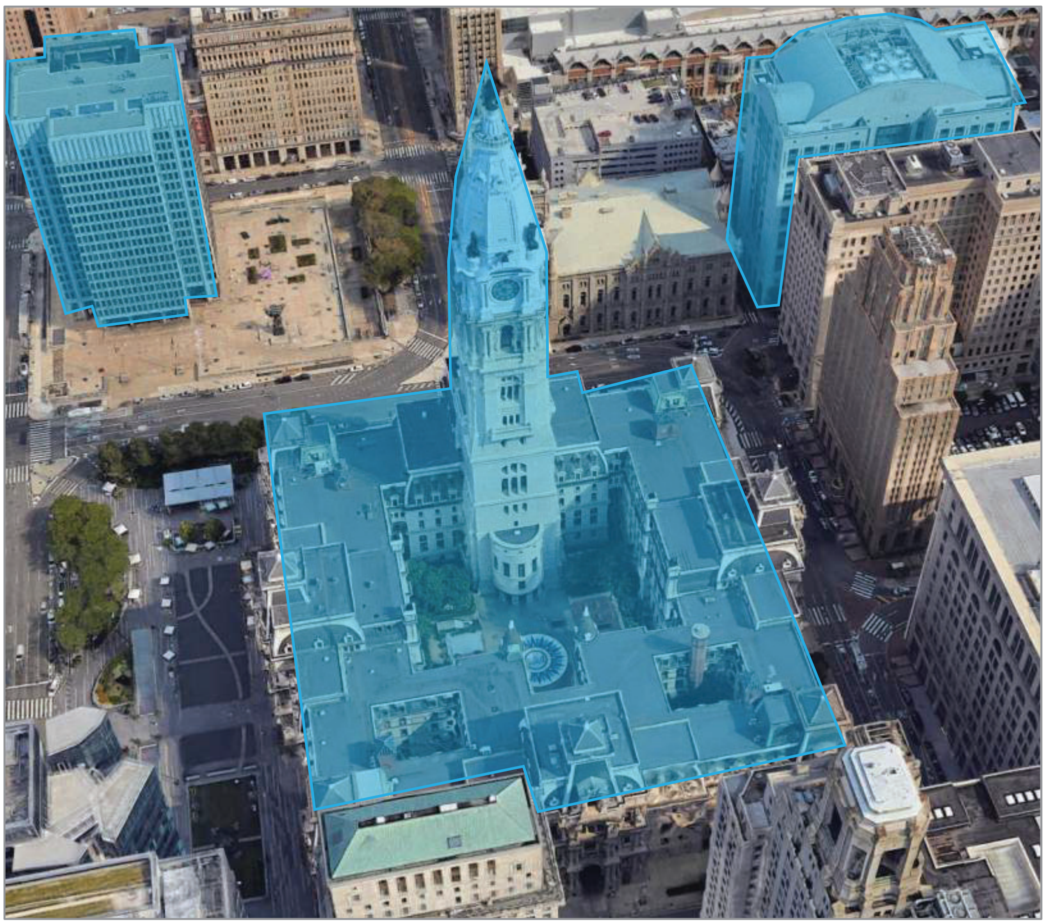
PROGRESS REPORT

City of Philadelphia – Office of Sustainability
Center for Criminal Justice Chiller Plant Optimization Project



SSM File: 110237.0013

First Update: September 9, 2022
Last Updated: October 24, 2023

ENGINEERING | SURVEYING | ENVIRONMENTAL SERVICES

TABLE OF CONTENTS

INTRODUCTION

Practical Energy Solutions (PES) was tasked with surveying the chilled water system serving the Center for Criminal Justice (CCJ), Municipal Services Building (MSB), and City Hall in Philadelphia. The purposes of the survey were to generate a comprehensive diagram of the plant and distribution piping, identify causes of poor plant performance and thermal discomfort in MSB and City Hall, and evaluate options for solving these issues.

The survey identified two general issues that are causing poor plant performance and thermal discomfort in the three buildings. It is PES's observation that both of the issues described below can be solved using the existing plant equipment and controls, with mostly minor modifications to distribution piping and control sequences.

1. The MSB and City Hall piping systems contain numerous bypasses and three-way valves. The large volume of bypassed water requires a continuously high flow rate and pumping power regardless of cooling demand. It also results in significant mixing between the supply and return water, elevating the supply temperature and decreasing the system's cooling capacity, a condition often referred to as "low delta-T syndrome."
2. The chiller plant control sequences and pump controls require modernization, with the plant often operating under fixed setpoint controls which tend to cause the chillers to operate poorly and generate high head pressure at low loads. When combined with "low delta-T syndrome," a potentially damaging low-end surge develops in the compressors. A water-side economizer is also needed to alleviate the majority of winter cooling demands.

This report serves as a working document for the continuing progress of the Energy Office's Center for Criminal Justice Chiller Plant Optimization Project, including an evolving scope of work, phasing approach, and progress log.

OVERVIEW OF EXISTING SYSTEMS

Center for Criminal Justice (CCJ)

The Center for Criminal Justice is approximately 500,000 ft2 and comprises 14 floors, a basement, sub-basement, and mechanical penthouse. The building is steel-framed with an EIFS exterior and opened in 1995.

The chiller plant located in the penthouse of CCJ serves CCJ, MSB, and City Hall. The plant contains two 1500-ton Trane water-cooled centrifugal VFD chillers, each with two compressors. The condenser system includes two cooling towers (four cells total) and six condenser water pumps.

The chilled water (CHW) loop has a primary/secondary pumping system; six primary pumps (two with VFDs) connect to the 24" CHW return header, and two sets of variable-speed secondary pumps serve CCJ (14" lines) and MSB/City Hall (18" lines). The 18" lines run to the basement of the hotel across the street from CCJ (formerly the City Hall Annex), where they split into 14" lines to serve City Hall and 12" lines to serve MSB. These lines proceed through underground tunnels to their respective buildings.

City Hall

City Hall was constructed in 1907 of steel and masonry and totals approximately 630,000 ft2 comprising eight floors and a basement. Chilled water piping has been extended in a piecemeal fashion through this building, and many areas still have DX window units or no cooling equipment. The original chillers were abandoned when City Hall was connected to the CCJ plant in 2001.

The 14" CHW lines enter City Hall in the northeast corner of the basement and proceed upwards. Branch lines connect in the basement to serve air handlers in Room 111 and the Mayor's offices. On the first floor, a line connects the Fire Command air handlers. Floors two, three, four, and five have capped branch lines for future use. A branch on floor six serves a group of fan coil units. On floor seven, the risers turn and run to the southeast corner, then turn down and run to the basement boiler room. A differential pressure transmitter is located at the top of the risers on the seventh floor. Branch lines on floor seven serve fan coil units and air handlers throughout that floor, as well as air handlers on the mezzanine and in rooms 826, 800, 600, 300, 343, and 138. These branches also connect to abandoned chillers in rooms 900 and 954. Finally, branch lines in the boiler room and basement corridors serve fan coil units in room 153 and air handlers in rooms B54, 154, and 167. Almost all terminal units have a three-way valve which allows water to bypass the coil when there is no demand for cooling.

Each set of branch lines forms a tertiary loop serving terminal units and typically has a small constant-speed pump as well as a bypass between the supply and return branches, referred to in the drawings as an "underslung" system. Several of these have manual valves in the bypass that can simply be closed, but many do not and should either have a valve installed or be permanently cut and capped.

Municipal Services Building (MSB)

The Municipal Services Building is approximately 350,000 ft2 with 16 floors, a basement, and mechanical penthouse. This building used to generate its own chilled water and was connected to the CCJ plant in 1995. The original chillers and cooling tower have been abandoned in place.

The 12" CHW lines leave the tunnel and enter MSB in the southeast corner of the basement mechanical room. A differential pressure transmitter is installed near the tunnel (i.e. at the beginning of the MSB circuit). There are at least four bypasses in the main piping in this mechanical room. Water currently free-wheels through one of the remaining distribution pumps, and the pump is manually turned on when there is a desire for more chilled water. There does not appear to be a bypass around these pumps. The existing 18" CHW risers connect to the 12" mains in this room and proceed upwards to the mechanical penthouse.

There are 11 air handlers in this building with CHW coils, four located in the basement and seven located in the mechanical penthouse. All units have three-way valves, and each bypass has a manual shutoff valve. The air handlers operate in economizer mode during the winter and do not require any chilled water. A dual temperature system serves perimeter fan coil units and is manually valved off from the CHW lines during the winter to prevent warm water from flowing into the main CHW loop.

SCOPE OF WORK

Eliminate System Bypasses

The secondary chilled water loop serving City Hall and MSB routinely shows a minimal change in temperature (1-2°F) while operating at a very high flow rate (approx. 4,000 gpm), indicating that a substantial amount of water may be short-circuiting from supply to return, likely through the numerous piping bypasses that exist in the system as a relic of constant-volume pumping. With the current variable-speed pumping configuration, most bypasses should be eliminated to allow the flow rate and pump speed to be reduced as cooling demand decreases.

Tasks

- Many of the bypasses in both City Hall and MSB already have manual balancing or shut-off valves installed. The majority of these valves can simply be closed. This will allow the variable-speed secondary chilled water pumps to slow down and save energy when cooling demand is low.
- If a valve is found to be frozen or damaged, isolate and remove the valve and either replace it or cap the pipe ends.
- Monitor the impact on both the chiller plant and City Hall or MSB building automation systems after closing each valve to quickly detect and avoid performance or comfort problems.
- A minimal amount of bypass may be required to ensure that terminal units near the end of the distribution system receive adequate chilled water.
- Install new manual shutoff valves in terminal unit bypasses that currently have no valve, permanently removing certain bypasses by cutting and capping the pipe ends, and revising pump controls throughout City Hall to avoid dead-heading the tertiary pumps.

Progress

- Several bypasses with existing valves closed in City Hall, though many remain. Coordinating closure of valves serving critical loads and terminal units needing verification of tertiary pump control to avoid dead-heading.
- Scope of work to close MSB AHU bypass valves delivered to facility manager; coordinating implementation and handling of critical loads.

Air- and Water-Side Economizer

PES was first asked to investigate the chiller plant because of poor performance during winter-time operation leading to chiller surging and concerns of damage to the chiller compressors. Year-round cooling is required in some parts of the buildings served by the chiller plant, particularly in the interior of City Hall. While we identified several possible opportunities to improve performance through reset sequences in the plant's control system (see Phase 3), the real goal is to shut down the chiller plant in the winter and use the cold ambient temperatures to provide "free" cooling through air- or water-side economizers.

Air-side economizer is a control sequence in the air handler that increases the portion of outside air intake to provide cooling when ambient conditions are favorable (e.g. when the ambient temperature or enthalpy is lower than the indoor temperature or enthalpy). Large air handlers, like those in CCJ and MSB, are often designed with air-side economizer capabilities. Small terminal units, like the fan-coil units and small air handlers serving City Hall, often have no ventilation or can only provide the minimum designed ventilation rate.

A water-side economizer consists of a heat exchanger located in the chiller plant and connected to both the chilled and condenser water loops. When the water temperature in the cooling tower basin is sufficiently cold, it can be directed through the heat exchanger to cool the chilled water loop without running the chillers. This is generally more expensive than air-side economizer, but can be a good application when air-side economizer is not feasible, such as in parts of City Hall.

A hybrid economizer approach may also be feasible, whereby the air-side economizer capabilities in the air handlers at CCJ and MSB are used to cool the chilled water in their coils for use at City Hall. This needs further investigation as it may only be applicable in a small range of ambient conditions and would require careful coordination between each building.

Tasks

- The air handlers in CCJ and MSB reportedly have air-side economizer capabilities, although the state of their control systems and sequences is uncertain and requires further investigation. If they are found to be non-functioning or improperly calibrated, take the necessary corrective action to restore air-side economizer operation.
- Identify all 24/7 and year-round cooling demands. Consolidate or remove these loads from the CHW loop to facilitate plant shut-down.
- Design and install a water-side economizer system in the CCJ chiller plant to handle winter cooling loads.

Progress

- Coordinating with Building Monitoring Program engineers to confirm air-side economizer functionality in CCJ and MSB and resolve any issues.
- Investigating all 24/7, year-round, and critical chilled water loads.
- Water-side economizer design in progress.

Optimize Chiller Plant Operations

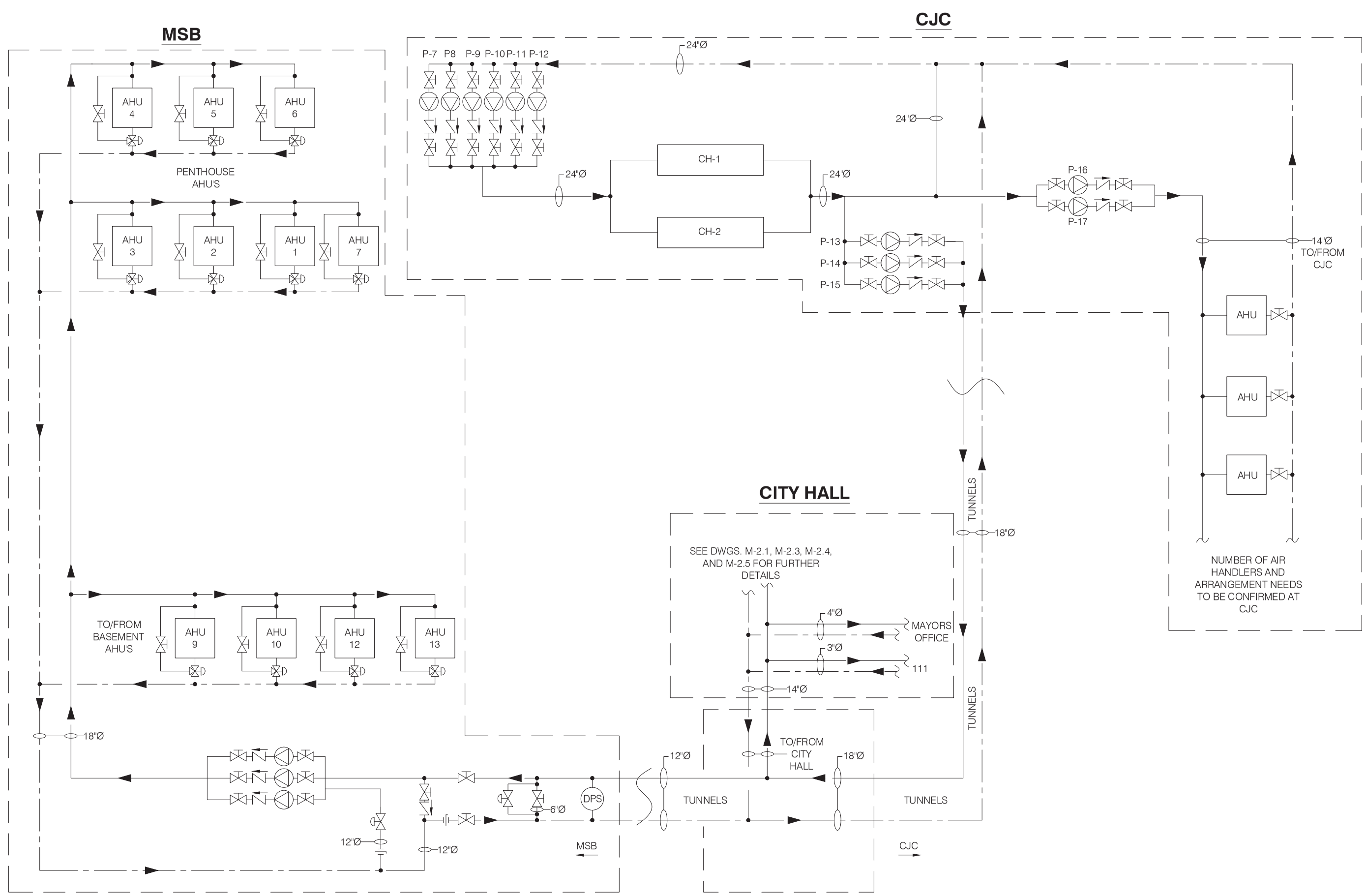
The chiller plant control system is responsible for sequencing the chillers, cooling towers, and pumps to provide adequate chilled water while maximizing energy efficiency. As weather conditions and cooling demands change throughout the year, the chiller plant should use various "reset" sequences to ensure that the total plant energy is always minimized.

Tasks

- Replace ageing cooling tower fan motors, install fan VFDs, add a wet-bulb temperature sensor, and implement a fixed approach condenser water temperature reset control sequence.
- Implement variable-speed primary chilled water pumping to reduce over-pumping.
- Implement a chilled water temperature reset control sequence.

Progress

- Electrical sub-meters installed for all major plant components for energy tracking and parsing of plant energy between the three buildings served.
- Coordinating detailed scope of work for implementation by existing mechanical and controls contractors.



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EXISTING CHILLED WATER SYSTEM FLOW DIAGRAM

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CITY HALL

CHILLED WATER SYSTEM STUDY

REV	DATE	DESCRIPTION
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EXISTING CHILLED WATER SYSTEM FLOW DIAGRAM

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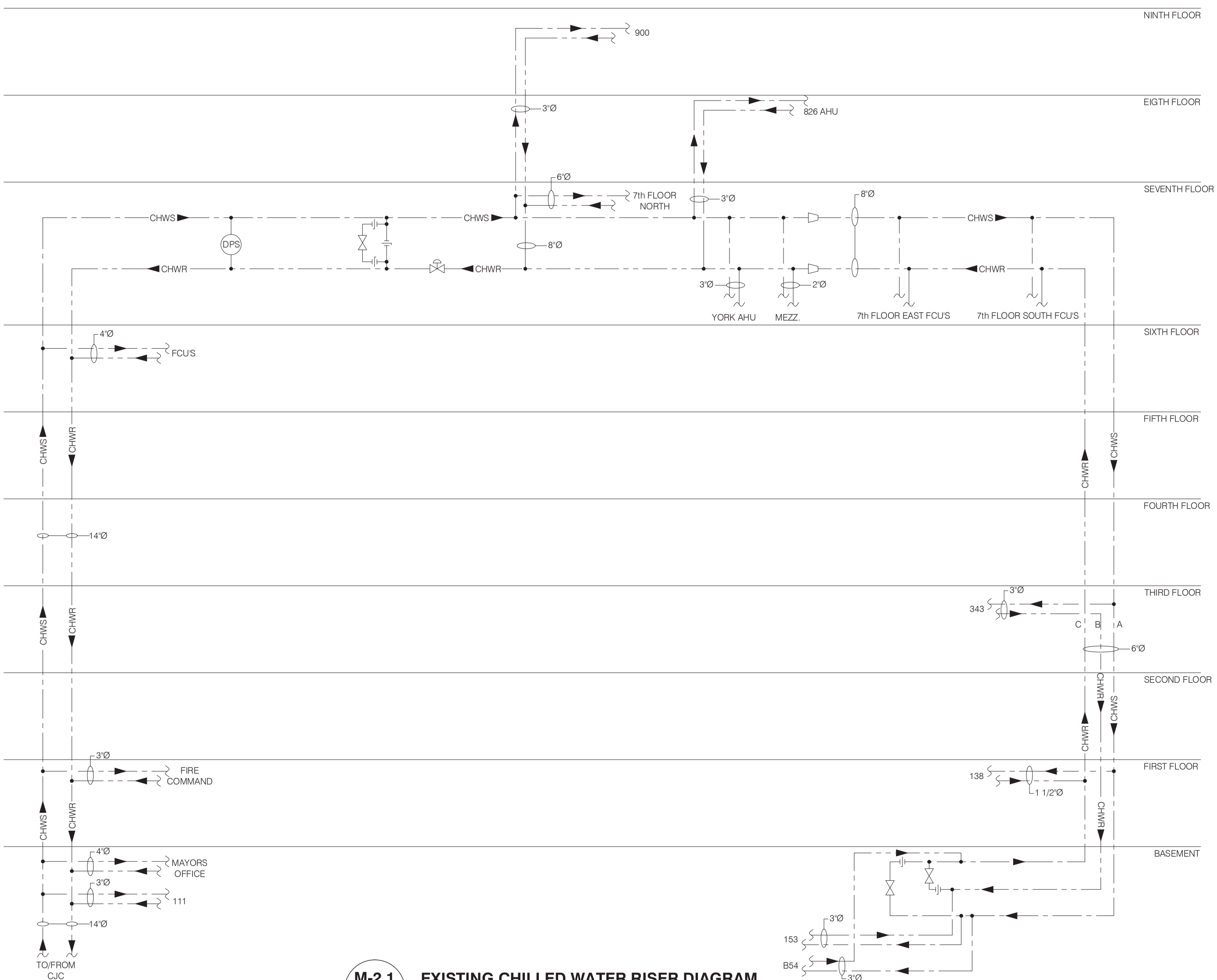

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EXISTING CHILLED WATER RISER DIAGRAM

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CITY HALL

CHILLED WATER SYSTEM STUDY

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EXISTING CHILLED WATER RISER DIAGRAM

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PRELIMINARY PV SOLAR FEASIBILITY

Date: May 1, 2023
To: Tammy Lee – City of Philadelphia, Office of Sustainability, Municipal Energy Office
From: Marika Selzler Williams, CEM – Practical Energy Solutions
Subject: Preliminary Photovoltaic Solar Feasibility – Health Center #5
SSM File: 110237.0008
cc: Paul Spiegel, Ben Pressman, Seth Nace – Practical Energy Solutions

BACKGROUND

The site was surveyed March 14, 2023 for the purpose of determining the viability for an on-site photovoltaic (PV) solar installation at Philadelphia District Five Health Center (Health Center #5), at 1900 N. 20th St.

SITE CHARACTERISTICS

Health Center #5 is a relatively flat roof surface with a relatively new (approx. 2018 installation) white EPDM rooftop in generally good condition. The roof is segmented into north and south sections, corresponding to the differing age of the two now-connected portions of the facility, separated by a parapet wall. Both roof areas are of the same surface and general condition. Three atriums with metal cages intersect the roof areas, approximately near the center. Existing rooftop equipment includes four HVAC units on the north roof, varying smaller HVAC units and the cooling tower system on the south roof, and exhaust fans and drainage throughout both.

Figure 1. Health Center #5 rooftop.

The facility's electrical distribution is served by a common 208V 3PH utility service with a 2000A main distribution panel serving both north and south facilities, located in the south portion of the building.

PV SOLAR AVAILABILITY

The roof is generally clear of obstructions, providing sufficient area for contiguous rooftop solar array segments. Shading is a mitigatable concern around the atriums, HVAC equipment, roof features, and from trees on the south side of the building. The areas best suited for array segments (blue) are depicted in Figure 2 coordinating to their potential for shading from equipment, trees, and other structures (red).

Figure 2. Rooftop shading on a hypothetical maximum quantity of rooftop PV panels.
Gradient from unshaded (blue) to most shaded (red).

The most available and unshaded areas can host a system of approximately **225kW DC**, depending on final design and equipment selection. The preliminary array configuration is illustrated in Figure 3.

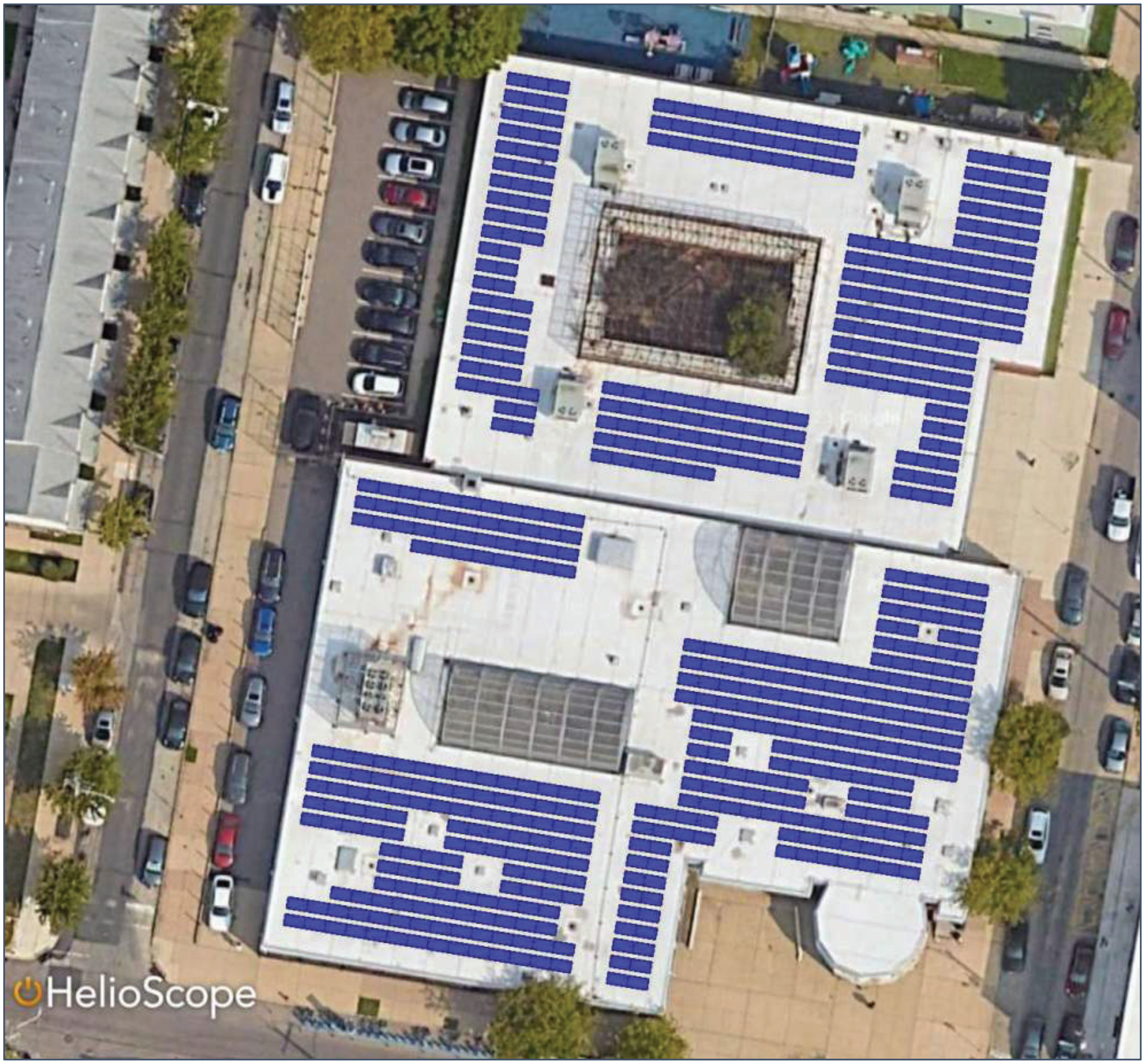

Figure 3. Preliminary proposed array layout, totaling 225kW DC.

This preliminary array is estimated to produce on the order of **294MWh annually**, equating to **33-39% of recent facility electricity consumption**, displayed in Figure 4.

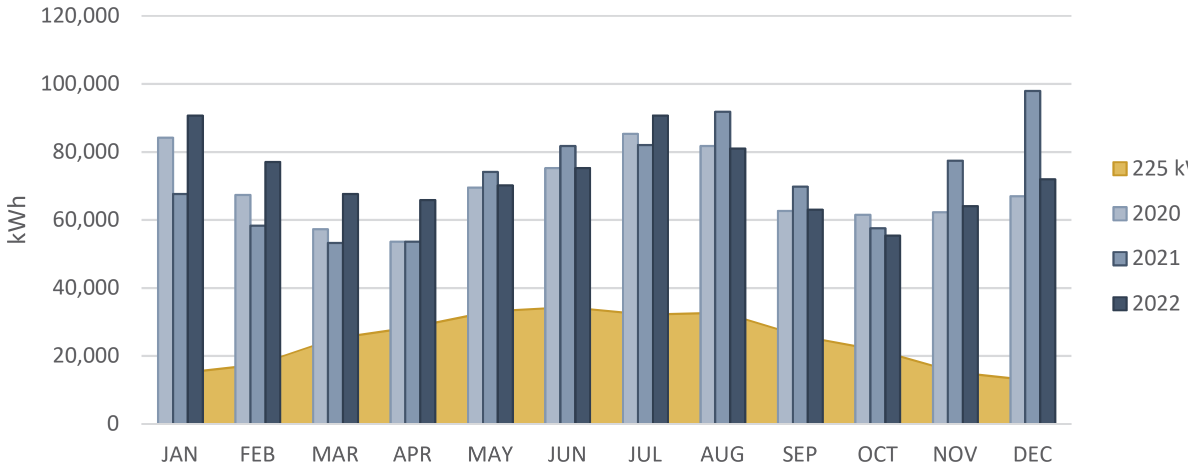

Figure 4. Monthly PV array production (area) contribution to facility electricity consumption (bars).

PV FINANCIAL FEASIBILITY

A PV system's impact on utility electricity costs is primarily on the "usage" ($/kWh) rate, with little predictable impact to the "demand" ($/kW) rate, which is set by the highest kW demand from the grid each month. While the PV array will likely have some impact to the monthly kW demand, it is not guaranteed (e.g. equipment needs power overnight while the array is not producing power, or the PV system is down). This facility is currently charged approximately $7.25/kW each month by PECO for demand with insignificant usage $/kWh charges, and is charged $0.085/kWh by WGL for usage, with no demand $/kW charges. Therefore, the PV system only reliably impacts the $0.085/kWh WGL charge.

Based on this current usage rate, the system can expect to yield a **$1,000 to $3,000 monthly reduction** in electric utility cost, totaling approximately **$25,000 annually**. This is 20-60% of the monthly and **40% of the facility's total electricity costs**.

Our initial high-level turnkey cost estimate is $650,000, or $2.90/W, for this 225kW DC system. With the assumption of monetizing under the Inflation Reduction Act Direct Pay a 50% Federal Investment Tax Credit (30% base credit plus 10% each domestic content and energy community bonuses) and application of the upcoming PECO rebate of $0.10/kWh produced for one year, the net project cost is $297,000.

This system under the following assumptions has a **simple payback of 8 years**, with a **$518,000 cumulative cash flow** over 20 years. If SRECs are not sold, the simple payback is instead 12 years with an estimated $230,000 cumulative cash flow over 20 years.

Table 1. Financial projection assumptions.

Size of Project kW DC	225.0	Current Electricity Pricing ($/kWh)	$ 0.085
Starting Annual kWh AC	294,000	Electricity Pricing Escalation (%/y)	2.0%
Est. Capital Cost	$ (650,000)	Current SREC Pricing ($/MWh)	$ 40.00
Est. Cost per Watt	$ 2.90	SREC Pricing Escalation (%/y)	3.0%

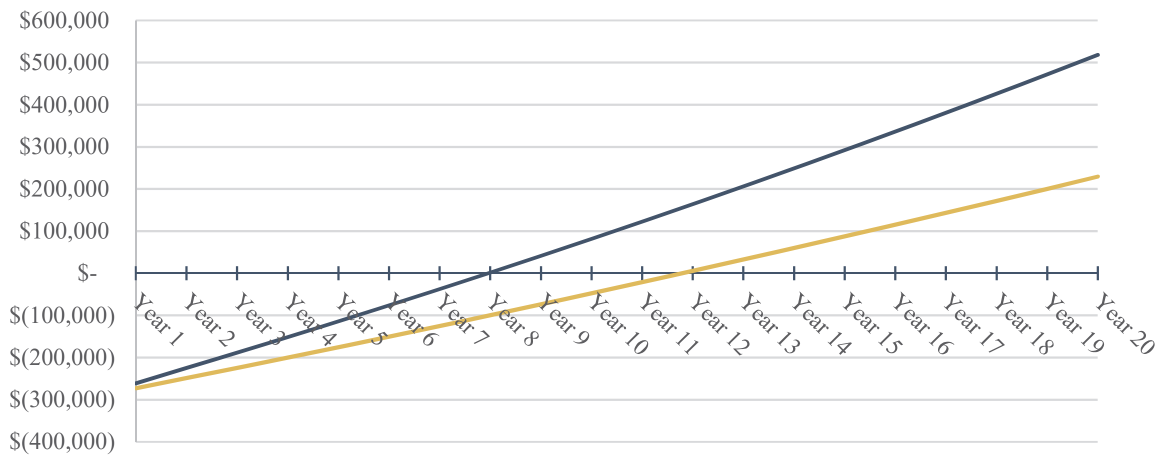

Figure 5. Projected cumulative cash flow; with SREC monetization in black, without SREC monetization is in yellow.

ELECTRICAL FEASIBILITY

Building demand typically does not exceed 215kW, or about 660A @ 0.9PF—**the building electrical distribution appears to have capacity for solar generation to be added.**

A 225kW PV solar array would require about 625A at 208V 3PH, and would require approximately an 800A disconnect that would need to be tapped to the existing bus, as it appears there is not room available in the lineup. Final engineering upon final system sizing should confirm all these aspects.

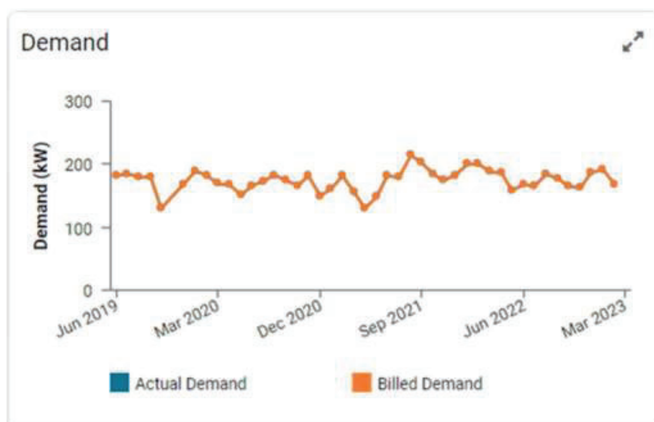

Figure 6. Health Center #5 monthly peak demand.

Planned improvements to the south facility's HVAC equipment will likely reduce the total electrical load and consumption, which would not negatively impact the feasibility of this array.

RECOMMENDATION

Installation of a rooftop solar array is in line with the City's Municipal Energy Master Plan goals for reducing greenhouse gas emissions and generation of electricity from renewable resources, while producing significant positive monetary savings. Further, incorporation of a battery storage system paired with the solar array can provide short-term resilience to grid outages and potentially long-term resilience to emergency systems given adequate sunshine, at a minimum reducing dependence on the traditional fossil-fuel generators. The value of battery storage—especially in the application of this Health Center as a community resource—should be evaluated for impact to resilience and demand response potential.

Should an array be installed near the southern-most extent of the building, as well as around the atriums, care should be taken to maintain the existing trees so their canopies do not inhibit the solar availability to the array.