Paulsboro Public Schools

Energy Savings Plan

September 18, 2023

Schneider Electric

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1.0 Executive Summary

1.1 Overview of the Energy Savings Improvement Program

The Energy Savings Improvement Program (ESIP) was created in 2009 by the NJ legislature to reduce energy & operational costs, reinvest in infrastructure, and support the individual goals of public entities across the state. ESIP is a design-build financing mechanism that is regulated by the NJ Board of Public Utilities (BPU). Paulsboro Public Schools will implement a comprehensive ESIP, using the ESCO model, that addresses building energy and infrastructure needs. The District is using Schneider Electric as the Engineer of Record, and their selected Third Party Energy Auditor is DLB Associates. The District will be handling its own financing process without the services of an FA or bond counsel.

The energy conservation measures (ECMs) included in the ESIP were developed in partnership with the District's staff to meet the following project goals:

1. Reduce energy and operational expenses
2. Improve indoor air quality and comfort inside the facilities
3. Replace failing HVAC that is well beyond useful life
4. Provide a much-improved learning and teaching environment

The ECMs in the Energy Savings Plan include HVAC upgrades, Building Automation System (BAS) upgrades, building envelope improvements, air quality enhancements, and LED lighting. The following chart provides an overview of the ECMs included at each facility.

ECM Matrix	Jr.Sr HS	Loudenslager	Billingsport	BOE	Garage
Efficiency					
LED Lighting - Interior & Exterior	✓	✓	✓	✓	
Building Envelope & Weatherization	✓	✓	✓	✓	
HW Pipe Insulation	✓				
Low Flow Hot Water Devices	✓	✓	✓	✓	
Vending Machine Controls	✓				
Comfort & IAQ					
Replace UVs w/ DX Cooling UVs	✓	✓			
Install Condensing Boilers & Air/Dirt Separators		✓	✓	✓	
Enhanced Air Purification - Bi-Polar Ionization	✓	✓	✓		
Building Exhaust System Upgrade		✓			
Building Automation Systems					
Optimize BAS/HVAC Controls	✓	✓	✓	✓	✓
Demand Controlled Ventilation	✓	✓	✓		
Infrastructure					
Micro CHP Boiler		✓			
Customer-Driven Projects					
LED Lighting - Albright	◆	◆	◆	◆	◆
Replace Steam Heating & DHW Plants	◆				
Replace Auditorium AHUs	◆				
Replace Gym AHUs - Add Cooling	◆	◆			

Legend	
Included ECMs	✓
Non-ESIP Project - Energy Savings	◆

2.0 Financial Analysis

2.1 Scope Summary

The intent of this project is to maximize savings for the District, improve indoor air conditions, reduce maintenance costs, and fund critical capital improvements (new classroom airside equipment with improved filtration and air purification, and cooling capacities). The following energy conservation measures have been reviewed with the School.

FORM II

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ENERGY CONSERVATION MEASURES (ECMs) SUMMARY FORM
PAULSBORO PUBLIC SCHOOLS
ENERGY SAVINGS IMPROVEMENT PROGRAM

ESCO Name: Schneider Electric

	Proposed Preliminary Energy Savings Plan: ECMs	Estimated Installed Hard Costs[1] ($)	Estimated Annual Savings ($)
Efficiency			
1	LED Lighting - Interior & Exterior	$ 134,959	$ 26,730
2	Building Envelope & Insulation	$ 169,670	$ 11,810
3	Vending Machine Controls & Low Flow HW Devices	$ 2,985	$ 1,064
HVAC & BAS			
4	New Unit Ventilators (DX Cooling) + Optimize BAS Controls	$ 5,736,208	$ 73,017
5	Replace Boilers & Air/Dirt Separators	$ 115,511	$ 29,034
6	Advanced Air Purification	$ 347,590	$ 49,198
Infrastructure			
7	Combined Heat & Power (CHP)	$ 186,771	$ 2,938
	Project Summary:	$ 6,693,694	$ 193,791

2.2 Financial Summary

The table below represents the total, turnkey cost of the ESIP based on the scope of work listed on the prior page and Form V from SE's RFP Response. Schneider Electric will serve as the primary contractor, responsible for the execution of all scopes of work under the ESP program.

FORM V

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCOs PROPOSED FINAL PROJECT COST FORM FOR BASE CASE PROJECT
PAULSBORO PUBLIC SCHOOLS
ENERGY SAVING IMPROVEMENT PROGRAM

ESCO Name: Schneider Electric

PROPOSED CONSTRUCTION FEES

Fee Category	Fees [1] Dollar ($) Value	Percentage of Hard Costs
Estimated Value of Hard Costs [2]:	$ 6,693,694	
Project Service Fees		
Investment Grade Energy Audit	$ 217,545	3.25%
Design Engineering Fees	$ 317,950	4.75%
Construction Management & Project Administration	$ 401,622	6.00%
System Commissioning	$ 117,140	1.75%
Equipment Initial Training Fees	$ 100,405	1.50%
ESCO Overhead	$ 401,622	6.00%
ESCO Profit	$ 351,419	5.25%
ESCO Termination Fee [*]	$ -	0.00%
Project Service Fees Sub Total	$ 1,154,662	17.25%
TOTAL FINANCED PROJECT COSTS:	$ 8,601,397	28.50%

PROPOSED ANNUAL SERVICE FEES

First Year Annual Service Fees	Fees [1] Dollar ($) Value	Percentage of Hard Costs
SAVINGS GUARANTEE *(OPTION)*	$ 17,173	
Measurement and Verification *(Associated w/ Savings Guarantee Option)*	included	
ENERGY STAR™ Services *(optional)*	$ 4,000	
Post Construction Services *(if applicable)*		
Performance Monitoring	included	
On-going Training Services	included	
Verification Reports	included	
TOTAL FIRST YEAR ANNUAL SERVICES	$ 21,173	

2.3 Cash Flow Analysis

FORM VI

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM
PAULSBORO PUBLIC SCHOOLS - ENERGY SAVINGS IMPROVEMENT PROGRAM

ESCO Name: Schneider Electric

Note: This energy savings plan is based on the following assumptions in all financial calculations:

(a) The cost of all types of energy should be assumed to inflate at **2.4% gas, 2.2% electric** per year.

1. Term of Agreement: 20 *years*
2. Construction Period [2] (months: 18 *months*
3. Cash Flow Analysis Format:

Cost of Construction [1]: $ 8,601,397
SSB-VEEVR Funding: $ 4,596,442
District Contribution: $ 560,000
Total To Be Financed: $ 3,444,955

Interest Rate: 4.65%

Year	Annual Electric Savings	Annual Natural Gas Savings	Annual Distributed Gen. Savings	Annual Operational Savings	Energy Rebates / Incentives	Total Annual Savings	Annual Project Costs	Annual Service Costs [3]	Board Costs	Net Cash-Flow to Client	Cumulative Cash Flow
Installation	$ 49,794	$ 125,172	$ 2,632			$ 177,599					$ -
1	$ 56,908	$ 143,054	$ 3,008	$ 20,468	$ 145,193	$ 368,630	$ 522,056	$ 21,173	$ 543,229	$ 3,000	$ 3,000
2	$ 58,160	$ 146,487	$ 3,074	$ 20,468		$ 228,189	$ 214,577	$ 10,612	$ 225,189	$ 3,000	$ 6,000
3	$ 59,439	$ 150,003	$ 3,142	$ 4,668		$ 217,252	$ 214,252	$ -	$ 214,252	$ 3,000	$ 9,000
4	$ 60,747	$ 153,603	$ 3,211	$ 4,668		$ 222,229	$ 219,229	$ -	$ 219,229	$ 3,000	$ 12,000
5	$ 62,083	$ 157,289	$ 3,282	$ 4,668		$ 227,322	$ 224,322	$ -	$ 224,322	$ 3,000	$ 15,000
6	$ 63,449	$ 161,064	$ 3,354	$ -		$ 227,867	$ 224,867	$ -	$ 224,867	$ 3,000	$ 18,000
7	$ 64,845	$ 164,930	$ 3,428	$ -		$ 233,203	$ 230,203	$ -	$ 230,203	$ 3,000	$ 21,000
8	$ 66,271	$ 168,888	$ 3,503	$ -		$ 238,663	$ 235,663	$ -	$ 235,663	$ 3,000	$ 24,000
9	$ 67,729	$ 172,941	$ 3,580	$ -		$ 244,251	$ 241,251	$ -	$ 241,251	$ 3,000	$ 27,000
10	$ 69,219	$ 177,092	$ 3,659	$ -		$ 249,971	$ 246,971	$ -	$ 246,971	$ 3,000	$ 30,000
11	$ 70,742	$ 181,342	$ 3,740	$ -		$ 255,824	$ 252,824	$ -	$ 252,824	$ 3,000	$ 33,000
12	$ 72,299	$ 185,694	$ 3,822	$ -		$ 261,815	$ 258,815	$ -	$ 258,815	$ 3,000	$ 36,000
13	$ 73,889	$ 190,151	$ 3,906	$ -		$ 267,946	$ 264,946	$ -	$ 264,946	$ 3,000	$ 39,000
14	$ 75,515	$ 194,715	$ 3,992	$ -		$ 274,221	$ 271,221	$ -	$ 271,221	$ 3,000	$ 42,000
15	$ 77,176	$ 199,388	$ 4,080	$ -		$ 280,644	$ 277,644	$ -	$ 277,644	$ 3,000	$ 45,000
16	$ 78,874	$ 204,173	$ 4,169	$ -		$ 287,217	$ 284,217	$ -	$ 284,217	$ 3,000	$ 48,000
17	$ 80,609	$ 209,073	$ 4,261	$ -		$ 293,944	$ 290,944	$ -	$ 290,944	$ 3,000	$ 51,000
18	$ 82,383	$ 214,091	$ 4,355	$ -		$ 300,829	$ 297,829	$ -	$ 297,829	$ 3,000	$ 54,000
19	$ 84,195	$ 219,229	$ 4,451	$ -		$ 307,875	$ 304,875	$ -	$ 304,875	$ 3,000	$ 57,000
20	$ 86,047	$ 224,491	$ 4,549	$ -		$ 315,087	$ 289,097	$ -	$ 289,097	$ 25,990	$ 82,990
Totals	**$ 1,460,374**	**$ 3,742,873**	**$ 77,199**	**$ 54,940**	**$ 145,193**	**$ 5,480,578**	**$ 5,365,804**	**$ 31,785**	**$ 5,397,589**	**$ 82,990**	

2.4 Incentives and Rebates

A variety of incentive and rebate programs were evaluated during the development of the Project. Based upon the scope of this project and discussions with the utility rebate program administrators, the following rebates are currently included:

Rebate Summary

ECM	ECM Description	Rebate Type	Utility	Estimated Rebates
1	LED Lighting - Interior & Exterior	Prescriptive	ACE	$ 12,525
2	Building Envelope & Insulation	Custom	SJG	$ 9,760
3	Vending Machine Controls & Low Flow HW Devices	Prescriptive + Custom	ACE & SJG	$ 872
4	New Unit Ventilators (DX Cooling) + Optimize BAS Controls	Prescriptive + Custom	SJG	$ 74,525
5	Replace Boilers & Air/Dirt Separators			$ -
6	Advanced Air Purification	Custom	SJG	$ 47,510
7	Combined Heat & Power (CHP)			$ -
	Total:			**$ 145,193**

All rebates and incentives are subject to program terms, conditions, approvals, and availability of funds. All rebates will be applied for by Schneider Electric on behalf of the District, with all rebate funds being sent directly to Paulsboro Public Schools.

Atlantic City Electric's commercial rebate and incentive program is administered by TRC. The program guide and incentive rates for various energy-saving measures are published on their website below.

https://commercialee.atlanticcityelectric.com/Home/Incentives.

South Jersey Gas has a commercial rebate and incentive program as well, which covers both gas and electric rebates, and is administered by Applied Energy Group. The program guide and incentive rates are published on their website below.

https://southjerseygas.com/save-energy-money/commercial-energy-savings/prescriptive-custom.aspx

3.0 Facility Descriptions and Energy Conservation Measures

3.1 Facility Descriptions

Paulsboro Jr/Sr High School

Paulsboro Jr/Sr High School is a 141,000 square foot building serving as the public middle school and high school for the local community. It is a three-story facility with many of the traditional school amenities: kitchen, cafeteria, auditorium, gym, offices, and classrooms. The original high school was built in 1916, with additions in 1931, 1965, and the library in 2001. The Jr/Sr High School has about 400 students and 60 teachers and staff members occupying the building each day.

Paulsboro has performed a number of building and infrastructure upgrades over the past 1-2 years, with more upgrades currently taking place. Many of the lights were recently upgraded to LED as part of a Regular Operating District (ROD) grant, but not all of the lights were converted to LED. The steam plant was converted to a hot water plant with condensing boilers, instant domestic water heaters, and new pumps and distribution equipment for both heating and domestic water systems. The air handling units (AHUs) serving the main gym and auditorium are being replaced in the summer/fall of 2023, as part of ROD grant program as well. DX cooling is being added as part of the AHU replacements, where cooling hasn't previously existed in these spaces. Another upgrade executed with ROD grants was to upgrade the BAS controls on the unit ventilators in each classroom, and the new heating hot water plant.

Classrooms consist of 48 floor-mounted, heating only unit ventilators (UVs) that were installed in 1964 and 1965. There is one UV that was installed in 2000, which has DX cooling, but the DX has been non-functional for many years. The UVs all have new DDC controls, but the mechanical equipment is still mostly original, unless it has been replaced. The HVAC equipment is scheduled on 24/7/365, even with the new BAS controls. Each classroom has a window A/C unit to provide some cooling to each space. These window A/C units are controlled solely by each teacher to whatever setpoint they desire, and are turned on/off by the teachers as well.

Loudenslager Elementary School

Loudenslager Elementary School (LES) is a 39,000 square foot school with typical classrooms, recreation, library/media, assembly, and administrative spaces that you would expect to find in a school. The original building was constructed in 1926, and had an addition in 2001. There are approximately 320 students and 40 staff members at LES. Like the Jr/Sr HS, many of the lights were recently upgraded to LED, but not all of the lights. New BAS controls were installed on the existing UVs around the same time as the High School UVs. The gym AHUs were replaced in 2023, and the two new AHUs have DX cooling. The two non-condensing hot water boilers that serve the entire building are being replaced in August-September of 2023, with condensing boilers under separate contract.

Twenty-six of Loudenslager's UVs were installed in 1973, and serve all of the classrooms and some other spaces throughout the building. Two of those basement UVs are ceiling-mounted and have DX cooling; both of which are operational, but they are extremely loud, especially for a classroom. The remaining 24 UVs are floor-mounted with hot water coils and a window A/C unit in each classroom that provides some cooling relief. These UVs all operate and are controlled in the same manner as the High School UVs.

There are three additional UVs in the Library and Media Center that were installed during the 2001 renovation. These UVs are self-contained DX cooling units, however none of them are currently operational. They are scheduled to be replaced with ROD grant funds in 2023 or 2024, by a separate contractor, so they are excluded from the ESIP scope.

Most of the building's exhaust fans do not operate, and this contributes to poor ventilation throughout the classrooms and other building areas. There is a large exhaust fan that serves one of the classroom wings, but that fan is oftentimes not operational as well.

Billingsport Early Childhood Center (BECC)

The last of the three schools in Paulsboro Public Schools is Billingsport, which is very similar to Loudenslager in many ways (size, occupancy, structure, lighting, HVAC, and BAS controls). Billingsport is 40,000 sq.ft., built in 1923 with additions in 1973 and 2001. The lighting situation at BECC is the same as Loudenslager. The hot water plant equipment is almost identical to that of LES as well, where the two non-condensing boilers are in the process of being replaced with condensing boilers in August/September of 2023. Each classroom has a unit ventilator with new BAS controls installed (same timeframe as the other schools). The two gym AHUs were replaced in 2020 with the same DX cooling and gas heat packaged units that were just installed at LES.

There are 32 total UVs at BECC, but three of them are being replaced under separate contract as part of a ROD grant, so they are excluded from the ESIP scope. Six of the remaining 29 UVs (from the 2001 addition) are UVs with self-contained DX and hot water coils. Only one of the DX systems works. The other 23 UVs in the building were installed in 1972 or 1973 and are heating only UVs. These rooms have a window A/C unit similar to the other heating-only classrooms across the District. The UVs are scheduled on 24/7/365, but allow the teachers to turn them on/off manually at the UV.

Admin Building

The Admin Buildings (BOE Office) a three-story, 7551 square foot building that was built in 1920. About ten people work in this building, and the top two floors are used only as storage areas. The first floor contains offices, a conference room, and bathrooms. The basement holds more storage and mechanical equipment. The single non-condensing hot water boiler was replaced with a condensing boiler under a separate contract during the summer of 2023. Most of the lighting was recently upgraded to LED at the same time as the schools were converted to LED. The spaces are served by three split system AHUs (heating and cooling), and there is HW baseboard heat along the perimeter of the building.

Bus Garage

The Bus Garage is a single-story 1700 square foot building that consists of a garage/bay area used mainly for storage, and a workspace / break room and bathroom. This building is very lightly occupied, with typically no more than one employee present. The lighting was recently converted to LEDs, and the workspace / break room area is heated by a gas-fired furnace, and there are a couple window A/C units to cool the space. The garage area is unconditioned.

More comprehensive facility descriptions with sizes, quantities, and capacities are available in the LGEA Reports [see Appendix **Error! Reference source not found.**s Box Folder].

3.2 ECM Descriptions

Please see the following descriptions of ECMs currently included in the project. Reference Appendix 6.2 – Preliminary Mechanical Designs and Appendix 6.5 – Scope of Work Details for additional project scope details.

1. LED Lighting Retrofit

Lighting was mostly converted to LEDs through by a lighting company through a ROD grant. The District's lights were converted to LEDs just before Paulsboro went out for an ESIP RFP. The LGEAs were completed while the lighting was still fluorescent, but soon after, many of the lights were retrofitted to LED. During the IGA process, the lighting contractor did not finish the scope of work, and was no longer responsive to Paulsboro's to come and finish the work they were contracted to do.

Schneider Electric performed an audit of all the lights throughout the District to develop a scope of work to ensure all the lighting was converted to LEDs. The scope in the ESIP is designed to fill in the gaps where the previous lighting contractor fell short of delivering a completed LED project to Paulsboro Public Schools.

In general, the scope includes new LED fixtures for the exterior and interior high bays. The interior wrap and lay-in fixtures that are not LED will be converted to LEDs to closely match what the previous contractor did, LED light bars. Though it isn't the traditional LED retrofit scope, it is important to keep lighting consistency across the District and not make maintenance overly complicated.

Please see Appendix 6.5 for a detailed line-by-line of the lighting scope of work.

Savings Methodology

Energy unit savings for the lighting upgrades are estimated by the Contractor. Electric energy and demand savings were then run through Schneider Electric's rate tariff simulation tool to arrive at annual energy cost savings, rather than using a blended or average utility rate, resulting in a more accurate representation of cost savings.

2. Building Envelope & Weatherization

This ECM addresses the shell of the building and how well it is keeping conditioned air in and ambient air out. During the IGA, we performed an onsite building envelope audit to identify and measure what specific improvements could be made to each site. Our onsite testing and analysis of energy consumption indicate there is an opportunity to improve the indoor air quality, occupant comfort, and reduce energy use by upgrading the existing air barrier systems. A detailed description of the scope, with measurements and floor plan layouts is in Appendix 6.5 – Scope of Work Details.

A tighter building envelope will provide the following benefits for Paulsboro:

- Drafts will be reduced providing greater comfort for the building occupants. A tighter building envelope will lower the possibility of "hot" or "cold" spots brought on by unconditioned air infiltrating into conditioned spaces.
- Decreased Energy Consumption - Less conditioned air will be lost through the building envelope and the Heating and Cooling equipment will operate less to maintain the set point of the conditioned space. This will decrease the energy consumed and save on energy costs.
- Improved Air Quality – Decreasing infiltration of contaminated air promotes less humidity and greater air quality. This allows for the existing systems to run at peak performance and maintain the highest level of air quality for the occupants.
- Reduced Maintenance Costs – Reducing the "runtime" will increase the operating life of the heating and cooling equipment and increase the performance of new equipment.

The descriptions below describe the specific findings and improvements as part of the scope:

- Attic Air Barrier Retrofit – There is no air barrier between the conditioned space and the vented area above the dropped ceiling. Fiberglass insulation alone does not stop air leakage. The air leakage reduces the effectiveness of the existing insulation.
- Attic Bypass Sealing – Interior walls, plumbing, electrical, and HVAC penetrations entering the attics that are not properly sealed allow conditioned air to escape into the vented attic space. Since warm air rises, sealing the attic from the conditioned space is crucial to maintaining an efficient building. Air movement through fibrous insulation reduces the effectiveness of the existing insulation.
  - Retrofit Attic Access Hatch – The current attic hatch setup is not insulated or weather stripped allows for unnecessary conductive and convective energy losses.
  - Install Attic Access Hatch – There is no material place currently that allows for easy coverage of the attic access areas of Paulsboro High School. A properly treated attic hatch will allow access while still maintaining an airtight and well insulated surface area at the top of the thermal envelope of the building.
  - Install Soffit Baffles - Install soffit baffles/propavents at full perimeter of the attics as indicated on floor plans. Materials are to be installed to prevent blockage of current attic ventilation by new attic flat insulation.
- Attic Flat Insulation – Attic insulation is crucial for controlling conductive heat loss in a building. After air gaps are sealed and convective air loss is reduced the biggest remaining form of heat loss becomes conduction. Under-insulated surfaces result in excessive energy loss due to the lack of a properly insulated thermal barrier.
- Caulking – There are unsealed perimeter joints and holes found at the entryway assembly as indicated on the floor plans. Old sealants have failed at the intersection between the existing framing and wall allowing air to infiltrate and exfiltrate the building.
- Door Weather Stripping – Deteriorated weather stripping materials, ineffective weather stripping installation and daylight showing at the perimeter of door systems create direct pathways for unwanted infiltration/ exfiltration throughout the school district.
- Roof-Wall Intersection Air Sealing – The roof-wall intersection is regularly an area that allows unwanted air leakage through the building shell. Exterior flashing and finish details at this area are not constructed to stop air leakage (exterior flashings are for water control, not air control); unsealed exterior flashing details combine with interior gaps in the framing between the roof and wall assembly to allow infiltration/ exfiltration.

Task	Admin	Billingsport	Jr-Sr HS	Loudenslager	Total
Attic Air Barrier Retrofit (SF)		433			433
Attic Air Barrier Retrofit (Units)			2		2
Attic Bypass Air Sealing (SF)		8,652	1,834		10,486
Attic Flat Insulation (SF)		9,085	6,538		15,623
Caulking (LF)			24		24
Door - Install Jamb Spacer (Units)				2	2
Door Weather Striping - Doubles (Units)		11	16	8	35
Door Weather Stripping - Singles (Units)	5	2	7	4	18
Install New Attic Hatch (Units)			1		1
Retrofit Attic Hatch (Units)		1			1
Roof-Wall Intersection Air Sealing (LF)			296	112	408

Savings Methodology

Savings for this ECM are derived by observing and measuring the size of openings or gaps in the building envelope and applying the ASHRAE 90.1 Crack Method. Annual energy and cost savings for this measure are listed by building in the Savings Table in Section 4.2 of this report.

3. Hot Water Pipe Insulation

When Paulsboro replaced the steam boiler plant at the Jr/Sr High School with a new hot water boiler plant in 2021-2022, many appurtenances from the installation were not insulated. As part of the ESIP scope of work, the following items would be insulated to reduce the heat losses to the mechanical room space.

Task	Jr-Sr HS
Balance Valve Insulation	2
Check Valve Insulation	3
End Cap Insulation	1
Flange Insulation	17
Pump Insulation	5
Straight Pipe Insulation (linear feet)	6
Strainer Insulation	3
Suction Diffuser Insulation	2
Tank Insulation	1
Triple Duty Valve Insulation	2

Savings Methodology

Savings for this measure are derived by identifying appurtenances throughout the district that were not insulated. The pipe diameter, piece of equipment, fluid type, proposed insulation thickness, proposed insulation type, total length, and annual heating hours were used to predict energy savings for insulation needed throughout the building. Annual energy and cost savings for this measure are listed in the Savings Table in Section 4.2 of this report.

4. Low Flow Hot Water Devices (Faucet Aerators)

Often overlooked in assessments for building energy efficiency are the cost savings achievable in domestic hot water usage, such as sinks, showers, and food preparation areas. The objective of this ECM is to reduce the amount of hot water usage by reducing the instantaneous water flow where that flow is excessive compared to common standards. Most water fixtures in the building are of older, high-flow design. This measure includes installing aerators on existing bathroom sink faucets. Energy savings are realized by having to use less fuel (natural gas) to heat the domestic water, because a lower volume of water needs to be heated.

Building	Qty
Jr/Sr HS	55
Loudenslager	14
Billingsport	20
Admin	4
Total	93

Savings Methodology

Savings for this measure are derived by identifying water fixtures that are using excessive water per use. By measuring pre-retrofit flow along with annual flushes, gallons, and minutes used, savings were found by calculating the difference between the existing case and the reduced flow rate proposed case. Annual energy and cost savings for this measure are listed by building in the Savings Table in Section 4.2 of this report.

5. Vending Machine Controls

Vending machines, equipped with display lighting and/or refrigeration systems to keep beverages at a set service temperature, are an almost constant energy user. In actuality, these machines are visited relatively infrequently in comparison to their active operating time and provide good opportunities for energy savings from occupancy and load-based controls. VendingMisers® will reduce the energy consumption of these machines during unoccupied hours. Installing these simple devices on the vending machines located throughout the District would be a nice and easy solution to save energy.

VendingMisers® use infrared occupancy sensors installed on or near the vending machine to detect pedestrian traffic to determine when the surrounding area has been vacant. Once deemed vacant (i.e. 15 minutes), the VendingMiser® will shut off the vending machine lights and power down the cooling system, if appropriate. The vending machine will be turned back on when occupancy is detected. For chilled product vending machines, the Miser continuously monitors the product temperature, and will power on the compressor, as needed, independent of occupancy, to ensure that the vended product stays cold. Electrical current sensors ensure that the machine is never shut down in the middle of a cooling cycle so as to protect the compressor from a high heat pressure start.

The scope of work for this ECM includes one refrigerated and one non-refrigerated vending machine at the Jr/Sr High School.

Savings Methodology

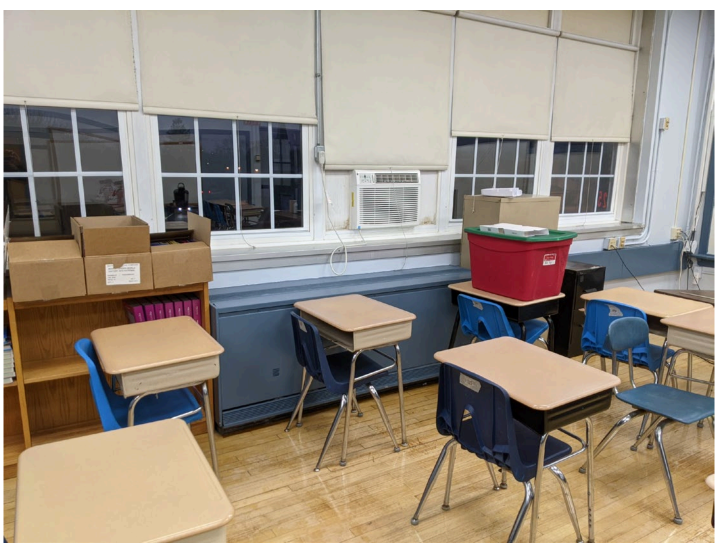
Savings for this measure are derived by utilizing existing vending machine average power output, along with the annual operating hours of the devices that are operating constantly. The savings are then found by reducing the run hours of the vending machines on a daily basis. Annual energy and cost savings for this measure are listed in the Savings Table in Section 4.2 of this report.

6. Replace Unit Ventilators with DX Cooling Unit Ventilators

In the HS, (48) UVs serve classrooms, and were installed in 1964 or 1965. They still contain mostly all original mechanical equipment. The pneumatic controls for the UVs were upgraded to DDC controls in 2021-2022, but much of the mechanical equipment from the ‘60s is faulty, damaged, or difficult to control even with new DDC. With the modern DDC controls, the school still has to run the UVs 24/7 to ensure the spaces are comfortable when teachers and students arrive each morning. Many of the outside air dampers do not function properly, or at all, which contributes to poor indoor air quality for the students and teachers. There is one newer UV in a computer classroom, that has DX cooling, but that cooling system hasn’t worked in years, according to the District’s staff.

Typical Jr/Sr HS UVs, installed in 1964 or 1965.

Loudenslager has 26 UVs in the replacement scope of work, with the same conditions as the High School UVs, except they were installed in 1973. Each classroom has a heating only UV, a window A/C unit, and new BAS controls. The equipment is very old, so the new controls are not able to adequately control the space temperature or indoor air quality, so Paulsboro has the HVAC equipment scheduled on 24/7.



Typical UVs at Loudenslager, installed in 1973.

Equipment	Quantity	ASHRAE Life Expectancy	Equipment Age	Years Beyond Useful Life Expectancy
Jr/Sr High School (1964)	22	20 years	58 years	**38 Years Beyond**
Jr/Sr High School (1965)	26	20 years	57 years	**37 Years Beyond**
Jr/Sr High School (est. 2000)	1	20 years	22 years	**2 Years Beyond**
Loudenslager ES (1973)	26	20 years	49 years	**29 Years Beyond**

For the ESIP scope of work, the existing UVs will be demolished and new UVs with DX cooling coils installed. Each UV will have a remote condensing unit, located either on the roof or ground-mounted on a pad nearby. The new BAS controllers will be removed and stored, and then re-installed after the new UVs are put in place. Each window A/C unit will be removed and returned to the customer. There is some new electrical work required because of the added DX load, so panelboard and wiring changes are included in the scope. A more detailed scope of work is specified below.

New Work – Unit Ventilators:

- New unit ventilators with hot water heating and DX cooling will be installed in the place of the removed UVs.
- Highlights of the new UVs specifications:
    - Economizer dampers for fresh air ventilation to the space
    - MERV-13 air filters for improved indoor air quality (IAQ)
    - Electronically commutated (EC) motor for variable airflow with maximum energy efficiency
- New UVs will be connected to the electrical, hydronic heating piping, and outside air (OA) louvers from the removed UVs.
- New DX condensing units will be installed, with refrigerant piping connected to new UVs. Condensing units will be installed on grade with equipment pads or on approved supports on the roof, as indicated on the attached Mechanical Sketches in Appendix A.
    - Crane hoists and roof cutting and patching as required for condensing units installed on the roof.
- The BAS controls that were saved in the Demo Scope will be re-installed in the new UVs, with additional control points wired for the DX cooling.
- A new heating valve and actuator will be installed in each UV to control the heat supplied to the space.
- A new economizer damper and actuator will be included in each UV
- Carpentry, plus typical patching and painting of areas surrounding new UV to match interior space
- Install new CO_2 monitors to meet SSB-VEEVR requirements.
- Perform air and water balancing of new equipment.
- Startup and commission UVs and all related controls and devices.
- Provide training to Paulsboro maintenance staff on operation and maintenance of the new equipment.

Please see Appendix 6.2 Preliminary Mechanical Sketches for more detail on the scope of work.

Savings and Savings Methodology

Savings for this measure are derived by identifying existing unit ventilators throughout the district that were passed their useful life. The existing fan size and cooling efficiency were gathered (window AC units), and the proposed unit ventilators were then identified to provide sufficient heating and cooling to the space. Savings were calculated by including the increased fan size for the proposed unit ventilators together with the increased efficiency of the proposed UVs. The increase in efficiency, as compared to the existing window A/C unit, provides a positive energy savings. Annual energy and cost savings for this measure are listed by building in the Savings Table in Section 4.2 of this report.

7. Install Condensing Boilers and Air/Dirt Separators

Loudenslager ES has two non-condensing boilers (1512 and 1209 MBH) with a rated efficiency of 84%. They are 20 years old and nearing the end of their useful life. Three new 969 MBH condensing boilers will be installed in their place, and connected back to the existing heating water system. Because the building is getting new UVs which have hot water coils, a high-quality air and dirt separator is going to be installed to help protect the new HW coils in the UVs.

Billingsport has two non-condensing boilers identical to Loudenslager, including the same age. The scope at Billingsport for this ECM is also identical to Loudenslager ES; three 969 MBH condensing boilers and an air/dirt separator.

The Admin Building has a single 177 MBH non-condensing hot water boiler (86% efficiency) which serves the heating load for the entire building. This boiler is being upgraded to a 190 MBH condensing boiler for improved heating efficiency and reduced energy costs.

Replacing non-condensing boilers with condensing boilers will bring improved heating efficiencies, which will result in lower gas usage and less energy spend to operate the boilers. The table below specifies the old and new boilers at each building. Please see Appendix 6.5 – Scope of Work Details for information on this ECM.

Building	Existing Boilers	New Boilers
Admin	(1) Weil-McLain, CGA-8-SPDN, 177MBH output, 86% eff.	(1) LochinvarKHB199N, 190MBH output, 95% eff.
HS	(2) HB Smith [1960], 3525MBH output steam boilers	(3) Lochinvar FBN2001, 1923MBH output, 96% eff.
LES	(1) Lochinvar, CHN1801, 1512MBH output, 84% eff. (1) Lochinvar, CHN1441, 1209MBH output, 84% eff.	(3) Lochinvar KBX1000N, 969MBH output, 97% eff.
BES	(1) Lochinvar, CHN1801, 1512MBH output, 84% eff. (1) Lochinvar, CHN1441, 1209MBH output, 84% eff.	(3) Lochinvar KBX1000N, 969MBH output, 97% eff.

Existing non-condensing boilers at Loudenslager (left) and Billingsport (right).

Savings and Savings Methodology

Savings for this measure are derived by using the existing boiler efficiencies per building that have aged and are passed their useful life. These non-condensing hot water boilers have been degraded over time and cannot provide efficient heating needed throughout the building. The proposed condensing boilers will have a significant improvement in heating efficiency, leading to a substantial fuel savings for each building. Annual energy and cost savings for this measure are listed by building in the Savings Table in Section 4.2 of this report.

8. Enhanced Air Purification – Bi-Polar Ionization (BPI)

Bringing in fresh outside air is a code requirement for buildings to remain healthy for people. Reducing the outside air flow rates, when permissible, and installing air purification technology will reduce particulate matter, volatile organic compounds, pathogens, other VOCs, and will create a healthier indoor learning environment. One such method is bi-polar ionization. A BPI device will be installed in each classroom unit ventilator, plus all rooftop units and air handling units that are not going to have demand-controlled ventilation installed as a scope of work. Bi-polar ionization allows less outside air to be brought into the building because of the enhanced purification performed by the BPI device. BPI will provide two critical benefits for Paulsboro:

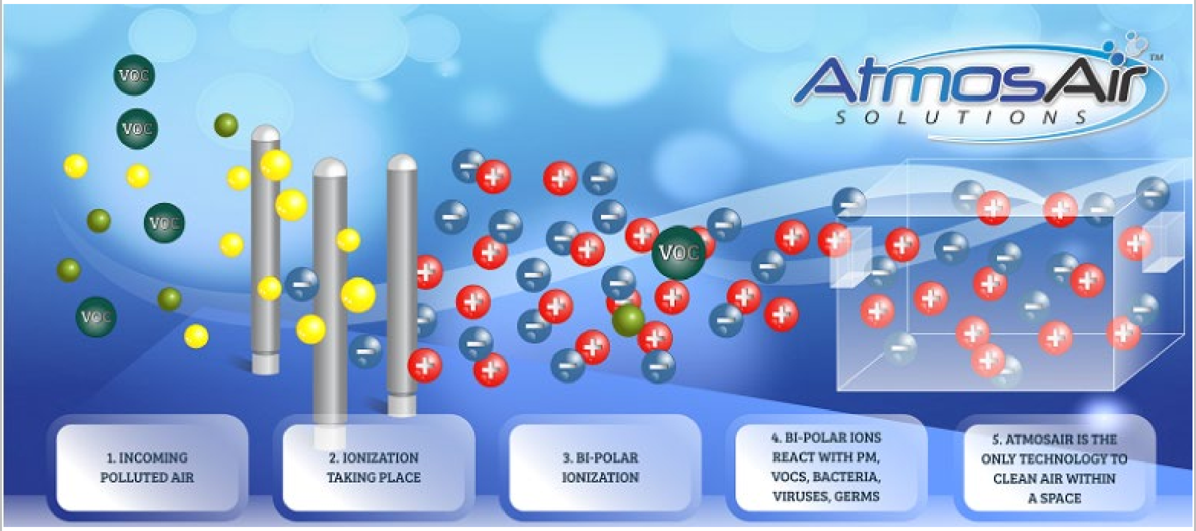
- Improved indoor air quality
- Significant energy and cost savings from bringing in less OA

The improved IAQ is very important to the District because of their schools' close proximities to a Mobil oil (petroleum) refinery; all schools are between ¼ and 1 mile from the refinery, which causes poor air quality in the surrounding areas. BPI will also help reduce unpleasant odors because of the ionization that occurs.

A small device will be installed in the airstream. This device will consume a small amount of power to generate ions. These ions will bond to particulate molecules in the space, and these bonded ions become heavier than air and fall out of the air, or increase in size so they are much more likely to be captured in the HVAC unit's air filters.

BPI Scope:

Building	UVs	AHUs / RTUs
Jr/Sr HS	49	4
Loudenslager	29	1
Billingsport	32	1



Atmos Air is a very reputable manufacturer of air purification technology we have used in many buildings across the country, many including schools.

Savings and Savings Methodology

Savings for this measure are derived by modifying the ventilation requirements (cfm/person, cfm/sqft) for each unit to optimize Indoor Air Quality Procedure (IAQP). This uses concentrations of pollutants to determine the Outdoor Air. Based on space type and number of people certain pollutant will be generated at difference rates. This allows the reduction of Outdoor Air from the existing Ventilation Requirement Procedure (VRP). The VRP uses a standardized cfm/person and cfm/sqft to calculate the required outdoor air. The difference of VRP and IAQP is what can be recognized as the bi-polar ionization reduction percentage. Annual energy and cost savings for this measure are listed by building in the Savings Table in Section 4.2 of this report.

9. Building Exhaust System Upgrade

For proper ventilation and IAQ at Loudenslager ES, it was assessed and determined that the building's exhaust system needs to be upgraded in conjunction with the installation of new UVs. The current layout and operation of the exhaust air system at Loudenslager would not allow for proper ventilation, which would compromise the air quality, the energy savings, and the occupant's comfort within the school. The scope of work for the exhaust system upgrade includes some new exhaust fans, ductwork, transfer grilles, controls, and a sound control strategy that is interlocked with the operation of the UVs and AHUs fans and OA dampers.

Please see Appendix 6.2 Preliminary Mechanical Sketches for more detail on the scope of work.

Savings and Savings Methodology

Savings for this measure are derived by identifying the existing exhaust fans throughout the building that are no longer operating or are past their useful life. Since much of the building has failing exhaust fans, the building needed to be pressurized properly to ensure proper ventilation. It was found that the existing exhaust fans were undersized, so the addition of the proper number of exhaust fans along with an increased fan size resulted in an energy penalty. This was necessary to provide proper comfort throughout the building. Annual energy and cost savings for this measure are listed in the Savings Table in Section 4.2 of this report.

10. Optimize BAS & HVAC Controls

Opportunities exist in each Paulsboro facility to improve the operation of space conditioning equipment. The District's schools are scheduled occupied 24/7 because the equipment is so old and unreliable, that turning equipment on/off and having setup and setback temperatures cause too many issues for school staff. The teachers are allowed to determine what setpoint the UVs control to, between 66 and 74 degrees.

The window A/C units that are in every room do not have any centralized controls, so the teachers are allowed to determine the temperature setpoint (down to 60 degrees), and turn them on/off as desired. It was observed during multiple site visits that the A/C units were cooling at the same time that the UVs were heating. And windows were open too.

Implementing schedules, consistent heating and cooling setpoints, and setup and setback controls will provide significant energy and cost savings for Paulsboro. The most effective way to save energy is to turn off equipment when it is not needed. These BAS optimization improvements are in-scope for all three schools, Jr/Sr High School, Loudenslager, and Billingsport. The three split system A/C units at Admin and the furnace at the Bus Garage will have schedule and setpoint controls installed through programmable thermostats, because these two buildings are not on the Building Automation System. The District will realize O&M savings due to this BAS optimization scope because there will be less wear and tear on the equipment with much shorter daily run times.

The boilers did not have hot water temp reset controls implemented, so that programming will be installed when the boilers are replaced at Loudenslager and Billingsport schools. This will provide gas energy savings so the boilers do not have to run as hot of temperatures during medium and low-load times. This will be especially critical since condensing water boilers and being installed, and the correct range of hot water return temperatures are needed for the condensing boilers to operate at their high efficiency ratings.

The savings incorporate an outside air baseline adjustment at each school that accounts for the energy penalty associated with bringing outside air into each school building, as compared to the baseline period where no outside air was being introduced into classrooms.

Savings and Savings Methodology

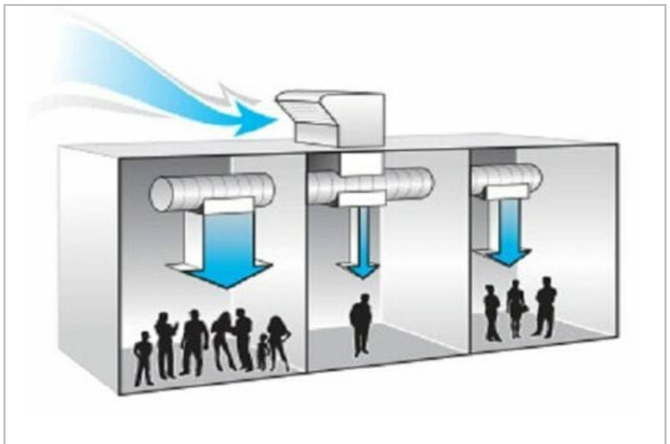
Savings for this measure are derived by modifying the existing fan schedules that are operating in the on position constantly. The excess fan usage along with the inability to incorporate setback temperatures allowed each building to recognize energy savings by establishing a setback temperature when spaces are unoccupied. They will also have reduced run hours to turn the fans off when the spaces are unoccupied. Annual energy and cost savings for this measure are listed by building in the Savings Table in Section 4.2 of this report.

11. Demand Controlled Ventilation (DCV)

Conditioning outdoor air (both heating and cooling) is one of the single largest energy-consuming tasks for a building. Any space that uses more ventilation than its occupancy levels require, results in excess energy usage to condition that outdoor air unnecessarily. HVAC systems are designed to provide a specified quantity of ventilation air corresponding to the maximum occupancy conditions for the space served. However, there are periods throughout the day when spaces within the building may be partially occupied or even unoccupied (such as gyms and cafeterias), yet ventilation rates are maintained at the maximum level, as though it were fully occupied. Demand Controlled Ventilation (DCV) can greatly reduce the energy consumed by the HVAC system by providing the right level of ventilation based on occupancy.

DCV is a ventilation control strategy that measures the carbon dioxide levels in a space (CO_2 is a great indicator of occupancy) and uses that measurement to adjust the amount of outdoor air supplied to a space at any given time. This strategy continuously adjusts the ventilation rate as dictated by ASHRAE ventilation requirements. By

ventilating the space only as required, the energy and associated costs spent to heat and cool outdoor air are reduced. DCV will be implemented in the District's large rooms that also have highly variable and unpredictable occupancy, such as gyms, media centers, cafeterias, auditoriums, etc.



Demand controlled ventilation varies outside air rates based on building occupancy. Blue arrows indicate amounts of fresh, outdoor air.

DCV scope includes:

- (5) AHUs at Jr/Sr HS [gym, auditorium, Library]
- (2) AHUs at Loudenslager [gym]
- (2) AHUs at Billingsport [gym]

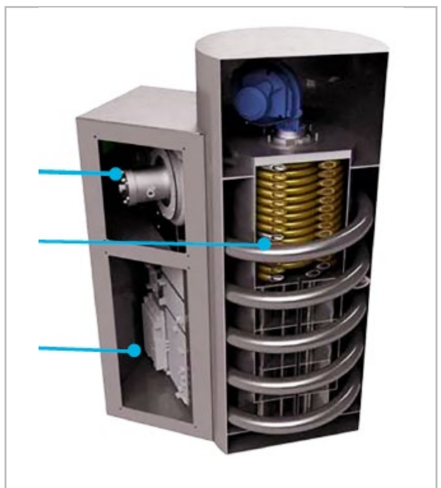
Savings and Savings Methodology

Savings for this measure are derived by modifying the volume of outside air delivered to the space within the building models created for each facility based on the anticipated variability of space occupancy. Annual energy and cost savings for this measure are listed by building in the Savings Table in Section 4.2 of this report.

12. Micro Combined Heat & Power (mCHP)

Traditional fossil fuel burning power plants are limited to a thermal

efficiency of electricity production of approximately 40%. The remainder of the thermal energy produced by burning fossil fuels is lost to internal process demands or rejected from the system through cooling towers or other means which heat the atmosphere. On-site power generation provides the opportunity to recover useful waste heat that would otherwise be lost to the atmosphere. A combined heat and power system uses natural gas to drive an engine which generates electricity, and then uses the waste heat from the system to provide heat to the building.



Cutaway of a mCHP boiler that consists of a condensing boiler and a generator.

A mCHP system would be installed at Loudenslager ES to generate electricity, while simultaneously using the waste heat for the heating hot water system. mCHP does save energy by reducing losses in the electricity-generation process from utility providers, while also by using the waste heat from the combustion process, and using it in your building to help offset the heat load and decrease the amount of heating the HW boilers need to produce. Per equivalent energy unit, the cost of electricity from a utility is higher than the cost for natural gas from the utility. So the main benefit from CHP comes from the cost savings of using natural gas to generate electricity onsite and utilizing the waste heat to further increase heating efficiencies, rather than purchasing electricity from the utility.

The mCHP unit will be integrated into the Building Automation System for monitoring purposes. Please see Appendix 6.2 Preliminary Mechanical Sketches for more detail on the scope of work.

The table below shows the emissions calculations related to just the micro-CHP scope, using the BPU protocols.

Therms Savings	kWh Savings	Emission Product	Emission Reduction (lbs)
32	25,674	CO_2	33,545
		NO_x	22
		SO_2	17

The emissions reductions are calculated based on the following factors, based on BPU protocols.

- 1,292 lbs. CO_2 per MWh saved
- 0.83 lbs. NO_x per MWh saved
- 0.67 lbs. SO_2 per MWh saved
- 11.7 lbs. CO_2 per therm saved
- 0.0092 lbs. NO_x per therm saved

Savings and Savings Methodology

Savings for this measure are derived by incorporating the mCHP into the existing heating plant of the building. The mCHP boiler will function as the primary boiler, which allows this efficient condensing boiler to take a portion of the building heating load off the other boilers in the plant. Along with this ability to reduce building heating load for the boiler plant, the mCHP will be able to generate electricity for the building when the building is in heating mode. The annual electric savings are found by using the heating operating hours along with the mCHP Part Load Ratio to provide electricity with the 6 kW boiler. Annual energy and cost savings for this measure are listed in the Savings Table in Section 4.2 of this report.

Customer-Driven Projects with Energy Savings

LED Lighting

Paulsboro Public Schools hired a contractor to retrofit their existing lights with LED light bars. Since this lighting scope of work occurred after the baseline period, and was ongoing during the ESIP RFP and IGA process, the energy savings from this scope were included in the ESIP savings. The LGEA reports provide a lighting line-by-line of what existed prior to this LED retrofit, and the lighting audit performed by Schneider Electric provided a lighting line-by-line of what currently exists. From these audits, we can accurately estimate the lighting savings at each building.

Savings and Savings Methodology

Energy unit savings for the lighting upgrades were calculated using data collected from lighting audits. Electric energy and demand savings were then run through Schneider Electric's rate tariff simulation tool to arrive at annual energy cost savings.

Steam to Hot Water Boiler Plant Conversion

Paulsboro had their steam heating plant at the Jr/Sr High School demolished and replaced with a hot water boiler and domestic water boiler plant. Because this upgrade occurred after the baseline period as well, the savings from this heating plant upgrade are included in the ESIP savings. We have documentation and photos of what existed prior to the upgrade, as Schneider Electric had already visited the facilities numerous times and had created an energy baseline from this existing equipment, before it was changed out.

Savings and Savings Methodology

Savings for this measure are derived by modifying the operating efficiency and boiler type of the heating equipment within the model. Energy and cost savings for this measure shown in the Savings Table in Section 4.2 of this report.

Replace HS Auditorium & Gym AHUs

The District is contracted with a 3rd party to replace six total air handling units (AHUs), with each adding DX cooling where it didn't previously exist.

- (2) AHUs for the Jr/Sr HS gym
- (2) AHUs for the Jr/Sr HS auditorium
- (2) AHUs for the Loudenslager gym (multi-purpose room)

The Loudenslager AHUs were installed in the spring of 2023, and the Jr/Sr High School AHUs are scheduled to be installed in the summer/fall of 2023. Because all of these occurred after the energy baseline period, a baseline adjustment is included for the increased energy usage from adding DX to all of these areas.

Savings and Savings Methodology

Savings for this measure are derived by adding the square footage of the space being served to the overall building cooled percentage. The efficiency of the AHUs are added to the total building cooling efficiency to provide energy savings. The fan size of each AHU is added to the total building fan kW in the model. Annual energy and cost savings for this measure shown in the Savings Table in Section 4.2 of this report.

3.3 Optional ECMs

The following opportunities were identified and investigated during the Investment Grade Audit but are not currently included in the Energy Savings Plan.

1. **LED Lighting Controls –** Install lighting controls to further save on energy costs. Additionally, dimming controls on the LED light bars to reduce the light levels where they are very high.
2. **HVAC Upgrades** – Unit ventilators at Billingsport were identified as ESIP scope, and the District even secured a state grant for some of the cost, however there wasn't enough savings from the ESIP project to be able to implement this UV replacement (with DX cooling) scope at this time. Replacement of other HVAC units such as Library RTU, split system AHUs for offices, and packaged AC units were investigated but not included in the final project scope. Self-contained UVs and VRF cooling UVs were investigated, but ultimately not included in the ESIP scope. A dedicated outside air system (DOAS) was looked into as an alternative to UVs, but was excluded from the scope due to high construction costs in such an old building.

3. **Building Exhaust System –** Upgrading Billingsport's exhaust system was developed in coordination with the UV replacement scope so as to harmonize the ventilation for the building with the UVs.
4. **Envelope and Attic Capital Project –** Comprehensive attic envelope scope at Admin was developed but not included in the final scope of work.
5. **Solar PV and Public Remote Net Metering Solar** – A Power Purchase Agreement RFP was held for onsite solar and for offsite public remote net metered solar. Because the onsite solar was limited to 50 kW AC of solar at each school, onsite solar scope was dropped. Paulsboro did award the Public Remote Net Metering project to a company, however that public RNM project fell through due to state rules and regulations.
6. **Combined Heat & Power –** CHP was examined for Loudenslager to become more energy efficient, but the small school size and limited availability of space led to other considerations for heating and electric generation.
7. **Replace Domestic Water Heaters –** Replacement of water heaters in-kind, and with heat pump water heaters was developed, but isn't included in the final scope.
8. **Air Balancing TAB –** a building-wide airside test, adjust, and balance scope was explored for the Admin building to help reduce hot/cold areas during the winter and summer months. This scope would work well if performed in conjunction with the Admin building's capital envelope project.
9. **Water Conservation Measures** – Water fixtures at the buildings are a mix of low flow and older higher flow and could benefit from recommissioning or replacement, however savings is not sufficient to cover the cost to perform such upgrades.
10. **Secondary Transformers –** Secondary transformers were audited, metered, and analyzed for replacement at each school, however the scope wasn't able to fit into the ESIP project.
11. **Kitchen Hood Controls –** Controls for the Jr/Sr High School kitchen hood.
12. **Kitchen Food Service Equipment –** The Jr/Sr High School was looked into as a candidate for receiving new kitchen equipment, especially when a state grant opened up, but the scope just didn't align with the school's priorities.
13. **Window Replacement** – Some windows in the District are older single pane windows (some are wooden) that are quite poor in energy efficiency ratings. These should be addressed as part of a larger building renovation.
14. **Roof Replacement –** The roofs were investigated for repair or replacement, but the savings and need weren't there for an ESIP project. The roof over the original High School is an area with the greatest roofing needs.
15. **Ball Fields –** Field lighting and field irrigation controls were investigated during the IGA, but savings and low customer priority weren't enough to warrant inclusion into the ESIP project.
16. **Other Capital Projects –** Replacing old domestic water piping, replacing interior doors for safety measures, paving a parking lot, secure school entrances, and new playgrounds were all studied as possible scope items, but no included in the final ESIP scope.

3.4 Ongoing Maintenance

Under the New Jersey ESIP legislation, all maintenance contracts are required to be procured separately from the ESIP contract. As part of the ESIP, Schneider Electric will:

- Properly commission all new equipment provided
- Provide meaningful equipment and operational training to Paulsboro staff for all new equipment
- Provide a comprehensive Operation and Maintenance (O&M) Manual for Paulsboro to follow
  - This will provide a roadmap of how to properly maintain the new equipment and ensure it is operating efficiently and as intended by the manufacturer and per the design documents
  - The O&M Manual will also include all warranty information

Below are expected O&M impacts for the District.

Improvement Measure	O&M Impact
LED Lighting	Reduced O&M by replacing non-LEDs with LEDs. Less frequent lamp or ballast changeouts will be required, as well as very minimal maintenance during the warranty period.
Building Envelope & Insulation	No change to current envelope maintenance.
Vending Machine Controls & Low Flow HW Devices	Vending machine controls are plug-in and do not require ongoing maintenance once commissioned. Faucet aerators require no ongoing maintenance once installed. They do not contain batteries.
UVs w/ DX Cooling & BAS Controls	Reduced O&M by having HVAC equipment that is 60 years younger than existing. All UVs will be fully commissioned and started up before turning equipment over to Paulsboro. Preventive maintenance will be required to optimize equipment performance and lifespan. These tasks will be specified in the O&M Manual. BAS controls will be fully commissioned (point-to-point) and sequences of operation will be fully verified as well. Upgrading the controls and HVAC equipment together will lead to less O&M on the classroom UVs than what is currently performed.
Boilers & Air/Dirt Separators	New boilers and air/dirt separators should improve the long-term O&M requirements for the heating water systems. There will be ongoing preventive maintenance to the boilers which will be very similar to current practices. These tasks will be specified in the O&M Manual.
Advanced Air Purification	These improvement measures (BPI and DCV) do not require ongoing maintenance once they are initially installed and commissioned.
Micro CHP	This will require some additional maintenance that the District doesn't currently provide, as they do not have a micro-CHP. The O&M requirements are the same as a condensing boiler, so the O&M tasks will not be unfamiliar to Paulsboro. The specific O&M tasks will be clearly identified in the O&M Manual provided at project closeout, and will be covered during customer training.

4.0 Energy Savings

4.1 Baseline Energy Use

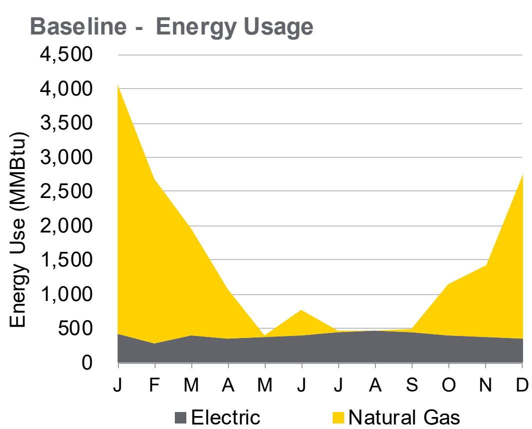
This baseline includes all facilities and was created by taking several years of utility data and utilizing the following:

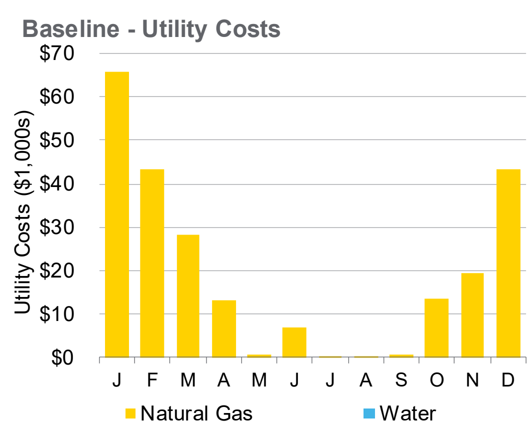
- Prorating the usage into clean monthly bins
- Weather normalizing the baseline to represent a typical meteorological year

Paulsboro Public Schools - All Sites - Baseline

	Electricity		Natural Gas		Water		Total	
Month *mmm*	Energy Use *kWh*	Energy Demand *kW*	Energy Use *Therm*	Cost *$*	Water Use	Cost *$*	Energy Use *MMBtu*	Cost *$*
Jan	125,078	328	36,321	$65,690	0	$0	4,059	$84,132
Feb	84,155	304	23,949	$43,412	0	$0	2,682	$57,812
Mar	118,312	302	15,466	$28,208	0	$0	1,950	$45,688
Apr	105,282	321	7,216	$13,251	0	$0	1,081	$29,756
May	106,790	349	383	$892	0	$0	403	$17,854
Jun	116,616	409	3,767	$6,880	0	$0	775	$25,906
Jul	131,721	374	158	$481	0	$0	465	$20,584
Aug	137,360	398	0	$201	0	$0	469	$21,028
Sept	133,153	464	315	$774	0	$0	486	$22,273
Oct	117,399	412	7,467	$13,668	0	$0	1,147	$32,659
Nov	106,943	335	10,535	$19,301	0	$0	1,419	$36,169
Dec	103,121	313	23,946	$43,290	0	$0	2,747	$59,549
Year	**1,385,931**	**4,309**	**129,525**	**$236,050**	**0**	**$0**	**17,683**	**$453,411**

	Electricity		Natural Gas		Water		Total	
Indices	**kBtu/sf**	**W/sf**	**kBtu/sf**	**$/sf**	**ft3/sf**	**$/sf**	**kBtu/sf**	**$/sf**
	20.6	**2.0**	**56.3**	**$1.03**	**0.0**	**$0.00**	**76.9**	**$1.97**





The following charts depict the month-by-month energy baseline for each facility:

Admin Building

	Electricity		Natural Gas		Water		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Water Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*		*$*	*MMBtu*	*$*
Jan	3,081	14	1,170	$2,115	0	$0	128	$2,630
Feb	3,228	15	1,068	$1,934	0	$0	118	$2,473
Mar	3,362	14	696	$1,275	0	$0	81	$1,832
Apr	2,980	16	408	$763	0	$0	51	$1,268
May	3,134	18	122	$257	0	$0	23	$791
Jun	3,279	15	52	$133	0	$0	16	$707
Jul	5,790	18	0	$41	0	$0	20	$1,021
Aug	5,193	17	0	$41	0	$0	18	$928
Sept	4,433	17	0	$41	0	$0	15	$807
Oct	3,134	15	310	$591	0	$0	42	$1,122
Nov	2,640	14	594	$1,093	0	$0	68	$1,547
Dec	2,400	12	792	$1,444	0	$0	87	$1,858
Year	**42,654**	**186**	**5,212**	**$9,727**	**0**	**$0**	**667**	**$16,984**

	Electricity		Natural Gas		Water		Total	
Indices	kBtu/sf	W/sf	kBtu/sf	$/sf	ft3/sf	$/sf	kBtu/sf	$/sf
	19.3	**2.4**	**69.0**	**$1.29**	**0.0**	**$0.00**	**88.3**	**$2.25**

Loudenslager Elementary School

	Electricity		Natural Gas		Water		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Water Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*		*$*	*MMBtu*	*$*
Jan	24,663	58	7,255	$13,242	0	$0	810	$16,954
Feb	19,562	60	5,297	$9,680	0	$0	596	$12,967
Mar	24,711	57	3,595	$6,583	0	$0	444	$10,289
Apr	23,867	70	2,003	$3,687	0	$0	282	$7,491
May	24,150	76	154	$322	0	$0	98	$4,228
Jun	23,504	93	0	$41	0	$0	80	$4,195
Jul	31,294	90	0	$41	0	$0	107	$4,856
Aug	27,171	88	0	$41	0	$0	93	$4,441
Sept	28,843	95	0	$41	0	$0	98	$4,710
Oct	25,521	84	1,432	$2,646	0	$0	230	$6,816
Nov	23,785	77	3,742	$6,850	0	$0	455	$10,737
Dec	23,388	63	4,956	$9,060	0	$0	575	$12,725
Year	**300,459**	**912**	**28,436**	**$52,236**	**0**	**$0**	**3,869**	**$100,408**

	Electricity		Natural Gas		Water		Total	
Indices	kBtu/sf	W/sf	kBtu/sf	$/sf	ft3/sf	$/sf	kBtu/sf	$/sf
	26.1	**2.4**	**72.5**	**$1.33**	**0.0**	**$0.00**	**98.6**	**$2.56**

Billingsport Elementary School

	Electricity		Natural Gas		Water		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Water Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*		*$*	*MMBtu*	*$*
Jan	28,414	77	11,471	$20,376	0	$0	1,244	$24,566
Feb	14,619	70	6,551	$11,653	0	$0	705	$14,512
Mar	24,286	67	2,074	$3,715	0	$0	290	$7,413
Apr	20,840	68	1,260	$2,272	0	$0	197	$5,662
May	18,716	68	0	$38	0	$0	64	$3,246
Jun	25,157	99	3,714	$6,624	0	$0	457	$10,915
Jul	20,722	100	158	$318	0	$0	87	$4,227
Aug	22,527	86	0	$38	0	$0	77	$3,850
Sept	26,278	100	0	$38	0	$0	90	$4,441
Oct	22,949	104	2,205	$3,947	0	$0	299	$8,131
Nov	22,658	74	766	$1,397	0	$0	154	$5,035
Dec	17,553	71	9,410	$16,723	0	$0	1,001	$19,863
Year	**264,719**	**986**	**37,609**	**$67,138**	**0**	**$0**	**4,664**	**$111,860**

	Electricity		Natural Gas		Water		Total	
Indices	kBtu/sf	W/sf	kBtu/sf	$/sf	ft3/sf	$/sf	kBtu/sf	$/sf
	22.7	**2.6**	**94.3**	**$1.68**	**0.0**	**$0.00**	**117.0**	**$2.81**

High School

	Electricity		Natural Gas		Water		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Water Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*		*$*	*MMBtu*	*$*
Jan	67,273	173	16,154	$29,435	0	$0	1,845	$39,183
Feb	45,646	152	10,757	$19,614	0	$0	1,231	$27,132
Mar	65,013	158	8,951	$16,328	0	$0	1,117	$25,678
Apr	56,652	161	3,474	$6,363	0	$0	541	$14,999
May	58,943	175	107	$235	0	$0	212	$9,227
Jun	61,438	190	0	$41	0	$0	210	$9,493
Jul	70,749	154	0	$41	0	$0	241	$9,888
Aug	79,164	196	0	$41	0	$0	270	$11,199
Sept	71,511	241	315	$614	0	$0	276	$11,893
Oct	64,551	199	3,455	$6,329	0	$0	566	$16,203
Nov	56,488	163	5,299	$9,684	0	$0	723	$18,329
Dec	58,259	159	8,605	$15,698	0	$0	1,059	$24,472
Year	**755,686**	**2,120**	**57,118**	**$104,424**	**0**	**$0**	**8,291**	**$217,694**

	Electricity		Natural Gas		Water		Total	
Indices	kBtu/sf	W/sf	kBtu/sf	$/sf	ft3/sf	$/sf	kBtu/sf	$/sf
	18.3	**1.7**	**40.5**	**$0.74**	**0.0**	**$0.00**	**58.9**	**$1.55**

Bus Garage

	Electricity		Natural Gas		Water		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Water Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*		*$*	*MMBtu*	*$*
Jan	1,646	7	271	$522	0	$0	33	$800
Feb	1,099	7	277	$531	0	$0	31	$727
Mar	940	6	150	$306	0	$0	18	$477
Apr	943	6	71	$166	0	$0	10	$336
May	1,847	12	0	$41	0	$0	6	$362
Jun	3,238	12	0	$41	0	$0	11	$597
Jul	3,168	12	0	$41	0	$0	11	$592
Aug	3,306	10	0	$41	0	$0	11	$610
Sept	2,088	11	0	$41	0	$0	7	$423
Oct	1,244	9	65	$156	0	$0	11	$387
Nov	1,373	7	133	$277	0	$0	18	$522
Dec	1,521	7	183	$365	0	$0	23	$631
Year	**22,413**	**105**	**1,150**	**$2,526**	**0**	**$0**	**192**	**$6,465**

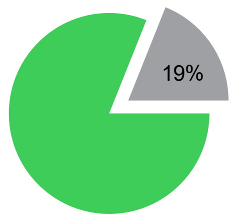
	Electricity		Natural Gas		Water		Total	
Indices	**kBtu/sf**	**W/sf**	**kBtu/sf**	**$/sf**	**ft3/sf**	**$/sf**	**kBtu/sf**	**$/sf**
	30.6	**4.8**	**46.0**	**$1.01**	**0.0**	**$0.00**	**76.6**	**$2.59**

4.2 Energy Savings

The following table highlights projected energy savings as a result of implementing the recommended ECMs.

Paulsboro Public Schools - Project Summary

Energy Cost Savings



Energy and Water Indices	Energy	Water	Cost
	kBtu/sf	*ft3/sf*	*$/sf*
Baseline	76.9	0.0	$1.97
Post Project	60.0	0.0	$1.60
% Savings	**22.0%**	**-**	**18.9%**

Project Summary by Site	Electricity Costs	Fossil Fuels Costs	Water Costs	Total Costs
Project *Phase*	*$*	*$*	*$*	*$*
Baseline	**$217,361**	**$236,050**	**$0**	**$453,411**
Admin	$2,326	$1,713	$0	$4,039
Loudenslager ES	$7,825	$11,429	$0	$19,254
Billingsport ES	$11,420	$13,097	$0	$24,518
Jr Sr High School	$14,836	$21,994	$0	$36,831
Bus Garage	$1,115	$108	$0	$1,224
Post Project	**$179,837**	**$187,709**	**$0**	**$367,546**
Savings	**$37,524**	**$48,341**	**$0**	**$85,865**
Percent Savings	**17.3%**	**20.5%**	**-**	**18.9%**

To estimate savings from the proposed project, Schneider Electric utilized energy modeling software and engineering formulas. Schneider Electric used Excel spreadsheets to accurately quantify savings for measures that have low interactivity. For measures that are significantly affected by interactions of different components, such as mechanical and BAS upgrades, Schneider Electric utilized ELEMENT, a proprietary building modeling tool used to develop baselines and savings for some builds. Using these modeling tool allows for the ability to model existing conditions and proposed retrofits to assess potential energy savings.

For detailed savings calculations for each ECM, please see the Appendix 6.1 Savings Calculations & Documentation and Appendix 6.1 Box Folder.

ECM Savings Summary by Site															
ECM Detail		Total Energy Savings			Total Cost Savings			Detail Unit Savings				Detailed Cost Savings		
Site	ECM	Energy Savings	EUI Savings	Site % Savings	Cost Savings	ECI Savings	Site % Savings	Electric	Electric	Natural Gas	Water	Electric	Natural Gas	Water
Name	Name	MMBtu	kBtu/sf	%	$	$/sf	%	kWh	kW	Therm		$	$	$
Admin	Building Envelope	8	1.1	1.2%	$163	$0.02	1.0%	190	0.0	75	0	$30	$133	$0
Admin	Exterior LED Upgrades - LSI Retrofit	0	0.0	0.0%	$7	$0.00	0.0%	48	0.0	0	0	$7	$0	$0
Admin	Interior LED Upgrades - LSI Retrofit	4	0.5	0.6%	$190	$0.03	1.1%	1,098	7.6	0	0	$190	$0	$0
Admin	LED Lighting - Albright	41	5.5	6.2%	$1,945	$0.26	11.5%	12,061	38.3	0	0	$1,945	$0	$0
Admin	Upgrade BAS	31	4.1	4.6%	$638	$0.08	3.8%	998	0.0	272	0	$155	$482	$0
Admin	Install Condensing Boilers	61	8.0	9.1%	$1,076	$0.14	6.3%	0	0.0	607	0	$0	$1,076	$0
Admin	Low Flow Hot Water Devices	1	0.2	0.2%	$21	$0.00	0.1%	0	0.0	12	0	$0	$21	$0
HS	Bi-Polar Ionization	884	6.3	10.7%	$17,629	$0.13	8.1%	17,410	48.0	8,248	0	$2,621	$15,008	$0
HS	Building Envelope	270	1.9	3.3%	$5,072	$0.04	2.3%	5,596	0.0	2,509	0	$506	$4,565	$0
HS	Demand Controlled Ventilation	450	3.2	5.4%	$8,827	$0.06	4.1%	22,342	0.0	3,740	0	$2,021	$6,805	$0
HS	Exterior LED Upgrades - LSI Retrofit	12	0.1	0.2%	$331	$0.00	0.2%	3,657	0.0	0	0	$331	$0	$0
HS	Interior LED Upgrades - LSI Retrofit	17	0.1	0.2%	$1,692	$0.01	0.8%	13,485	57.4	-290	0	$2,219	-$527	$0
HS	LED Lighting - Albright	108	0.8	1.3%	$10,137	$0.07	4.7%	96,612	314.8	-2,222	0	$14,180	-$4,043	$0
HS	Outside Air Baseline Adjustment	-2,579	-18.3	-31.1%	-$50,793	-$0.36	-23.3%	-37,944	-123.3	-24,492	0	-$6,229	-$44,565	$0
HS	Pipe Insulation	97	0.7	1.2%	$1,772	$0.01	0.8%	0	0.0	974	0	$0	$1,772	$0
HS	Replace Steam Plant	499	3.5	6.0%	$7,341	$0.05	3.4%	-49,084	-27.4	6,667	0	-$4,789	$12,130	$0
HS	Replace Uvs (DX)	174	1.2	2.1%	$3,667	$0.03	1.7%	-6,563	28.0	1,968	0	$87	$3,580	$0
HS	Upgrade BAS	1,815	12.9	21.9%	$35,860	$0.25	16.5%	99,951	0.0	14,738	0	$9,043	$26,817	$0
HS	Vending Machine Controls	9	0.1	0.1%	$233	$0.00	0.1%	2,574	0.0	0	0	$233	$0	$0
HS	Low Flow Hot Water Devices	26	0.2	0.3%	$473	$0.00	0.2%	0	0.0	260	0	$0	$473	$0
HS	Replace Auditorium AHUs Baseline Adju	-32	-0.2	-0.4%	-$2,905	-$0.02	-1.3%	-9,296	-100.0	-8	0	-$2,891	-$14	$0
HS	Replace Gym AHUs Baseline Adjustmen	-28	-0.2	-0.3%	-$2,505	-$0.02	-1.2%	-8,178	-85.4	-5	0	-$2,496	-$9	$0
Bus Garage	LED Lighting - Albright	23	9.1	11.9%	$1,048	$0.42	16.2%	6,657	12.5	0	0	$1,048	$0	$0
Bus Garage	Upgrade BAS	8	3.0	4.0%	$175	$0.07	2.7%	431	0.0	61	0	$67	$108	$0
LES	Abandon Whole Building Exhaust Fan	-52	-1.3	-1.3%	-$2,077	-$0.05	-2.1%	-15,167	-39.7	0	0	-$2,077	$0	$0
LES	Bi-Polar Ionization	309	7.9	8.0%	$6,049	$0.15	6.0%	5,162	13.7	2,909	0	$756	$5,293	$0
LES	Building Envelope	77	2.0	2.0%	$1,449	$0.04	1.4%	1,480	0.0	723	0	$134	$1,316	$0
LES	CHP	91	2.3	2.3%	$2,938	$0.07	2.9%	25,674	42.0	32	0	$2,880	$58	$0
LES	Demand Controlled Ventilation	231	5.9	6.0%	$4,552	$0.12	4.5%	12,442	0.0	1,883	0	$1,126	$3,426	$0
LES	Exterior LED Upgrades - LSI Retrofit	12	0.3	0.3%	$318	$0.01	0.3%	3,517	0.0	0	0	$318	$0	$0
LES	Interior LED Upgrades - LSI Retrofit	9	0.2	0.2%	$909	$0.02	0.9%	7,158	30.8	-154	0	$1,189	-$280	$0
LES	LED Lighting - Albright	28	0.7	0.7%	$2,871	$0.07	2.9%	24,028	95.6	-540	0	$3,853	-$982	$0
LES	Outside Air Baseline Adjustment	-1,224	-31.2	-31.6%	-$24,063	-$0.61	-24.0%	-18,327	-53.3	-11,613	0	-$2,932	-$21,132	$0
LES	Replace Uvs (DX)	85	2.2	2.2%	$2,056	$0.05	2.0%	-2,989	26.2	952	0	$323	$1,733	$0
LES	Upgrade BAS	827	21.1	21.4%	$16,159	$0.41	16.1%	38,923	0.0	6,945	0	$3,522	$12,637	$0
LES	Install Condensing Boilers	456	11.6	11.8%	$8,289	$0.21	8.3%	0	0.0	4,555	0	$0	$8,289	$0
LES	Low Flow Hot Water Devices	6	0.2	0.2%	$159	$0.00	0.2%	1,759	0.0	0	0	$159	$0	$0
LES	Boiler Reset Controls	60	1.5	1.5%	$1,083	$0.03	1.1%	0	0.0	595	0	$0	$1,083	$0
LES	Replace Gym AHU Baseline Adjustment	-18	-0.5	-0.5%	-$1,438	-$0.04	-1.4%	-5,182	-46.1	-7	0	-$1,425	-$13	$0
BES	Bi-Polar Ionization	432	10.8	9.3%	$8,678	$0.22	7.8%	6,430	32.8	4,103	0	$1,402	$7,276	$0
BES	Building Envelope	183	4.6	3.9%	$3,354	$0.08	3.0%	3,564	0.0	1,710	0	$322	$3,032	$0
BES	Demand Controlled Ventilation	179	4.5	3.8%	$3,463	$0.09	3.1%	9,765	0.0	1,455	0	$883	$2,580	$0
BES	Exterior LED Upgrades - LSI Retrofit	46	1.1	1.0%	$1,207	$0.03	1.1%	13,346	0.0	0	0	$1,207	$0	$0
BES	Interior LED Upgrades - LSI Retrofit	11	0.3	0.2%	$1,049	$0.03	0.9%	8,571	33.6	-181	0	$1,370	-$321	$0
BES	LED Lighting - Albright	40	1.0	0.9%	$5,025	$0.13	4.5%	45,759	182.3	-1,160	0	$7,081	-$2,056	$0
BES	Outside Air Baseline Adjustment	-1,325	-33.2	-28.4%	-$26,221	-$0.66	-23.4%	-18,720	-87.1	-12,607	0	-$3,867	-$22,353	$0
BES	Upgrade BAS	880	22.1	18.9%	$16,539	$0.41	14.8%	31,424	0.0	7,725	0	$2,843	$13,696	$0
BES	Install Condensing Boilers	561	14.1	12.0%	$9,945	$0.25	8.9%	0	0.0	5,609	0	$0	$9,945	$0
BES	Low Flow Hot Water Devices	7	0.2	0.1%	$178	$0.00	0.2%	1,963	0.0	0	0	$178	$0	$0
BES	Boiler Reset Controls	73	1.8	1.6%	$1,299	$0.03	1.2%	0	0.0	733	0	$0	$1,299	$0
Total Project Savings		3,882	16.9	22.0%	$85,865	$0.37	18.9%	352,626	401.3	26,782	0	$37,524	$48,341	$0

**The electricity generated from the CHP (boxed in red above) is in actuality Distributed Generation (DG), not energy savings. The modeling and calculation tools do not distinguish the difference in this report, but it is important to note the DG compared to the rest of the energy savings in the project.*

ECMs or ECM names may change during the course of the IGA development, so some of the ECM names in the ECM Savings Summary by Site table above do not perfectly match up with the ECM name on Form II. The table below correlates ECMs between the two tables.

ECM Savings Summary by Site Description	Correlated ECM Name on Form II
Building Envelope	Building Envelope & Insulation
Install Condensing Boilers	Replace Boilers & Air/Dirt Separators
Low Flow Hot Water Devices	Vending Machine Controls & Low Flow HW Devices
Exterior LED Upgrades - LSI Retrofit	LED Lighting - Interior & Exterior
Interior LED Upgrades - LSI Retrofit	LED Lighting - Interior & Exterior
LED Lighting - Albright	LED Lighting - Interior & Exterior
Upgrade BAS	New Unit Ventilators (DX Cooling) + Optimize BAS Controls
Bi-Polar Ionization	Advanced Air Purification
Demand Controlled Ventilation	Advanced Air Purification
Boiler Reset Controls	Replace Boilers & Air/Dirt Separators
Outside Air Baseline Adjustment	Baseline Adjustment
Pipe Insulation	Building Envelope & Insulation

ECM Savings Summary by Site Description	Correlated ECM Name on Form II
Replace Auditorium AHUs Baseline Adjustment	Baseline Adjustment
Replace Gym AHUs Baseline Adjustment	Baseline Adjustment
Replace Steam Plant	Replace Boilers & Air/Dirt Separators
Replace Uvs (DX)	New Unit Ventilators (DX Cooling) + Optimize BAS Controls
Vending Machine Controls	Vending Machine Controls & Low Flow HW Devices
Abandon Whole Building Exhaust Fan	New Unit Ventilators (DX Cooling) + Optimize BAS Controls
CHP	Combined Heat & Power (CHP)
Replace Gym AHU Baseline Adjustment	Baseline Adjustment

In addition to the energy savings noted above, this project will provide O&M savings for the District.

ECM	Annual O&M Savings	Years Claimed
LED Lighting	$8,668	5
UV Replacements	$8,000	2
Boiler Replacements	$1,300	2
Steam to Hot Water Boiler Plant Conversion	$2,500	2

4.3 Environmental Impact

The following table summarizes the environmental impact of the project.

Therms Savings	kWh Savings	Emission Product	Emission Reduction (lbs)
26,782	352,626	CO_2	768,942
		NO_x	539
		SO_2	236

The emissions reductions are calculated based on the following factors, based on BPU protocols.

- 1,292 lbs. CO_2 per MWh saved
- 0.83 lbs. NO_x per MWh saved
- 0.67 lbs. SO_2 per MWh saved
- 11.7 lbs. CO_2 per therm saved
- 0.0092 lbs. NO_x per therm saved

5.0 Implementation

5.1 Design & Compliance Issues

This project was developed using the proper Building Codes, Energy Codes, and Electrical Codes. Safety is of the utmost important to Schneider Electric, not only for our customers, but also for our employees and subcontractors. SE will comply with all the required safety codes and protocols to ensure a successful implementation.

5.2 Assessment of Risks

This assessment of risks is meant to provide Paulsboro Public Schools with an idea of the potential risks that lie within the ESIP project. By no means is this an effort to eliminate responsibility of the ESCO to provide an Energy Savings Plan that meets industry standards of engineering, energy analysis, and expertise. This is included to allow the District to understand where potential failure points could be that would result in savings not being achieved or operational issues.

- If actual operation of the buildings deviates significantly from the parameters outlined in the Energy Savings Plan with respect to temperature set points and occupied times, energy savings associated with the building automation system and HVAC upgrades could be affected.
- Building Automation System sequences of operation must not be over-ridden or changed permanently. Overrides are permitted for maintenance or special occasions but must be reset to maintain energy savings.
- If outside air dampers or control sequences are over-ridden for extended periods, it would have an impact on the savings realized by Paulsboro.
- Lighting systems will require maintenance as they age. Replacement parts need to be of similar energy efficiency to maintain savings.

5.3 Post Project Support

The following is a description of services and terms that are used within this section.

Remote Energy Management, Training & Technical Support

This involves live remote telephone and internet support used to provide instruction, assisted troubleshooting, and system training. This on-call service provides technical support for all installed systems and measures and helps reduce system downtime.

Remote System Monitoring and Reporting

Activities include monitoring live conditions, reviewing and analyzing trends, recording deficiencies, as well as tuning, adjusting, and optimizing parameters. This also includes reporting operational performance of specific systems and equipment necessary to sustain energy savings, comfort, and safety. This helps manage and ensure key variables for energy measures are maintained to allow for sustained savings, performance, and comfort.

On-site Visits

On-site visits include a review and report of changes to operations (past, present, and future), usage, status, and conditions of building systems and equipment relative to their impact on energy performance. ECM and systems training can be provided upon request. Benefits include:

- Expert advice to aid in energy planning based on operational and future commitments

- Identifying excess energy targets and recommendations for improvement
- An increase in overall energy awareness

Resource Advisor

Resource Advisor is Schneider Electric's enterprise-level application providing secure access to data reports and summaries to drive the City's energy and sustainability programs. Resource Advisor combines quality assurance and data capture capabilities of utility information into one energy management solution.

Client Services Program

Schneider Electric's Client Services program is designed to assist Paulsboro Public Schools in sustaining savings over the long term. Based on the scope of this project, Schneider Electric recommends an ongoing services and post-project support program as described below. The Installation scope is included in the ESIP project already, and the 1st year of post project support is included in the project's cash flow as well. After the first year, Paulsboro will have the option to select whichever services they would like, and enter into a separate agreement with Schneider Electric for them.

	Initial Term			
	Installation	Year 1	Year 2	Year 3
Remote Energy Management Training and Technical Support - Total Hours	Included	8	4	Customer Option
Remote System Monitoring and Reporting - BAS Reviews and Interaction	Included	Monthly	Bi-monthly	Customer Option
On-Site Visits – Energy Consulting and Assessment	Included	Bi-Annual	Annual	Customer Option
On-Site Training - Total Hours	Included	4	2	Customer Option
Resource Advisor - with Energy Star Module Package (2 meters) - Setup and Annual Subscription (Setup Fee only included during Installation Period)	Included	Included	Included	Customer Option
Resource Advisor - with Energy Star Module Package (9 meters) - Setup and Annual Subscription (Setup Fee only included during Installation Period)	Customer Option	Customer Option	Customer Option	Customer Option
	Installation	Year 1	Year 2	Year 3
Total (Base Price)	$11,854	$15,703	$9,142	Customer Option
Total (Add Option)	$1,602	$1,470	$1,470	Customer Option

5.4 Measurement and Verification (M&V) Plan

The M&V Plan that is recommended for Paulsboro for this ESIP project is based around non-measured savings, leveraging the savings models as the basis. Because of the nature of the project, and the specific scopes of work (new UVs with added DX cooling), a more comprehensive M&V Plan is not recommended. The District would not see a favorable return on their investment if a more detailed M&V strategy was selected, such as tracking utility meters (IPMVP Option C). The cost to perform this level of M&V would constitute a sizeable portion of the overall savings that would be tracked, thus providing less savings for Paulsboro to make use of in the budget.

6.0 Appendices

6.1 Savings Calculations & Documentation

Below is a high-level summary of how savings were calculated for each measure included in this report. **For further documentation of savings calculations, please see the Appendices Box folder.**

Energy Analysis Methodology

Many tools and approaches exist for effectively analyzing energy conservation measures. Some ECMs are best analyzed in an individual spreadsheet calculation while other more comprehensive ECMs require higher levels of computer modeling to capture the entirety of their impact on energy consumption and demand. In general, the complexity of analysis tools escalates from spreadsheet calculations to, to more sophisticated computer software-based building simulation tools such as eQuest. Aspects such as total savings potential, influence on other ECMs, influence from weather, and overall complexity are all considered when selecting the analysis approach or tool for an ECM.

Below is a table displaying the ECMs and the analysis tool used for calculating the savings. Following the table are descriptions for each of the analysis tool and approaches used for calculating savings.

ECM	Analysis Tool
Bi-Polar Ionization	ELEMENT/Spreadsheet Calculations
Install Condensing Boilers	ELEMENT/Spreadsheet Calculations
Building Envelope	Spreadsheet Calculations
Upgrade BAS	ELEMENT/Spreadsheet Calculations
LED Lighting	ELEMENT/Spreadsheet Calculations
Pipe Insulation	Spreadsheet Calculations
Low Flow Hot Water Devices	Spreadsheet Calculations
Outside Air Baseline Adjustment	ELEMENT
Replace Unit Ventilators	ELEMENT
Boiler Reset Controls	ELEMENT
Replace Gym AHU	ELEMENT
Abandon Whole Building Exhaust Fan	ELEMENT
Combined Heat and Power	Spreadsheet Calculations
Demand Controlled Ventilation	Spreadsheet Calculations
Replace Steam Plant	ELEMENT
Replace Auditorium AHU	ELEMENT
Vending Machine Controls	Spreadsheet Calculations

Savings Methods – Spreadsheet Calculations

Schneider Electric utilizes a mixture of spreadsheet calculations and basic formula calculation tools. eCalc is a proprietary Microsoft Excel based spreadsheet calculation tool used for calculating energy consumption and savings for an ECM, rather than a comprehensive building analysis approach. Often an approach using eCalcs or other spreadsheet calculations is the most accurate and reasonable way of approaching ECMs in which their operation, situation, or contribution to the baseline is limited.

What separates eCalcs from other spreadsheet-based tools is its integration of bin weather data into many of its standard calculations. Equipment or infiltration often has fluctuating savings opportunity as outside air reaches new high and low average temperatures through different seasons. By capturing the quantity of hours inside specific temperature ranges, these ECMs can better replicate the demand on the system, run hours, and heating and cooling loads. Below is an example of an eCalc spreadsheet for calculating envelope improvement savings.

eCalcs: Energy Calculation Suite

Life Is On | Schneider Electric

projectName - Loudenslager ES

Infiltration

Building Data

Building Name	Loudenslager ES
Weather City	PA, Philadelphia-International
Building Height, ft	15
Building Orientation, deg	0
Building L/W Ratio	3.0
Internal Draft Coefficient	0.7

Building Operating Conditions

Occupied Set Point Temp, oF	72.0
Cooling Setup Temp, oF	80.0
Percent of Building Cooled, %	73%
Cooling Seasonal Efficiency, %	356%
Heating Setback Temp, oF	60.0
Percent of Building Heated, %	100%
Heating Seasonal Efficiency, %	93%

Shelter Characteristics

Direction	Shelter Class	Terrain Category
See Reference Tables for Descriptions		
North	3	3
East	3	3
South	3	3
West	3	3

Building Crack Definitions

Penetration	Type	H	Qty	Length	Gap	% Open	Total Area	Wall Only
Name	*Select*	*ft*	*#*	*ft*	*inches*	*%*	*sqft*	*sqft*
Crack 1	Roof	7.5				100%	0.0	0.0
Crack 2	Door	-4.5	1	264	1/8	100%	2.8	2.8
Crack 3	Door	-4.5	1	80	1/8	100%	0.8	0.8
Crack 4	Roof-Wall	7.5	1	81	1/8	100%	0.8	0.8
Crack 5	Roof-Wall	7.5	1	31	1/12	100%	0.2	0.2
Crack 6	Wall	0.0				100%	0.0	0.0
Crack 7	Wall	0.0				100%	0.0	0.0
Crack 8	Wall	0.0				100%	0.0	0.0
Crack 9	Wall	0.0				100%	0.0	0.0
Crack 10	Wall	0.0				100%	0.0	0.0
Crack 11	Wall	0.0				100%	0.0	0.0
Crack 12	Wall	0.0				100%	0.0	0.0
Crack 13	Wall	0.0				100%	0.0	0.0
Effective H (Wall Only)		-1.8					4.6	4.6

Notes: H is the height difference between the crack and the neutral pressure level of the building.

Effective Building Coefficients

Shelter Coefficient	0.7
Wind Shear Exponent	0.14
Boundary Layer Thickness, ft	900
Wall Pressure Coefficient	0.11
Roof Pressure Coefficient	-0.30

Site Parameters

Average Wind Speed, mph	9.4
Site Corrected Wind Speed, mph	8.4
Model Wind Coefficient	0.22
Draft Factor	0.13
Volume Factor, ft/min (in-wg)^0.5	2,603

Energy Engineering Calculations

	Temperature Bin Hours						Calculated Infiltration Rates				Energy Transfer		Energy Savings	
	Mid Pt				BAS		Occupied Rates		Unoccupied Rates		Occupied	Unocc	Cooling	Heating
	Temp	MCWB	Density	Enthalpy	Occupied	Unocc	Wall	Roof	Wall	Roof	Load	Load	Savings	Savings
Ref	*oF*	*oF*	*lb/ft3*	*Btu/lb*	*hrs/yr*	*hrs/yr*	*cfm*	*cfm*	*cfm*	*cfm*	*kBtu/yr*	*kBtu/yr*	*kBtu/yr*	*kBtu/yr*
1	9	6.5	0.085	2.8	17	5	287	0	106	0	-584	-47	0	678
2	13	10.1	0.084	3.9	18	20	246	0	102	0	-501	-170	0	721
3	16	14.0	0.083	5.1	43	34	196	0	180	0	-896	-464	0	1,463
4	20	17.4	0.082	6.3	53	56	132	0	231	0	-697	-903	0	1,721
5	24	20.3	0.082	7.3	130	112	55	0	272	0	-672	-1,952	0	2,822
6	28	24.1	0.081	8.7	207	144	156	0	309	0	-2,794	-2,530	0	5,725
7	31	27.7	0.080	10.0	300	211	213	0	341	0	-5,057	-3,587	0	9,295
8	35	31.1	0.080	11.3	226	194	257	0	370	0	-4,187	-3,098	0	7,834
9	39	33.8	0.079	12.5	268	248	293	0	396	0	-5,182	-3,665	0	9,513
10	43	37.4	0.079	14.0	299	207	326	0	421	0	-5,689	-2,603	0	8,916
11	46	41.4	0.078	15.8	283	234	357	0	446	0	-4,993	-2,204	0	7,738
12	50	44.7	0.077	17.5	226	186	385	0	468	0	-3,599	-1,164	0	5,122
13	54	47.7	0.077	19.0	288	231	410	0	489	0	-4,018	-709	0	5,083
14	58	52.1	0.076	21.4	366	274	436	0	511	0	-3,620	679	0	3,163
15	61	56.2	0.075	23.9	386	278	461	0	514	0	-2,009	0	0	2,161
16	65	59.1	0.074	25.8	254	185	482	0	512	0	-352	0	0	379
17	69	62.0	0.074	27.8	357	315	503	0	510	0	1,096	0	225	0
18	73	65.8	0.073	30.6	355	319	525	0	507	0	3,427	0	704	0
19	76	67.7	0.073	32.0	328	209	541	0	505	0	4,365	0	896	0
20	80	69.2	0.072	33.3	211	100	556	0	511	0	3,482	458	809	0
21	84	70.1	0.072	34.0	241	62	570	0	526	0	4,490	396	1,003	0
22	88	72.2	0.071	35.8	164	20	585	0	543	0	3,860	215	837	0
23	91	74.7	0.070	38.1	71	5	602	0	560	0	2,108	82	450	0
24	95	75.0	0.070	38.4	14	1	612	0	571	0	430	17	92	0
25	99	76.9	0.069	40.1	5	0	626	0	586	0	179	0	37	0
					5,110	3,650							5,052	72,333

Savings Summary

Type	Savings	Units	Utility Type
Cooling	1,480	kWh	Electricity
Heating	723	Therm	Natural Gas - Therm

Savings Methods – ELEMENT

The ELEMENT tool was developed to provide transparency into the end use breakdown of energy consumption for each fuel type. The simplified building inputs and schedules are used in a powerful hourly load analysis to provide quick building calibrations. Energy saving scenarios can be run quickly to see the financial impact to the overall project and generate useful graphs for visualization and reports.

ELEMENT is Schneider Electric's proprietary Microsoft Excel based spreadsheet calculation tool used for simulating building energy consumption. Its purpose is to allow a user with prior knowledge of a facility and its energy using equipment to simulate energy consumption, compare the outputs to historical utility data of the facility, breakout the calibrated baseline into its end use components and determine the energy savings of Energy Conservation Measures (ECMs).

The tool uses a variety of Excel functions and custom generated algorithms written in Visual Basic for Applications (VBA) to quickly simulate the energy consumption of a simple to moderately complex building. Heating and cooling loads are determined on an hourly basis (8,760 hours per year) using TMY2 or TMY3 weather data and the building definitions specified by the user. Loads are generated by the user inputs and key building variables are defined and adjusted to calibrate and predict energy impacts.

Calculations

The Element tool is an hourly load and energy analysis tool used for whole building energy models. The results show end use breakdowns of energy on a monthly basis while allowing for quick calibration to utility billing data. Energy conservation measures can be easily defined and reviewed using the ECM tab to redefine variables used in the baseline model. Each new ECM run is sequential and uses the variable last defined by the previously successful run. The savings are determined by the difference in runs by either actual, percent or minimum unit method, as described previously.

The hourly outdoor air conditions and solar data are imported from the National Renewable Energy Laboratories (NREL) typical meteorological year (TMY) data set. The building calendar defines up to four typical day types that occur throughout the year. These day types are used by the hourly load percentage schedules and HVAC schedules used to define the operation of internal and external building loads, as well as the fan operation of the HVAC system. All 365 days of the year are assigned a day type as defined by the calendar and each hour of the day has an hourly load percentage for each load schedule name and on or off status for each HVAC schedule name. The occupied and unoccupied set points are also driven by the on/off status of the HVAC fan. An algorithm determines if the system is in heating or cooling mode based on the user inputs and weather data in order to determine which occupied heating or cooling set point to use.

Zone and system loads are calculated using industry standard engineering equations (ASHRAE) as listed below based on the user defined building parameters described in the baseline calculation inputs section. The total sensible system load determines if heating or cooling energy is required (negative results for heating and positive values for cooling). Calculations are repeated for each hour of the year to determine the total annual loads and energy consumption.

The following is a sampling of the variables and equations used for calculations the building loads and energy consumption and demand.

Weather and Solar Data

Outdoor Air Dry Bulb Temperature, ^oF
Outdoor Air Density, lbm air/ft^3
Outdoor Air Humidity Ratio, lbm water/lbm air
Solar Direct Normal Irradiance, Btu/ft^2
Solar Diffuse Horizontal Irradiance, Btu/ft^2

Sol-air Temperature, ^oF

- $T_{SA} = T_{OA} + (\alpha \times I_N / h_o) - (\varepsilon \times \Delta R / h_o)$
    - α = wall or roof absorptivity of solar radiation based on surface color, dimensionless
    - I_N = direct normal solar flux on wall and diffuse horizontal irradiance on roof, Btu/hr-ft^2
    - h_o = the convective heat transfer coefficient on exterior wall or roof = 3.0 Btu/h-ft^2 ^oF
    - ε = hemispherical emittance of exterior surface = 1.0 Btu/h-ft^2
    - ΔR = long wave radiation incident on exterior surface and blackbody radiation
        - For vertical surfaces (walls), ΔR = 0 (vertical surfaces)
        - For horizontal surfaces (roof), ΔR = 20.0 Btu/h-ft^2

Zone Loads

Sensible Zone Loads, Btu

Internal Heat Gains

- Lighting, $Q_{S\_LTG} = L_{LTG} \times A_{BLDG} / 1000 \times HLP_{LTG} \times C$
- Equipment, $Q_{S\_EQUIP} = L_{EQUIP} \times A_{BLDG} / 1000 \times HLP_{EQUIP} \times C$
- People, $Q_{S\_PEOPLE} = n_{PEOPLE} \times HGF_{S\_PEOPLE} \times HLP_{PEOPLE}$
    - A_{BLDG} = building area, ft^2
    - C = conversion factor kW to kBtu = 3412 kBtu/kWh
    - HGF_{S_PEOPLE} = heat gain factor (sensible) based on activity level, (see Table 1), Btu/h-person
    - HLP = hourly load percentage of peak load based on assigned schedule, %
    - L = peak load density, W/ft^2
    - n_{PEOPLE} = number of people, persons

Envelope Loads

- Wall, $Q_{S\_WALL} = 1/R_{WALL} \times (A_{WALL} - A_{WINDOW}) \times (T_{SA\_WALL} - T_{SP})$
- Roof, $Q_{S\_ROOF} = 1/R_{ROOF} \times (A_{ROOF}) \times (T_{SA\_ROOF} - T_{SP})$
- Window Conduction, $Q_{S\_WINDOW,C} = U_{WINDOW} \times A_{WINDOW} \times (T_{OA} - T_{SP})$
- Window Radiation, $Q_{S\_WINDOW,R} = A_{WINDOW} \times SHGC \times (1 - ES) \times I_N$
- Infiltration, $Q_{S\_INFIL} = \rho \times c_p \times q_{INF} \times A_{WALL} \times 60 \times (T_{OA} - T_{SP})$
    - ρ = density of outdoor air, lbm/ft^3
    - A_{ROOF} = roof area, ft^2
    - A_{WALL} = exterior wall area, ft^2
    - A_{WINDOW} = window area, ft^2
    - c_p = heat capacity of air = 0.24 Btu/lbm ^oF
    - ES = exterior shading, %
    - q_{INF} =infiltration rate per area of exterior wall, CFM/ft^2
    - R_{WALL} = R-value of roof, hr-ft^2-^oF/Btu
    - R_{ROOF} = R-value of roof, hr-ft^2-^oF/Btu
    - SHGC = solar heat gain coefficient based on window selection (see Table 2), dimensionless
    - T_{OA} = outdoor air dry bulb temperature, ^oF
    - T_{SA_ROOF} = sol-air temperature of the roof, ^oF
    - T_{SA_WALL} = sol-air temperature of the wall, ^oF
    - T_{SP} = indoor air dry bulb temperature, ^oF
    - U_{WINDOW} = U-value of the window based on window selection (see Table 3), Btu/h-^oF-ft^2

Latent Zone Loads, Btu

Internal Heat Gains

- People, $Q_{L\_PEOPLE} = n_{PEOPLE} \times HGF_{L\_PEOPLE} \times HLP_{PEOPLE}$
  - HGF_{L_PEOPLE} = heat gain factor (latent) based on activity level (see Table 1), Btu/h-person

Envelope Loads

- Infiltration, $Q_{L\_INFIL} = \rho \times h_{fg} \times q_{INF} \times A_{WALL} \times 60 \times (\omega_{OA} - \omega_{SP})$
  - h_{fg} = latent heat of vaporization of water = 1054.8 Btu/lbm water
  - ω_{OA} = humidity ratio of outdoor air, lbm water/lbm air
  - ω_{SP} = humidity ratio of indoor space set point, lbm water/lbm air

Total Zone Loads, kBtu

- Sensible, $Q_{S\_ZONE} = (Q_{S\_LTG} + Q_{S\_EQUIP} + Q_{S\_PEOPLE} + Q_{S\_WALL} + Q_{S\_ROOF} + Q_{S\_WINDOW,C} + Q_{S\_WINDOW,R} + Q_{S\_INFIL}) / 1000$
- Latent, $Q_{L\_ZONE} = (Q_{L\_PEOPLE} + Q_{L\_INFIL}) / 1000$
- Total, $Q_{TOTAL\_ZONE} = Q_{S\_ZONE} + Q_{L\_ZONE}$

System Loads

Ventilation, CFM

- Ventilation Rate, $Q_{OA} = R_{PEOPLE} \times n_{PEOPLE} + R_{AREA} \times A_{BLDG}$
  - R_{PEOPLE} = outdoor air rate per person, CFM/person
  - R_{AREA} = outdoor air rate per floor area, CFM/ft^2

Ventilation Loads, Btu

- Ventilation Sensible, $Q_{S\_VENT} = \rho \times c_p \times 60 \times Q_{OA} \times (T_{OA} - T_{SP})$
- Ventilation Latent, $Q_{L\_VENT} = \rho \times h_{fg} \times 60 \times Q_{OA} \times (\omega_{OA} - \omega_{SP})$

Total System Loads, kBtu

- System Sensible, $Q_{S\_SYSTEM} = Q_{S\_ZONE} + (Q_{S\_VENT} / 1000)$
- System Latent, $Q_{L\_SYSTEM} = Q_{L\_ZONE} + (Q_{L\_VENT} / 1000)$
- System Total, $Q_{TOTAL\_SYSTEM} = Q_{S\_SYSTEM} + Q_{L\_SYSTEM}$

Energy Consumption

Electric, kWh

- Lighting, $E_{LTG} = L_{LTG} \times A_{BLDG} / 1000 \times HLP_{LTG}$
- Equipment, $E_{EQUIP} = L_{EQUIP} \times A_{BLDG} / 1000 \times HLP_{EQUIP}$
- Miscellaneous Electric Load 1, $E_{MISCE,1} = L_{MISCE,1} \times HLP_{MISCE,1}$ (typical of 3)
  - $L_{MISCE,1}$ = peak miscellaneous electric load 1, kW (typical of 3)
  - $HLP_{MISCE,1}$ = hourly load percentage of miscellaneous electric load 1 (typical of 3)
- Fans, $E_{FAN} = E_{C,FAN} + E_{P,FAN} + E_{V,FAN}$
  If the HVAC schedule is on or if the fan availability is enabled and there is a load on the system, then
  - Constant fan speed, $E_{C,FAN} = L_{C,FAN}$
  - Proportional fan speed, $E_{P,FAN} = L_{V,FAN} \times PL$
  - Variable fan speed, $E_{V,FAN} = L_{V,FAN} \times PL^{2.5}$
    - $L_{C,FAN}$ = constant fan load, kW
    - $L_{V,FAN}$ = variable fan load, kW
    - S_{MIN_FAN} = minimum fan speed, %
    - PL = percentage of load equal to the maximum of $(Q_{S\_SYSTEM} / Q_{HTG\_DESIGN})$, $(Q_{TOTAL\_SYSTEM} / Q_{CLG\_DESIGN})$, or (S_{MIN_FAN})

- Pumps, $E_{PUMP} = E_{C,PUMP} + E_{P,PUMP} + E_{V,PUMP}$ (typical of heating and cooling)
  If the HVAC schedule is on or if the pump availability is enabled and there is a load on the system, then
  - Constant pump speed, $E_{C,PUMP} = L_{C,PUMP}$
  - Proportional pump speed, $E_{P,PUMP} = L_{V,PUMP}$ x PL
  - Variable pump speed, $E_{V,PUMP} = L_{V,PUMP}$ x $PL^{2.5}$
    - $L_{C,PUMP}$ = constant pump load, kW (typical of heating and cooling)
    - $L_{V,PUMP}$ = variable pump load, kW (typical of heating and cooling)
    - S_{MIN_PUMP} = minimum pump speed, % (typical of heating and cooling)
    - PL_{HTG} = percentage of heating load equal to the maximum of (Q_{S_SYSTEM} / Q_{HTG_DESIGN}) or $S_{MIN\_PUMP,HTG}$
    - PL_{CLG} = percentage of cooling load equal to the maximum of (Q_{TOTAL_SYSTEM} / Q_{CLG_DESIGN}) or $S_{MIN\_PUMP,CLG}$

If the HVAC schedule is on or if the fan availability is enabled and there is a load on the system, then energy calculations will be done for heating or cooling depending on the polarity of the load (positive for cooling, negative for heating).

- Heating (Electric), E_{HTG} = (-1) x Q_{S_SYSTEM} x $P_{HTG,E}$ / η_{HTG_E} / 3.412
    - $\eta_{HTG,E}$ = electric nominal heating efficiency, %
    - $P_{HTG,E}$ = percentage of load assigned to electric heat, %
    - Q_{S_SYSTEM} = hourly calculated heating load (negative values), kBtu
- Cooling, E_{CLG} = Q_{TOTAL_SYSTEM} / 12 x η_{CLG_PL} x P_{CLG}
  - Part Load Ratio, PLR_{CLG} = Q_{TOTAL_SYSTEM} / (Q_{CLG_DESIGN} x OF_{CLG}), dimensionless
  - Energy Input Ratio, EIR_{CLG} = a + b x PLR_{CLG} + c x PLR_{CLG}^2 + d x PLR_{CLG}^3, dimensionless
  - Cooling Part Load Efficiency, η_{CLG_PL} = η_{CLG} x PLR_{CLG} / EIR_{CLG}, kW/ton
    - a, b, c, d = cooling efficiency curve coefficients (see Table 4) based on system selection, dimensionless
    - η_{CLG} = nominal cooling efficiency, kW/ton
    - OF_{CLG} = oversize factor used to adjust calculated cooling design load, %
    - P_{CLG} = percent of building with cooling, %
    - Q_{CLG_DESIGN} = total cooling design load based on design day conditions, kBtu
    - Q_{TOTAL_SYSTEM} = hourly calculated cooling load (positive values), kBtu

Fuel, kBtu

- Miscellaneous Fuel Load 1, $F_{MISCF,1}$ = $L_{MISCF,1}$ x $HLP_{MISCF,1}$ / $\eta_{MISCF,1}$ (typical of 3)
  - $L_{MISCF,1}$ = peak miscellaneous fuel load 1, kBtu (typical of 3)
  - $HLP_{MISCF,1}$ = hourly load percentage of miscellaneous fuel load 1 (typical of 3)
  - $\eta_{MISCF,1}$ = miscellaneous fuel load 1 stand-alone efficiency, % (typical of 3)
    - Note: $\eta_{MISCF,1}$ = $\eta_{HTG\_PL,F}$ if miscellaneous load is included on main boiler plant

The heating energy consumption of fuel is calculated and further broken down to provide more resolution into three main end use categories: Envelope, Infiltration, and Ventilation.

- Envelope, F_{HTG_ENV} = (-1) x Q_{S_ZONE} x (1 - $P_{HTG,E}$) x (1 - P_{INF}) / $\eta_{HTG\_PL,F}$
- Infiltration, $F_{HTG,INF}$ = (-1) x Q_{S_ZONE} x (1 - PHTG,E) x P_{INF} / $\eta_{HTG\_PL,F}$
- Ventilation, $F_{HTG,VENT}$ = (-1) x Q_{S_VENT} x (1 - $P_{HTG,E}$) / $\eta_{HTG\_PL,F}$
  - Part Load Ratio, PLR_{HTG} = Q_{S_SYSTEM} / (Q_{HTG_DESIGN} x OF_{HTG}), dimensionless
    - For miscellaneous fuel loads on the plant, Q_{S_SYSTEM} includes these loads.
  - Energy Input Ratio, EIR_{HTG} = a + b x PLR_{HTG} + c x PLR_{HTG}^2, dimensionless
  - Fuel Part Load Efficiency, $\eta_{HTG\_PL,F}$ = $\eta_{HTG,F}$ x PLR_{HTG} / EIR_{HTG}, %

    - a, b, c = heating efficiency curve coefficients (see Table 5) based on system selection, dimensionless
    - $\eta_{HTG,F}$ = fuel nominal heating efficiency, %
    - OF_{HTG} = oversize factor used to adjust calculated heating design load, %
    - $P_{HTG,E}$ = percentage of load assigned to electric heat, %
    - Q_{HTG_DESIGN} = heating design load calculated on design day conditions, kBtu
    - Q_{S_SYSTEM} = hourly calculated heating load (negative values), kBtu
  - Zone Envelope Sensible Load, $Q_{S\_ZONE,ENV} = Q_{S\_WALL} + Q_{S\_ROOF} + Q_{S\_WINDOW,C} + Q_{S\_WINDOW,R}$
  - Percent of Zone Sensible Load attributed to infiltration, $P_{INF} = Q_{S\_ZONE,INF} / (Q_{S\_ZONE,ENV} + Q_{S\_INF})$

Energy Demand

Electric, kW

The tool determined the peak kW load of the month and displays the demand of each end use category component for that hour.

On the following page is an example of an Element model for Billingsport Elementary School. The element model below was used to predict savings for modified BAS scheduling as well as other ECMs.

ELEMENT+

Loudenslager ES

Element

Baseline Calculation Inputs

Building Envelope

39,244	Building Area, sqft
Medium	Building Weight
Exterior Walls	
12.00	R_wall, hr-sqft-oF/Btu
29,652	Total Exterior Wall Area, sqft
Light	Outside Surface Color
Windows	
Alum w/ Thermal Breaks	Frame Type
1/8 in. Clear Double	Glass Type
5%	Exterior Shading Percentage
5,041	Window Area, sqft
20%	% North Facing
30%	% East Facing
20%	% South Facing
30%	% West Facing
Roof	
22.00	R-value, hr-sqft-oF/Btu
39,244	Roof Area, sqft
Light	Outside Surface Color
3.00	Plenum Height, ft

Internal Space Loads

	Peak Load	Units	Schedule
Lighting	0.77	W / sqft	Lighting
Equipment	0.40	W / sqft	Equipment
People	379	People	People
People Activity Level	Sedentary Work		

Outdoor Air

Infiltration	
0.300	CFM / sqft of Exterior Wall Area
11.5	Average Ceiling Height, ft
1.179	Air Change Per Hour, ACH
Ventilation	
4.5	OA Rate, CFM per person
0.01	OA Rate, CFM per sqft
2,265	OA CFM Total
OFF Night	OA Modulation Schedule

Dehumidification

No	Does Building Dehumidify?
Fuel	Type of Reheat

Supply Fans

Const kW	10.49	Variable kW	
Schedule	Baseline	Speed Ctrl	Proportional
Availability	Enabled	Min Speed	100%

Space Set Points

	Occupied	Unoccupied	
Heating	71.0	71.0	oF
Cooling	73.0	73.0	oF
	55.0	55.0	% RH

Heating Pumps

Pump kW	2.26	Availability?	Enabled
Speed Ctrl	Constant	Min Speed	100%

Cooling Pumps

Pump kW		Availability?	Enabled
Speed Ctrl	Constant	Min Speed	100%

Fuel Distribution

Fuel 1	100%	Fuel 2	0%

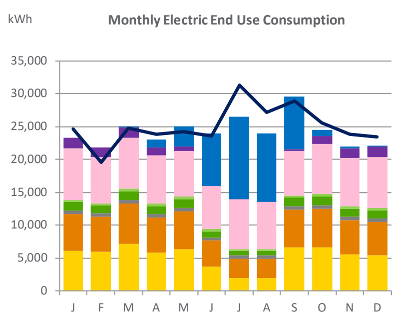
Heating and Cooling Systems

Heating	HW Blr - Forced Draft	System Type
	78%	Fuel Efficiency, %
	1.00	Oversize Factor
	0%	% Load Electric Heat
	100%	Electric Efficiency, %
Cooling	DX Cooling	System Type
	1.19	Cooling Efficiency, kW/ton
	1.00	Oversize Factor
	60%	% Bldg Cooled
	No	Remote Chilled Water?

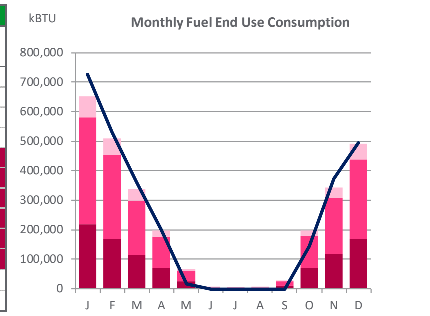
Miscellaneous Loads

Electric	Peak kW	Schedule		
Exterior Ligh	1.4	Ext Lighting		
DHW	4.5	DHW		
Exhaust Fan	0.5	EF ON		Stand-alone
Fuel	**Peak kBtu**	**Schedule**	**Plant?**	**Efficiency**
		Off	No	100%
		Off	No	100%
		Off	No	100%

Energy Modeling Calibration



	Electric Calibration				Fuel Calibration		
	Modeled	**Utility**	**Error**		**Modeled**	**Utility**	**Error**
	kWh	kWh	%		kBTU	kBTU	%
	23,309	24,663	-5%	Jan	652,557	725,509	-10%
	21,846	19,562	12%	Feb	508,901	529,723	-4%
	24,969	24,711	1%	Mar	336,209	359,550	-6%
	22,963	23,867	-4%	Apr	196,240	200,343	-2%
	25,024	24,150	4%	May	65,835	15,429	327%
	23,977	23,504	2%	Jun	4,558	0	n/a
	26,544	31,294	-15%	Jul	2,083	0	n/a
	24,014	27,171	-12%	Aug	5,704	0	n/a
	29,548	28,843	2%	Sep	28,505	0	n/a
	24,480	25,521	-4%	Oct	197,635	143,179	38%
	21,996	23,785	-8%	Nov	343,719	374,204	-8%
	21,976	23,388	-6%	Dec	492,324	495,648	-1%
	290,643	**300,459**	**-3.3%**		**#######**	**########**	**-0.3%**



Baseline Breakout Analysis

Electric Consumption

	Internal Loads		Miscellaneous Loads			Fans and Pumps			Heating and Cooling			
	Lighting	Equipment	terior Lightir	DHW	Exhaust Fans	Fans	Clg Pumps	Htg Pumps	Heating	Cooling	Dehumid	Reheat
	21.8%	20.5%	2.2%	4.7%	1.4%	30.2%	0.0%	3.9%	0.0%	15.3%	0.0%	0.0%
Month	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh
1	6,143	5,544	534	1,285	352	7,773	0	1,678	0	0	0	0
2	6,013	5,262	482	1,220	318	7,049	0	1,502	0	0	0	0
3	7,153	6,097	534	1,415	352	7,783	0	1,540	0	95	0	0
4	5,847	5,312	517	1,231	340	7,416	0	1,211	0	1,088	0	0
5	6,395	5,683	534	1,318	352	7,007	0	686	0	3,050	0	0
6	3,694	3,931	517	907	340	6,566	0	47	0	7,974	0	0
7	1,930	2,920	534	670	352	7,563	0	20	0	12,555	0	0
8	1,930	2,920	534	670	352	7,091	0	54	0	10,463	0	0
9	6,604	5,726	517	1,328	340	6,787	0	307	0	7,938	0	0
10	6,648	5,821	534	1,350	352	7,615	0	1,238	0	922	0	0
11	5,595	5,174	517	1,199	340	7,427	0	1,439	0	307	0	0
12	5,386	5,130	534	1,188	352	7,741	0	1,621	0	24	0	0
	63,337	**59,519**	**6,289**	**13,781**	**4,140**	**87,819**	**0**	**11,343**	**0**	**44,416**	**0**	**0**

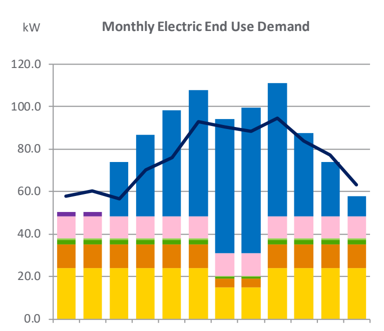
Fuel Consumption

	Miscellaneous Loads			Heating			
	0	0	0	Envelope	Infiltration	Ventilation	Reheat
	0.0%	0.0%	0.0%	34.2%	55.0%	10.8%	0.0%
Month	kBtu	kBtu	kBtu	kBtu	kBtu	kBtu	kBtu
1	0	0	0	217,256	362,360	72,941	0
2	0	0	0	168,722	282,921	57,258	0
3	0	0	0	115,140	183,217	37,852	0
4	0	0	0	70,000	107,028	19,212	0
5	0	0	0	24,695	35,288	5,853	0
6	0	0	0	1,763	2,401	394	0
7	0	0	0	795	1,082	206	0
8	0	0	0	2,147	2,995	563	0
9	0	0	0	10,922	14,866	2,718	0
10	0	0	0	70,829	107,729	19,077	0
11	0	0	0	118,133	189,261	36,324	0
12	0	0	0	167,889	270,838	53,597	0
	0	**0**	**0**	**968,290**	**#######**	**305,995**	**0**

Albright Baseline 95,844

Electric Demand

	Internal Loads		Miscellaneous Loads			Fans and Pumps			Heating and Cooling			
	Lighting	Equipment	terior Lightir	DHW	Exhaust Fans	Fans	Clg Pumps	Htg Pumps	Heating	Cooling	Dehumid	Reheat
	27.4%	11.9%	0.0%	2.4%	0.6%	12.7%	0.0%	0.5%	0.0%	44.6%	0.0%	0.0%
Month	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
1	24.1	11.0	0.0	2.3	0.5	10.5	0.0	2.3	0.0	0.0	0.0	0.0
2	24.1	11.0	0.0	2.3	0.5	10.5	0.0	2.3	0.0	0.0	0.0	0.0
3	24.1	11.0	0.0	2.3	0.5	10.5	0.0	0.0	0.0	25.8	0.0	0.0
4	24.1	11.0	0.0	2.3	0.5	10.5	0.0	0.0	0.0	38.3	0.0	0.0
5	24.1	11.0	0.0	2.3	0.5	10.5	0.0	0.0	0.0	50.0	0.0	0.0
6	24.1	11.0	0.0	2.3	0.5	10.5	0.0	0.0	0.0	59.4	0.0	0.0
7	15.1	3.9	0.0	0.9	0.5	10.5	0.0	0.0	0.0	63.2	0.0	0.0
8	15.1	3.9	0.0	0.9	0.5	10.5	0.0	0.0	0.0	68.8	0.0	0.0
9	24.1	11.0	0.0	2.3	0.5	10.5	0.0	0.0	0.0	62.7	0.0	0.0
10	24.1	11.0	0.0	2.3	0.5	10.5	0.0	0.0	0.0	39.2	0.0	0.0
11	24.1	11.0	0.0	2.3	0.5	10.5	0.0	0.0	0.0	25.5	0.0	0.0
12	24.1	11.0	0.0	2.3	0.5	10.5	0.0	0.0	0.0	9.6	0.0	0.0
	271	**118**	**0**	**24**	**6**	**126**	**0**	**5**	**0**	**442**	**0**	**0**



Modeling the ECMs

After the model has been calibrated, changes are made to the model, which represent implementation of the proposed scope conditions of the energy and water conservation measure. ECMs are implemented and run individually to assess the energy savings of each ECM. All ECMs are modeled with consideration to potential overlap inflating modeled savings. ECMs are run sequentially, building upon each other. This results in more accurate estimate of savings than if each ECM were run in comparison to the baseline.

For detailed savings calculations for each ECM, please see the Appendix 6.1 – Savings Calcs and Documentation Box Folder.

6.2 Preliminary Mechanical Designs

Please see the Appendices Box folder for preliminary mechanical designs.

6.3 Local Government Energy Audit (LGEA)

Please see the Appendices folder in Box for the Local Government Energy Audit reports.

6.4 SSB-VEEVR Grant Program

Please see the Appendices folder in Box for the SSB-VEEVR approvals.

6.5 Scope of Work Details

Please see the Appendices folder in Box for any scope of work details not detailed in the Energy Savings Plan.

6.6 Spare Appendix

This Appendix is not currently being used, but is here as a placeholder for future use if needed.

6.7 Third Party Review & Approval Report

This review is in process; all correspondence will be saved, stored, and tracked.

6.8 Board of Public Utilities (BPU) Approval

This review has not been started; it will be completed after the 3rd Party Review is complete.