



Township of Union Public Schools

Energy Savings Plan

September 24, 2020

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1.0 Executive Summary

Overview of the Energy Savings Improvement Program

The Energy Savings Improvement Program, or 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. The ESIP program is a design-build financing mechanism that is regulated by the NJ Board of Public Utilities (BPU). Since 2009, over 100 school districts have taken part in the ESIP program. For more information, please visit the [NJ Clean Energy Program](#) website or Sustainable Jersey's "[How-to ESIP](#)" Guide.

Background

In April 2019, TUPS completed the Local Government Energy Audit (LGEA) for all facilities. In July 2019, TUPS issued an RFP for an Energy Services Company, and in October 2019 selected Schneider Electric to develop & implement the District's ESIP. In December 2019, TUPS and Schneider Electric executed an Investment Grade Audit agreement to finalize the ESIP program. Since then, Schneider Electric, the administration, and the facilities team have been working together to determine the final scope, costs, savings, and incentives for this project.

We are pleased to provide the following Energy Savings Plan (ESP) as a result of the IGA process. This report is a draft and will be updated following the District's input on desired scope for the project.

We have spent significant time visiting the schools, speaking with staff, performing preliminary engineering, analyzing utility information, and creating energy models. We would like to thank the administration, faculty and staff, and the members of the Board of Education for providing their time, assistance, and input.

ESIP Core Team Members

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Paul Kutsko, Senior Automation Engineer
Paul Ciamaglia, Mechanical Engineer
Bob Loprete, Senior Estimator
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Jason Mikula, Energy Engineer




Next Steps

The following next steps are required prior to the implementation phase of this ESIP program:

1. Following third-party verification, the Energy Savings Plan will be reviewed and approved by the BPU
2. Following BPU approval, the BOE approves the Final Energy Savings Plan, authorizing construction, financing, and measurement & verification contracts

Project Goals

This Energy Savings Improvement Program (ESIP) will address the following TUPS goals:

 Reduce Energy & Operational Costs	 Improve Indoor Air Quality & Comfort	 Fund Major Capital Needs
<p>LED lighting upgrades</p> <p>Solar installations</p> <p>Water conservation</p> <p>Insulation & weatherproofing</p>	<p>Upgrades to heating, ventilation, and air conditioning systems</p> <p>Centralized air conditioning for Union High School gym</p> <p>New building management system for temperature control</p>	<p>Roof repair & replacement</p> <p>Upgrading chiller, cooling tower, and boilers</p> <p>Electrical upgrades</p>

Financial Impact

The ESIP legislation requires that projects are budget-neutral. In other words, this project will be funded 100% by reallocating electric, gas, water, sewer, operations and maintenance costs. By leveraging third-party funding, the District will be able to:

- Fund **\$24 million in capital improvements**
- No increase in the budget and no impact to taxpayers
- Generate energy & operational cost **savings of over \$970,000 per year**
- Secure **\$8.3 million in rebates and incentives:** over \$8 million for renewable energy (solar) and \$1.1 million for energy efficiency upgrades
- **Boost the local economy** by creating an estimated 234 jobs and \$67 million in total economic activity

ESIP Highlights: \$

\$973,158 Annual energy & operational savings

\$8,270,124 Funding from rebates & incentives

\$23,557,307 Total Project Cost

These figures are subject to change based upon the final scope of work selected by the District and approved by the third-party review and the NJ Board of Public Utilities.

Projects Included

The following opportunities and projects are currently included in the District's ESIP. This scope of work is subject to change as we welcome feedback from the Administration, Board of Education, the District's third-party reviewer, and the Board of Public Utilities.

Legend:

	Included in ESIP
	Optional
	Not Applicable

Energy Conservation Measure (ECM)	HS	BMS	KMS	Jeff	BH	CF	Frank	HC	Liv	Wash	Ham	FH	Admin
Phase I													
Efficiency & Infrastructure													
1 LED Lighting Upgrades													
2 Building Envelope Improvements													
3 Water Fixture Recommissioning													
4 High Efficiency Transformers													
5 Walk-in Refrigeration Controls													
6 Drop Ceiling Installation													
Heating, Ventilation, and Air Conditioning (HVAC) Systems													
7 Steam Trap Replacement													
8 Building Automation System (BAS) w/ Demand Controlled Ventilation (DCV)													
9 Rooftop Unit & Split System Replacement													
10 New Gym Air Handling Units w/ AC, HW Converter, & CHP													
11 New Chiller, Cooling Tower, and Pumps with Controls													
Phase II													
12 Solar Photovoltaic (PV) System													
13 Roof Repair, Replacement, & Warranty Extension													
14 Burnet Auditorium HVAC Renovation with Cooling Addition													
15 Steam Boiler Plant Replacement with Controls													

Note: All scope indicated above is preliminary & subject to change based on input from the District and approval from the District's third-party reviewer and the Board of Public Utilities.

2.0 Financial Analysis

2.1 Scope Summary

The intent of this project is to maximize savings for the District, fund critical capital improvements, and achieve the strategic goals of the District. We believe that the following energy conservation measures are the best solution to maximizing savings and meeting the District's needs.

Phase I

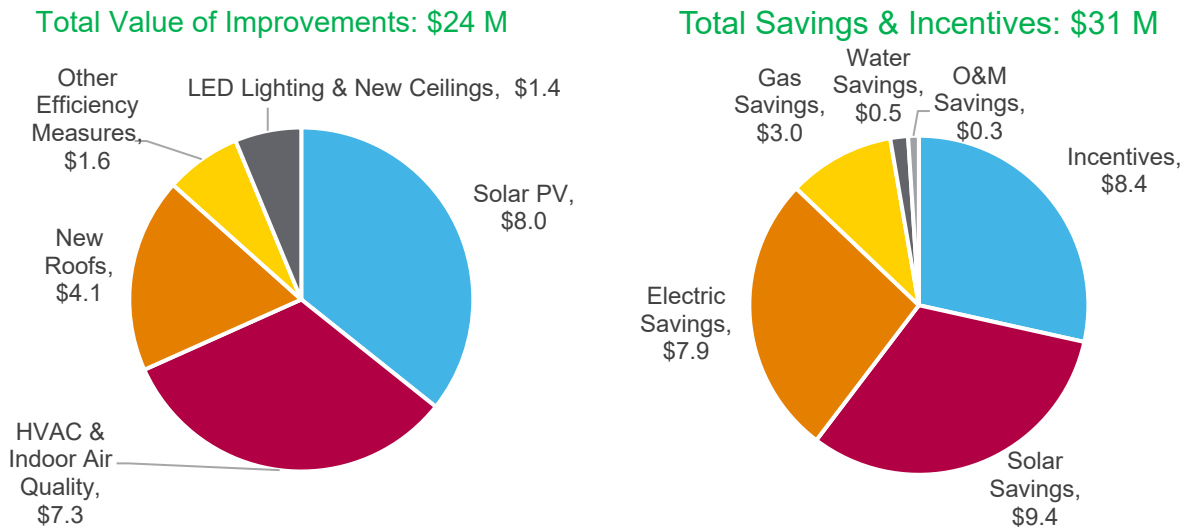
Proposed Energy Conservation Measures (ECMs)	Location(s)	Estimated Installed Hard Costs ¹ (\$)	Estimated Annual Savings (\$)
Efficiency & Infrastructure			
1 LED Lighting Upgrades	All	\$ 1,234,824	\$ 169,648
2 Building Envelope Improvements	All except CFES	\$ 822,746	\$ 45,144
3 Water Fixture Recommissioning	All schools	\$ 398,663	\$ 21,934
4 High Efficiency Transformers	HS	\$ 74,634	\$ 5,336
5 Walk-in Refrigeration Controls	HS, BMS	\$ 21,994	\$ 1,554
6 Solar Photovoltaic (PV) System	All schools	\$ -	\$ -
6 Drop Ceiling Installation	BMS, BHES	\$ 102,918	\$ -
13 Roofing Design, Engineering, and Bidding Documents	HCES, BMS, HS, BHES, KMS, WES	\$ 100,000	\$ 8,369
Heating, Ventilation, and Air Conditioning (HVAC) Systems			
7 Steam Trap Replacement	HS, BMS, KMS, CFES, FES, LES, WES	\$ 320,299	\$ 29,036
8 Building Automation System (BAS) with Demand Controlled Ventilation	All schools except JES	\$ 1,741,450	\$ 130,390
9 Rooftop Unit & Split System Replacement	HS, BMS, KMS, FES, HCES, LES, Admin	\$ 454,233	\$ 313
10 New Gym AHUs w/ AC, HW Converter, Chiller & CHP	HS	\$ 1,894,330	\$ 11,180
11 New Chiller, Cooling Tower, and Pumps with Controls	HCES	\$ 874,537	\$ 5,056
14 Steam Boiler Plant Replacement with Controls	FES	\$ -	\$ -
Grand Total		\$ 8,040,628	\$ 427,959
Turn-key with ESCO		\$ 6,805,804	
Direct Install (Total Cost)		\$ 1,234,824	
Direct Install (Customer share)		\$ 361,792	

Phase II

Proposed Energy Conservation Measures (ECMs)	Location(s)	Estimated Installed Hard Costs ¹ (\$)	Estimated Annual Savings (\$)
12 Solar Photovoltaic (PV) System	All schools	\$ 7,634,758	\$ 1,005,105
13 Roof Repair, Replacement, & Warranty Extension - Contractor Cost	HCES, BMS, HS, BHES, KMS, WES	\$ 3,862,530	\$ -
14 Burnet Auditorium HVAC Renovation w/ Cooling Addition	BMS	\$ 693,256	\$ -
15 Steam Boiler Plant Replacement with Controls	FES	\$ 409,215	\$ 2,103
Grand Total		\$ 12,599,759	\$ 1,007,207
Turn-key with ESCO		\$ 8,737,229	
Roofing Contractor		\$ 3,862,520	

2.2 Financial Summary

With this project, TUPS will be able to realize \$24 million in improvements to the District with no increase in the budget and no impact on taxpayers. The project will be funded by \$8.3 million in anticipated incentives (27%), and \$22.6 million (73%) in reallocated utility cost savings over the next 20 years.



The table below represents the total, turn-key cost of the ESIP based on the scope of work listed on the prior page and Form V from SE's RFP Response. This ESIP program is a firm fixed-price contract. Schneider Electric will serve as the primary contractor, responsible for the execution of all scopes of work under the ESIP program except for the Direct Install scopes of work and the roofing upgrades, which the District will contract directly for.

Fee Category	Phase I	Phase II	Percentage of Hard Costs
	Fees (1) Dollar (\$) Value	Fees (1) Dollar (\$) Value	
Estimated Value of Hard Costs (2):	\$ 6,805,804	\$ 8,737,229	
Project Service Fees			
Investment Grade Energy Audit	\$ 153,131	\$ 196,588	2.25%
Design Engineering Fees	\$ 255,218	\$ 327,646	3.75%
Construction Management & Project Administration	\$ 306,261	\$ 393,175	4.50%
System Commissioning	\$ 68,058	\$ 87,372	1.00%
Equipment Initial Training Fees	\$ 34,029	\$ 43,686	0.50%
ESCO Overhead	\$ 442,377	\$ 567,920	6.50%
ESCO Profit	\$ 408,348	\$ 524,234	6.00%
ESCO Termination Fee	\$ -	\$ -	0.00%
Project Service Fees Sub Total	\$ 816,696	\$ 1,048,467	12.00%
TOTAL FINANCED PROJECT COSTS:	\$ 8,473,225	\$ 10,877,850	24.50%
TOTAL FINANCED PROJECT COSTS (BOTH PHASES)	\$ 19,351,076		

This ESIP may be funded through a combination of financing (lease purchase or energy savings obligations) over 15-20 years, rebates and incentives, and capital contribution from the District. There are several remaining variables that may alter the scope of this project, including District input, final scope selection, financing term, interest rate, incentives and rebates.

2.3 Cash Flow Analysis – Phase I Only

Phase I ONLY

ESIP Project
Turn-key ESCO Cost \$ 8,473,225
Roofing Contractor \$ -
Direct Install (Customer share) \$ 361,792
Legal & Financing Costs \$ 225,000

Total Amount to be Financed \$ 9,060,017

Interest Rate to Be Used for Proposal Purposes: 2.15%

Year	Annual Electric Savings	Annual Natural Gas Savings	Water Savings	Annual O&M Savings	Energy Rebates/ Incentives	Total Annual Savings	Annual ESIP Costs	Annual Service Costs (\$)	CHP O&M Costs	Board Costs	Net Cash-Flow to Client	Cumulative Cash Flow
7/1/2020	Install	\$ 80,090	\$ 15,204		\$ 37,276	\$ 365,223				\$ -	\$ -	\$ -
7/1/2021	\$ 310,204	\$ 106,787	\$ 20,273	\$ 73,008	\$ 89,894	\$ 600,164	\$ 805,054	\$ 147,800	\$ 7,534	\$ 960,387	\$ 5,000	\$ 5,000
7/1/2022	\$ 317,028	\$ 109,349	\$ 20,759	\$ 74,614	\$ 51,684	\$ 573,444	\$ 501,611	\$ 59,300	\$ 7,534	\$ 568,444	\$ 5,000	\$ 10,000
7/1/2023	\$ 324,003	\$ 111,974	\$ 21,257	\$ 76,255	\$ 5,600	\$ 539,089	\$ 494,256	\$ 32,300	\$ 7,534	\$ 534,089	\$ 5,000	\$ 15,000
7/1/2024	\$ 331,131	\$ 114,661	\$ 21,768	\$ 77,933	\$ 5,600	\$ 551,092	\$ 538,559		\$ 7,534	\$ 546,092	\$ 5,000	\$ 20,000
7/1/2025	\$ 338,416	\$ 117,413	\$ 22,290	\$ 79,647		\$ 557,766	\$ 545,232		\$ 7,534	\$ 552,766	\$ 5,000	\$ 25,000
7/1/2026	\$ 345,861	\$ 120,231	\$ 22,825			\$ 488,917	\$ 476,383		\$ 7,534	\$ 483,917	\$ 5,000	\$ 30,000
7/1/2027	\$ 353,470	\$ 123,116	\$ 23,373			\$ 499,959	\$ 487,425		\$ 7,534	\$ 494,959	\$ 5,000	\$ 35,000
7/1/2028	\$ 361,246	\$ 126,071	\$ 23,934			\$ 511,251	\$ 498,717		\$ 7,534	\$ 506,251	\$ 5,000	\$ 40,000
7/1/2029	\$ 369,193	\$ 129,097	\$ 24,508			\$ 522,799	\$ 510,265		\$ 7,534	\$ 517,799	\$ 5,000	\$ 45,000
7/1/2030	\$ 377,316	\$ 132,195	\$ 25,096			\$ 534,607	\$ 522,074		\$ 7,534	\$ 529,607	\$ 5,000	\$ 50,000
7/1/2031	\$ 385,617	\$ 135,368	\$ 25,699			\$ 546,883	\$ 541,683		\$ -	\$ 541,683	\$ 5,000	\$ 55,000
7/1/2032	\$ 394,100	\$ 138,617	\$ 26,315			\$ 559,032	\$ 554,032		\$ -	\$ 554,032	\$ 5,000	\$ 60,000
7/1/2033	\$ 402,770	\$ 141,944	\$ 26,947			\$ 571,661	\$ 566,661		\$ -	\$ 566,661	\$ 5,000	\$ 65,000
7/1/2034	\$ 411,631	\$ 145,350	\$ 27,594			\$ 584,575	\$ 579,575		\$ -	\$ 579,575	\$ 5,000	\$ 70,000
7/1/2035	\$ 420,687	\$ 148,839	\$ 28,256			\$ 597,782	\$ 592,782		\$ -	\$ 592,782	\$ 5,000	\$ 75,000
7/1/2036	\$ 429,942	\$ 152,411	\$ 28,934			\$ 611,287	\$ 606,287		\$ -	\$ 606,287	\$ 5,000	\$ 80,000
7/1/2037	\$ 439,401	\$ 156,069	\$ 29,628			\$ 625,098	\$ 620,098		\$ -	\$ 620,098	\$ 5,000	\$ 85,000
7/1/2038	\$ 449,068	\$ 159,814	\$ 30,340			\$ 639,222	\$ 634,222		\$ -	\$ 634,222	\$ 5,000	\$ 90,000
7/1/2039	\$ 458,947	\$ 163,650	\$ 31,068			\$ 653,665	\$ 648,665		\$ -	\$ 648,665	\$ 5,000	\$ 95,000
7/1/2040	\$ 469,044	\$ 167,577	\$ 31,813			\$ 668,435	\$ 553,526		\$ -	\$ 553,526	\$ 114,910	\$ 209,910
Totals	\$ 7,921,729	\$ 2,780,624	\$ 527,880	\$ 381,457	\$ 190,064	\$ 11,801,753	\$ 11,277,107	\$ 239,400	\$ 75,336	\$ 11,591,843	\$ 209,910	

2.4 Incentives, Rebates, and Curtailment Services

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

	Direct Install	PJM Energy Efficiency Credit	Pay for Performance (P4P)	Smart Start	Combined Heat & Power (CHP)	Elizabeth-town Gas Rebates	Total
Installation	\$ 913,145		\$5,714	\$ 10,562	\$21,000	TBD	\$ 37,276
Year 1		\$8,800	\$46,094		\$35,000		\$89,894
Year 2		\$5,600	\$46,094		\$14,000		\$51,694
Year 3		\$5,600					\$5,600
Year 4		\$5,600					\$5,600
Total	\$913,145	\$25,600	\$97,902	\$10,562	\$70,000		\$1,117,208
						Total Financed Rebates:	\$190,064

The rebates indicated in blue above are not included in the project financing or cash flow analysis. All rebates and incentives are subject to program terms, conditions, approvals, and availability of funds.

NJ Clean Energy Program – Direct Install

The Direct Install program is applicable to small to mid-sized commercial and industrial facilities with an average peak electric demand that does not exceed an average of 200 kW in the preceding 12 months. The Direct Install program is funded up to 80% by the NJ Clean Energy program, and can address lighting, HVAC, refrigeration, motors, variable frequency drives, and more. For more information, please visit:

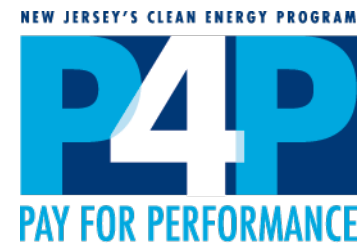


<https://www.njcleanenergy.com/commercial-industrial/programs/direct-install>

All schools except for the High School have qualified for the Direct Install program. Scope of work documents have been completed by the Direct Install contractor and can be found in Appendix 7.3.

NJ Clean Energy Program – Pay for Performance (P4P)

The P4P program provides incentives for comprehensive, whole-building energy improvements. This program is administered by TRC, and requires Approved Partners, such as Schneider Electric, to create the Energy Reduction Plan and acquire the incentive on behalf of the District. To learn more about the P4P program, please visit:



<http://www.njcleanenergy.com/commercial-industrial/programs/pay-performance>

Hannah Caldwell is the main facility that qualifies for P4P. Schneider Electric will work through the application and approval process on behalf of the District throughout Construction and the first 2 years of the project.

NJ Clean Energy Program – Smart Start

The Smart Start Program provides prescriptive rebates for specific equipment changes, such as lighting upgrades or installation of variable frequency drives (VFDs). To learn more about the Smart Start Program, please visit:



<http://www.njcleanenergy.com/ssb>

The New Jersey Clean Energy Program requires that customer choose either the P4P or the Smart Start program. Based upon our analysis, all schools that do not qualify for P4P will utilize the Smart Start program.

NJ Clean Energy Program – Combined Heat and Power

One of the goals of the State of New Jersey is to enhance energy efficiency through on-site power generation with recovery and productive use of waste heat, and to reduce existing and new demands to the electric power grid. The Board of Public Utilities seeks to accomplish this goal by providing generous financial incentives for Combined Heat & Power (CHP) installations. For more information, please visit:

<https://www.njcleanenergy.com/commercial-industrial/programs/combined-heat-power/combined-heat-power>

PJM Energy Efficiency Program (PJM EE)

The Energy Efficiency program is designed to provide financial benefit to the consumer for permanent reductions in electrical load. Examples of energy efficiency projects include upgrading to more efficient lighting, or replacing HVAC systems with more efficient ones, or other ECMs that reduce electrical load.

TUPS will see permanent reductions in peak kW, primarily from lighting upgrades. After the installation of this Project, Schneider Electric will work to ensure that these incentives are secured on behalf of the District.

PJM Capacity Market Program (Demand Response)

The capacity market program stems from the need for utilities to balance electric supply with electric demand on the grid. Because there is a finite amount of generating capacity, demand response was created to allow consumers to shed demand when needed by PJM. Consumers must work with Curtailment Service Providers (CSPs) to shed electrical load when needed by PJM, in order to generate revenue. The load-shaving can be done through a variety of measures including energy efficiency, on-site generation, or manual shutdown.

Based upon the current conditions of the District's building automation systems, it has been deemed that demand response may not be an immediate opportunity. However, following the ESIP project and the installation of more sophisticated building automation systems, Schneider Electric will evaluate demand response revenue opportunities under future programs.

3.0 Energy Conservation Measures

3.1 ECM Descriptions – Phase I

Please see the following descriptions of ECMs currently included in the project. Scope of work indicated as “Optional” in red is currently not included in the project but is provided for the District’s consideration.

1. LED Lighting Upgrades

Overview

Lighting systems are amongst the top energy users in most facilities. LED lighting technologies require about half of the power as conventional lighting systems to provide the same light output. Retrofitting or replacing lighting fixtures with LED provides multiple benefits including reduced energy consumption, modernized lighting technologies, improved light quality, and reduced maintenance costs. Further energy savings can be achieved through the control of operating hours using occupancy sensors for interior lighting and photocontrols (for dusk to dawn operation) or other technologies (such as time clocks) for exterior lighting.

This project is utilizing the states Direct Install Program to implement the lighting scope. This is a lucrative program that covers up to 80% of the cost to install these systems. Below is the list of sites that qualify for this incentive:

Direct Install Sites	
Burnet Middle School	Kawameeh Middle School
Jefferson ES	Battle Hill ES
Connecticut Farms ES	Franklin ES
Hannah Caldwell ES	Livingston ES
Washington ES	Hamilton
Field House	BOE Building

Scope

To understand the lighting improvement opportunities in your facilities, Schneider Electric proposes a comprehensive lighting study to analyze existing lamp, ballast and fixture configurations in conjunction with the lighting layout configuration, space and task type, light output and light level readings. Inefficient and outdated existing light fixtures will either be re-lamped, retrofit, or replaced with new LED technology.

Linear Fluorescent to LED Retrofit

For typical T8 fluorescent lamp fixtures, Schneider Electric recommends a retrofit with new line voltage LED tubes with integrated drivers. Lighting quality is improved, less heat is added to the spaces, and tubes illuminate at full output when energized without delay. In areas where the Insert Customer Name -General would like to improve the aesthetics or upgrade outdated fixtures, LED Door Kits can be installed rather than replacing the entire fixture. Door kits provide high uniformity amongst existing lighting systems while reusing the housing of the existing troffer.

A standardized lighting system will simplify maintenance and provide consistent lighting color and performance throughout the Insert Customer Name -General's facilities. The long life of LED tubes results in fewer burnouts, longer intervals between replacements and reduced maintenance costs.



Figure 1. LED Door Kit

LED Door kits are a lower cost option to fixture replacements.

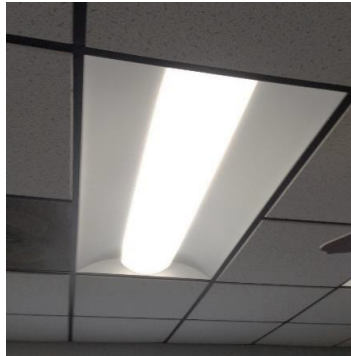


Figure 2. LED Door Kit Installed

Door kits unify and modernize existing lighting systems.



Figure 3. High Efficiency LED Tube

Interior lighting improvements will incorporate retrofitting to new, energy efficient LED technology.

Exterior Lighting LED Replacements

Exterior lighting is a necessity for security and occupant safety. It is typically more expensive to install and is operated for many more hours than indoor lighting. The high number of operational hours means that outdoor lighting is a great area to target for increased energy efficiency. Many different options are available for outdoor lighting. New LED fixtures are typically a great choice because of the high number of operating hours required with exterior lighting. They consume less energy and have a much greater life expectancy in comparison to other exterior lighting options. This typically results in fewer burnouts.

For a complete lighting scope of work, please visit the lighting line by line in the Appendix.

2. Building Envelope Improvements

Overview

This ECM addresses the shell of the building and how well it is keeping conditioned air in and ambient air out. Our onsite testing and analysis of energy consumption indicate there is an opportunity to improve the indoor air quality, occupant comfort, and energy use by upgrading the existing air barrier systems. A tighter Building Envelope will provide the following advantages:

- 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.

Scope

The following is a breakout of the Building Envelope scope by facility:

Task	HS	BMS	KMS	Jeff	BH	CF	Frank	HC	Liv	Wash	Ham	FH	Admin	Total
AC Unit Weatherization (Units)	18	52	31		48	20	9		32	18	29			257
Attic Air Barrier Retrofit (SF)						426		1,880	600					2,906
Attic Bypass Air Sealing (SF)							1,840		4,805					6,645
Attic Flat Insulation (SF)						19,467	3,565		12,100	9,904				45,036
Buck Frame Air Sealing (LF)				204				9						213
Caulking (LF)		18,850			808		7,842	43	13,847	12,526	4,785		60	58,761
Door - Install Jamb Spacer (Units)				1	15			4		8				28
Door Weather Stripping - Doubles (Units)	51	19	10	8	11	7	7	9	7	6	5	3	1	144
Door Weather Stripping - Singles (Units)	22	5	3	5	5	3	3	20	3	3	3	5	11	91
Overhang Air Sealing (LF)	10							105						115
Overhang Air Sealing (SF)								40						40
Overhead Door Weather Stripping (Units)	3	1	1										13	18
Roll-Up Door Weather Stripping (Units)								2						2
Roof-Wall Intersection Air Sealing (LF)	2,245			763	189			264			178	308		3,947
Unit Ventilator Air Sealing (Units)		25							12		8			45
Wall Air Sealing (LF)	1,044			279			102	351	470	359				2,605
Wall Air Sealing (SF)	390								60					450

3. Water Fixture Recommissioning

Overview

The school buildings utilize diaphragm flush valves on the water closets. Most of these valves are designed to flush at least 1.6 with about 1/3 of the total water closets flushing 3.5 gallons per flush (GPF). Urinals are mostly 1 GPF. As a result of Federal Laws enacted in 1996, water closet manufacturers redesigned their china to effectively complete the flush process with 1.6 gallons. This scope includes replacement of the handle assembly and vacuum breaker assembly for both water closets and urinals. In many instances, this measure will result in a savings per flush of over 30 percent.

Scope

The following water conservation scope will be installed:

Site Information		Quantities										Scope of Work													
Building	Recommended Scope of Work Option #	In Scope of Work	Lavatory Sinks	General Use Sinks	Multipurpose Lav Sinks	Tank Toilets	Pressure Assist Toilets	Flushometer Toilets	Urinals	CONRUN Urinals	Hoppers	Wall Showers	Handheld Showers	Flushometer Fixtures					Tank Toilets			Sinks			
														Valve Recommissioning	Valve Rebuilding	Valve Replacement	Spud & Flushtube Replacement	Control Stop Modify/Replace	Handle-Mount Hands-Free	System Tuning	Retrofit Upgrade	Convert & Retrofit Upgrade	Vandal Resistant Flow Control	Manual Faucet	Hands-Free Faucet
Union HS & Field House	3	x	94	4	-	11	-	86	44	-	-	64	-	1	-	129	102	-	5	1	10	-	88	-	-
Burnet MS	3	x	45	1	-	1	-	59	28	-	-	-	-	-	-	81	51	-	3	-	1	-	40	-	-
Kawameeh MS	3	x	62	6	-	8	2	37	20	-	-	-	-	-	-	57	41	-	1	-	8	-	29	-	-
Jefferson ES	2	x	26	16	-	-	-	27	7	-	-	-	-	-	34	-	9	-	-	-	-	-	42	-	-
Battle Hill ES	3	x	29	16	-	13	-	30	14	-	-	-	-	-	-	44	23	-	-	-	13	-	45	-	-
Connecticut Farms ES	3	x	32	17	-	4	-	36	16	-	-	-	-	-	-	52	33	-	-	-	4	-	41	-	-
Franklin ES	3	x	21	22	-	-	-	36	10	-	-	-	-	-	-	46	27	-	-	-	-	-	38	-	-
Hannah Caldwell ES	3	x	44	39	-	2	-	48	9	-	-	-	-	-	-	57	35	-	-	-	2	-	83	-	-
Livingston ES	3	x	42	20	-	2	-	44	17	-	-	-	-	-	-	61	54	-	-	-	2	-	44	-	-
Washington ES	3	x	36	17	-	1	-	43	15	-	-	-	-	-	-	58	41	1	14	-	1	-	40	-	-
Administration Bldg	3	x	10	1	-	1	3	9	5	-	-	-	-	-	-	14	12	-	1	-	1	-	9	-	-
Total		x	441	159	0	43	5	455	185	0	0	64	0	1	34	599	428	1	24	1	42	0	499	0	0

*Note: China replacement is not part of the scope unless called out. Please refer to appendices to see Fixture Line by Line.

4. High Efficiency Transformers

Overview

This measure replaces existing secondary transformers with new high efficiency transformers. With the age and condition of many of the electrical transformers, replacement with new equipment is recommended for efficiency improvement as well as reliability and safety. New transformers have lower losses across the transformer core.

Secondary transformers reduce voltage from distribution level, to building level voltage (normally from 480V to 120/208V) to maintain power in the facility. These transformers operate continuously; therefore, utilizing new, high efficiency transformers results in long term, steady energy savings.



Figure 4. High Efficiency Transformer

Scope

A transformer survey was performed during the investment grade audit and an inventory of existing equipment was compiled. Savings were calculated based on replacing this equipment with higher efficiency transformers.

kVA	Existing Qty	Replacement Qty	Manufactured Date
High School			
30	3	0	Unknown
75	1	1	1970
112.5	1	1	1970
150	2	2	1970
Hannah Caldwell – Optional			
30	2	0	Unknown
75	1	1	1990
112.5	1	1	1990
300	3	3	1990

5. Walk-in Refrigeration Controls

Overview

The walk-in coolers and freezers utilize an indoor evaporator, outdoor condensing unit, and electric door heaters to maintain the cooler and freezer temperatures and the door surface temperatures to avoid condensation and ice formation. This measure will install efficient Electronically Commutated Motors (ECM) on the indoor evaporator fans to replace the permanent split capacitor (PSC) motor. The ECM motor can maintain an efficiency of 65-75% versus a PSC motor of 12-45% efficiency. The electric door heaters currently are “on” all the time. This measure will also install a controller that measures the ambient temperature and relative humidity. It performs internal calculations to pulse the electrical power to the heaters such that the surfaces are kept above the temperature where moisture will form on the cooler and freezer door jambs and surrounding surfaces.

Scope

High School

2 Cooltrol® zones will provide savings by controlling the temperature, evaporator fans and door heaters on the entry doors of a walk-in cooler and freezer. 1-Door Freezer will be controlled. One (1) electric defrost will be intelligently controlled. In addition, the motors will also be replaced with EC motors (2 motors total).

Burnet Middle School

2 Cooltrol® zones will provide savings by controlling the temperature, evaporator fans and door heaters on the entry doors of a walk-in cooler and freezer. 1-Door Freezer will be controlled. In addition, the motors will also be replaced with EC motors (6 motors total).

6. Drop Ceiling Installation

Overview

This ECM is to provide the installation of new drop ceilings.

Scope

Burnet Middle School

- Remove and Replace 12,700 square feet (SF) of acoustical ceiling in all the hallways of the 2 floor and the Lobby area of the 1st floor.
- New Lighting Fixtures will be provided by the lighting contractor.
- Removal of all other devices such as clocks, cameras, fire alarms, etc will be executed by the District.



Figure 5. Existing Ceilings.

A new drop ceiling will improve aesthetics in Burnet MS and Battle Hill ES hallways.

Battle Hill

- Remove and Replace 8,100 square feet (SF) of acoustical ceiling in all the hallways of the 1st and 2nd floor.
- New Lighting Fixtures will be provided by the lighting contractor.
- Removal or Modification of all other devices such as clocks, cameras, fire alarms, etc will be executed by the District.

7. Steam Trap Replacement

Overview

A steam trap device is used to discharge condensate and some gases with negligible loss of live steam. Steam traps are designed to vent excess steam at the condensate receiver. However, a failed steam trap will vent an excess amount of steam causing it to reject heat in areas where it is not needed. Most steam traps are designed to fail in the open position. Often times steam can be heard rushing through a failed trap. By remaining open, steam is allowed to return back to the condensate receiver without ever changing state in the heating coil. Steam traps fail in two ways.

- When a steam trap fails open, some or all of the steam produced by the boiler will end up returning to the condensate return system resulting in a large loss of energy. The heat energy in steam is utilized when it condenses into liquid in the heat exchanger (radiator, convector, air handling unit coil, etc.) and releases its latent heat. It is at this point that the steam trap should allow only the liquid condensate to return to the boiler. When the steam is sent straight to the condensate return system due to a failed open trap, most of the energy goes un-utilized.
- When a steam trap fails in a closed position, the condensate will not be allowed to enter the condensate return system, resulting in some or all of the condensate staying in the heat exchange coil, depending on the severity of the trap failure. As the condensate backs up in the coil, the heating capacity of the unit is largely reduced (if not eliminated completely) due to the lack of steam in the heat exchanger caused by the condensate blockage. Also, when condensate is left in the steam line, it will sub cool (below saturation temperature) and form carbonic acid that will attack the interior of the piping and its components. Under certain conditions, condensate that has backed up into the heat exchanger could freeze and cause considerable damage.



Figure 6. Steam Trap Retrofit

Steam traps capture and discharge liquid condensate into a return system as part of a steam distribution system. Retrofits offer the ability to address trap failures and implement trap improvements.

Scope

Schneider Electric will replace all failed steam traps at the following locations:

- High School
- Burnet MS
- Kawameeh MS
- CFES
- Franklin ES
- Livingston ES
- Washington ES

8. Building Automation System (BAS) Upgrade

Overview

Updating a control system can greatly increase the efficiency of a building. A Building Automation System (BAS) allows building operators to control equipment from a central location. Individuals will have the ability to identify and diagnose equipment issues without ever having to leave the office. A centralized, building automation system installation will include a combination of the following:

- Installing new direct digital controls (DDC), where applicable,
- Incorporating existing DDC points, and
- Utilizing enable/disable control of existing terminal equipment.

With a microprocessor based direct digital control (DDC) system there are many opportunities to optimize building systems without sacrificing occupant comfort or safety. The BAS will allow energy managers to better control their energy use and consumption through the following control and reporting features including:

- Set point control and monitoring,
- Scheduling of equipment,
- Identification and verification of issues with equipment,
- Implementation of advanced control sequences, and
- Trending and reporting features.

All direct digital controls will be seamlessly integrated within the overarching BAS. The BAS will facilitate communications between the various systems and provide for a full featured graphical user interface accessible through a PC workstation or remotely via the internet.

Through this interface, the facility staff will be able to view all spaces and systems for monitoring and troubleshooting purposes. Floor plan views for each facility will provide a live snapshot of conditions within each space including the current room temperatures, set points and effective occupancy. Detailed equipment graphics pages will display the status and configuration of mechanical equipment operated by DDC systems and all control points on the system will be accessible. Global and individual scheduling will be provided for all systems and all control points can be set up for instantaneous monitoring, trending, or alarming as required.

Some areas will only receive enable/disable control (also known as “red-wire” control) of existing terminal units.

Terminal unit red-wire control is a simple but multi-featured solution to provide basic unit scheduling. Relays will be installed and wired to break power to the currently installed conventional thermostats operating the equipment during unoccupied hours. Temperature sensors installed in the space will allow the units to be re-enabled, as necessary, to maintain setback temperatures.

Terminal unit “red-wire” control allows for advanced scheduling in a very cost-effective manner. This type of control simply schedules units to turn on and off based on a time schedule while re-enabling units during unoccupied times to maintain desired setup or setback temperature. As opposed to user-based control, where units can be accidentally left on, this control will continuously turn units on and off as needed.

The following highlights the key benefits of this solution:

- **Reduce Energy Costs** – Control strategies use energy more effectively.
- **Improve Occupant Comfort** – New, calibrated system provide better temperature control.
- **Better Visibility** – Graphics, remote monitoring, and alarms help identify and prevent issues.

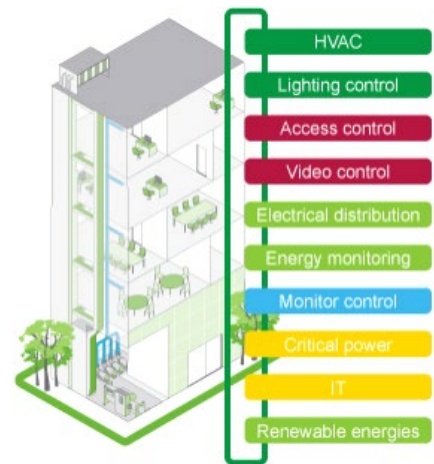


Figure 7. Building Automation System (BAS)

A BAS with new and integrated Direct Digital Controls and graphics equipped user interface workstations allows building personnel to better manage and control energy use.

- **Enhance System Performance** – EMS will allow for new control strategies to be implemented.
- **Extends Equipment Life** – With reduced run times, equipment wear and tear will be lessened.
- **Reduce Maintenance Costs** – New, standardized control system will require less maintenance and replacement parts are more readily available.

Scope

The following section outlines the existing HVAC systems that will be incorporated into the new BAS. Any new HVAC equipment, meters, or other devices that will be incorporated into the new BAS are outlined in their associated ECM description.

Union High School

The existing DDC controls for the main steam/hot water plant will be integrated into the new BAS. The following systems will receive new DDC controls as part of the BAS upgrade:

- Main chilled water plant
- Gymnasium hot water plant
- Two (2) rooftop units (RTU 15 & 16)
- Five (5) rooftop units (*Auditorium, Wrestling, Fitness, Cafeteria*)
- Two (2) heating and ventilation units (*Gym*)
- Two (2) unit ventilators (*Gym*)
- One (1) split-system air conditioning unit (*Library*)

The following systems will receive enable/disable control incorporated into the new BAS:

- 117 unit ventilators
- Five (5) air handling units
- Three (3) ductless split-systems
- Twenty (20) split-system air conditioning units
- Eleven (11) rooftop units

Burnet Middle School

The following systems will receive new DDC controls as part of the BAS upgrade:

- Steam plant

The following systems will receive enable/disable control incorporated into the new BAS:

- Fifty-nine (59) unit ventilators
- Two (2) air handling units
- One (1) rooftop unit (*Auditorium*)

Kawameeh Middle School

The following systems will receive new DDC controls as part of the BAS upgrade:

- Steam plant
- One (1) split-system air conditioning unit (*Auditorium*)
- Two (2) air handling units (*Gym & Cafeteria*)

Connecticut Farms Elementary School

The following systems will receive new DDC controls as part of the BAS upgrade:

- Cafeteria fan

The following systems will receive enable/disable control incorporated into the new BAS:

- Twenty-eight (28) unit ventilators
- Two (2) rooftop units

Franklin Elementary School

The following systems will receive new DDC controls as part of the BAS upgrade:

- Steam plant
- Two (2) unit ventilators (*Cafeteria*)
- Three (3) rooftop units (*Associated with Direct Install*)

The following systems will receive enable/disable control incorporated into the new BAS:

- Thirty (30) unit ventilators
- Twenty-eight (28) split-system air conditioning units
- One (1) unit heater

Hannah Caldwell Elementary School

The following systems will receive new DDC controls as part of the BAS upgrade:

- Hot water plant
- Chilled/condenser water plant
- One (1) split-system air conditioning unit (*Classroom 167*)
- Three (3) ductless split-systems (*Various locations*)
- Thirty-one (31) unit ventilators
- One (1) split-system air conditioning unit
- Two (2) ductless split-systems
- Three (3) VAV rooftop units
- Fourteen (14) VAV boxes
- Nine (9) rooftop units
- Four (4) air handling units
- Fourteen (14) fan coil units

Washington Elementary School

The following systems will receive new DDC controls as part of the BAS upgrade:

- Steam plant
- Four (4) split-system air conditioning units (*Associated with Direct Install*)

The following systems will receive enable/disable control incorporated into the new BAS:

- Thirty-five (35) unit ventilators

- Six (6) rooftop units
- Four (4) ductless split-systems

Demand Controlled Ventilation

Overview

Building ventilation management is the most far reaching and cost effective opportunity presenting itself in energy management and comfort control. Any space that uses more ventilation than its occupancy levels require results in excess energy consumption from conditioning unnecessary outside air. Air distribution 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 individual spaces within the building may be partially occupied or even unoccupied, yet ventilation rates are maintained as if the space was fully occupied. Demand Controlled Ventilation (DCV) can greatly reduce the energy consumed by the HVAC system by providing the right level of ventilation.

DCV is a control strategy where the measured amount of Carbon Dioxide (CO₂ is an indicator of occupancy) is used to vary the amount of outside ventilation air supplied to the space based on the actual occupancy. This strategy continuously adjusts the ventilation rate as dictated by code when the space is not occupied at full design level capacity. By ventilating the space only as required, the energy and associated costs spent to treat outdoor air are reduced. Good candidates for DCV control are systems that serve large, open spaces with variable and unpredictable occupancy and where CO₂ can be measured effectively.

The following highlights the key benefits of this solution:

- **Reduce Energy Costs** – Less energy for heating and cooling is required by modulating outdoor air levels based on actual space occupancy.
- **Improve Ventilation Control** – Monitoring carbon dioxide levels will ensure the proper amount of outside air is introduced.

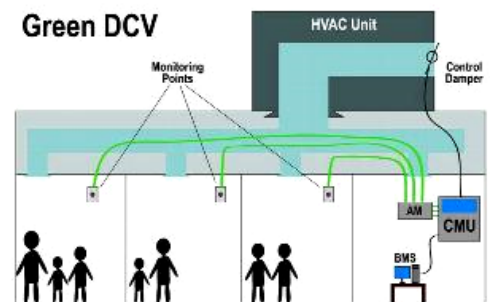


Figure 8. Example of Demand Controlled Ventilation

Demand controlled ventilation varies outside air rates based on building occupancy.

Scope

The equipment associated with this scope of work will receive new DDC controls including a space CO₂ sensor and modulating electronic outside air damper actuator. The following is a breakout of the HVAC units included in the DCV scope by facility:

Union High School:

- One (1) auditorium rooftop unit
- Two (2) large gymnasium heating and ventilation units
- Two (2) small gymnasium unit ventilators
- One (1) wrestling room rooftop unit
- One (1) fitness room rooftop unit
- One (1) library split-system air conditioning unit

- Two (2) cafeteria rooftop units

Burnet Middle School:

- One (1) auditorium rooftop unit

Kawameeh Middle School:

- One (1) auditorium split-system air conditioning unit
- One (1) gymnasium air handling unit
- One (1) cafeteria air handling unit

Connecticut Farms Elementary School:

- One (1) cafeteria fan (*VFD instead of damper actuator*)

Franklin Elementary School:

- Two (2) cafeteria unit ventilators

Hannah Caldwell Elementary School:

- One (1) gymnasium air handling unit
- One (1) cafeteria air handling unit
- Two (2) auditorium air handling units

Livingston Elementary School:

- One (1) gymnasium heating and ventilation unit (*new controller will be standalone from the new BAS*)

9. Rooftop Unit & Split System Replacement

Overview

This ECM addresses the aging unitary equipment through the school district. Most of the HVAC equipment is original to the building construction and is beyond expected service life. The equipment is in fair to poor condition and replacement is recommended.

Replacing the antiquated equipment will improve cooling efficiency, as well as address associated maintenance issues with failing equipment. The average efficiency of the existing equipment is about 8.0 EER (energy efficiency ratio), while new units have much higher efficiencies of 11.0 to 12.2 EER depending on unit size. Equipment will be replaced with like-sized tonnage, or downsized, where applicable. Most of the existing units use R22 refrigerant, while the new units will use more environmentally friendly refrigerant, such as R410A.

In most cases the new equipment will also include new direct digital controls to incorporate additional control strategies not currently implemented. These include airside economizer with enthalpy control, variable frequency drives on fans, conversion of existing constant volume systems to single zone VAV for high occupancy spaces such as auditoriums and gymnasiums.

Replacement systems will be sized with similar nominal capacities for both heating and cooling. Adaptive mounting curbs will be furnished, as necessary, for rooftop unit replacements.



Figure 9. Union High School Rooftop Unit

Scope

This measure involves replacing the following unitary DX equipment:

UNION HIGH SCHOOL – GROUP 1 – OPTIONAL

EQUIPMENT	EXISTING (QTY.) – CAPACITY	NEW (QTY.) – CAPACITY	EFFICIENCY UPGRADE
DX RTU with Gas Heat	(1) – 3 tons	(1) – 3 tons	10 SEER -> 17 SEER
DX RTU with Gas Heat	(2) – 6.25 tons	(2) – 6.25 tons	9 SEER -> 14.5 SEER

UNION HIGH SCHOOL – GROUP 2 – OPTIONAL

EQUIPMENT	EXISTING (QTY.) – CAPACITY	NEW (QTY.) – CAPACITY	EFFICIENCY UPGRADE
DX RTU with HW Heat	(2) – 5 tons	(2) – 5 tons	12.1 EER -> 14 EER, economizer
DX RTU with HW heat	(2) – 7 tons	(2) – 7 tons	10.9 EER -> 14 EER, economizer
Split DX, cooling only	(1) – 4 tons	(1) – 4 tons	10 SEER -> 15 SEER

Township of Union Public Schools
Energy Savings Plan

UNION HIGH SCHOOL – GROUP 3 – OPTIONAL

EQUIPMENT	EXISTING (QTY.) – CAPACITY	NEW (QTY.) – CAPACITY	EFFICIENCY UPGRADE
Split DX, cooling only	(7) – 4 tons	(7) – 4 tons	10 SEER -> 15 SEER

UNION HIGH SCHOOL – GROUP 4 - INCLUDED

EQUIPMENT	EXISTING (QTY.) – CAPACITY	NEW (QTY.) – CAPACITY	EFFICIENCY UPGRADE
DX RTU with HW Heat	(2) – 7 tons	(2) – 7 tons	10.9 SEER -> 14 SEER

BURNET MIDDLE SCHOOL – OPTIONAL

EQUIPMENT	EXISTING (QTY.) – CAPACITY	NEW (QTY.) – CAPACITY	EFFICIENCY UPGRADE
NEW Split DX with Steam Heat - Cafeteria	367 MBH Heating Only	16 tons cooling + 367 MBh Heating	VRF style Heat Pump with Steam Heat Duct Coil
NEW Split DX – Cooling Only	NA	(2) – 30 tons total	14 SEER

KAWAMEEH MIDDLE SCHOOL – OPTIONAL

EQUIPMENT	EXISTING (QTY.) – CAPACITY	NEW (QTY.) – CAPACITY	EFFICIENCY UPGRADE
Vertical DX UV with Steam Heat	(6) – 1,250 CFM	(6) – 1,250 CFM	9 EER -> 11 EER
Split DX with Electric Heat	(1) – 2 tons	(1) – 2 tons	10 SEER -> 17 SEER
Split DX with Steam Heat	(1) – 50 tons	(1) – 52 tons	Single zone VAV, hot gas bypass, DCV
NEW Split DX with Steam heat	NA	16 Total tons + 322 MBH Steam Duct Coil	VRF style Heat Pump with Steam Duct Coils

FRANKLIN ELEMENTARY SCHOOL – GROUP 1 – OPTIONAL

EQUIPMENT	EXISTING (QTY.) – CAPACITY	NEW (QTY.) – CAPACITY	EFFICIENCY UPGRADE
Split DX, cooling only	(5) – 3 tons	(5) – 3 tons	10 SEER -> 17 SEER
Split DX, cooling only	(6) – 3.5 tons	(6) – 3.5 tons	10 SEER -> 17 SEER

FRANKLIN ELEMENTARY SCHOOL – GROUP 2 – OPTIONAL

Township of Union Public Schools
Energy Savings Plan

EQUIPMENT	EXISTING (QTY.) – CAPACITY	NEW (QTY.) – CAPACITY	EFFICIENCY UPGRADE
Split DX, cooling only	(2) – 20 tons	(2) – 20 tons	9.7 EER -> 10.2 EER; single zone VAV

FRANKLIN ELEMENTARY SCHOOL – GROUP 3 – OPTIONAL

EQUIPMENT	EXISTING (QTY.) – CAPACITY	NEW (QTY.) – CAPACITY	EFFICIENCY UPGRADE
Split DX, cooling only	(4) – 3 tons	(4) – 3 tons	10 SEER -> 17 SEER
Split DX, cooling only	(3) – 3.5 tons	(3) – 3.5 tons	10 SEER -> 17 SEER

HANNAH CALDWELL ELEMENTARY SCHOOL - INCLUDED

EQUIPMENT	EXISTING (QTY.) – CAPACITY	NEW (QTY.) – CAPACITY	EFFICIENCY UPGRADE
DX VAV RTU w/ HW Heat	(1) – 5 tons	(1) – 5 tons	10 SEER -> 17.2 SEER
DX CV RTU w/ HW Heat	(1) – 10 tons	(1) – 10 tons	9 EER -> 12.5 EER, single zone VAV

DIRECT INSTALL RTU SCOPE - INCLUDED

- Kawameeh – (1) York Packaged RTU – 4 tons
- Franklin – (3) Carrier Packaged RTU – 4 tons
- Livingston – (5) Lennox Packaged RTU – 5 tons
- Washington – (4) Fujitsu Split System – 3 tons
- BOE Bldg – (2) Trane Packaged RTU – 2 tons
- BOE Bldg – (5) Trane Packaged RTU – 3 tons
- BOE Bldg – (1) Trane Packaged RTU – 4 tons
- BOE Bldg – (1) Lennox Packaged RTU – 5 tons
- BOE Bldg – (1) Trane Split System – 4 tons
- HCES – (1) Trane Packaged RTU – 4 tons
- HCES – (1) Trane Packaged RTU – 5 tons
- HCES – (1) Trane Packaged RTU – 10 tons
- HCES – (1) Trane RTU – 5 tons

10. New Gym Air Handling Units w/ AC, HW Converter Replacement, & CHP

Overview

The Union High School Gym is a very large space that is not only utilized for normal school activities and sporting events, but also for community events and graduation. In prior years, the District has had to provide a rental HVAC unit to provide cooling for the space during events such as graduation since the existing HVAC system does not provide air conditioning. Additionally, there is a large DHW load located in each of the locker rooms that flank each side of the gym.

Scope

New Gym Air Handling Units with Air Conditioning

The Gym HVAC units will be replaced with 2 packaged units that will sit on top of each of the locker room roofs. Connection to the existing distribution system will be provided and the units will have DX Cooling with HW Heat. The units will provide adequate ventilation for 2500 occupants, which is the Fire Department's maximum occupancy for the space. For details of the design, please refer to the Appendix.

Hot Water Converter Replacement

This measure will demolish the existing steam-to-hot water exchanger and hot water distribution pumps, and tie back to the existing plant loop served by two (2) existing condensing boilers. During IGA it was determined that this plant has enough excess heating capacity to pick up the additional heating zones. New zone distribution pumps equipped with VFDs for soft start will be provided.

Combined Heat & Power (CHP) System

We propose to provide a combined heat and power (CHP) system as well as new HVAC to provide Heat, Ventilation, and Cooling to the space. The CHP unit will be able to generate power and capture the byproduct heat to use for the DHW load year-round. A single 35 kW natural gas engine generator will feed power back to the main electrical feed for that school. The installation of a dedicated water loop between the engine and a new DHW exchanger will provide DHW heating in both winter and summer and an additional level of redundancy. This CHP system is approximately 88% efficient based on the ratio of input energy to used output energy. As a reference, electricity generated at power plants is typically less than 40% efficient.



Figure 10. Union High School Gym

Replacing the HVAC system and adding cooling to the Union High School Gym will improve comfort and athletic performance while reducing O&M costs for a rental chiller.

11. New Chiller, Cooling Tower, and Pumps with Controls

Overview

This ECM addresses the aging chilled water plant at Hannah Caldwell Elementary School. The school consists of several additions and renovations. The main building utilizes a dual temperature system for heating and cooling. The cooling plant consists of a water-cooled centrifugal chiller, forced draft cooling tower, and base-mounted primary pumps.

Scope

All major chilled water plant components are at the end of their useful life. This measure involves replacing the chiller, cooling tower, primary pumps, and several ancillary plant components (e.g. air/dirt separator, expansion tank, refrigerant monitor, and mechanical room emergency ventilation). Upgrading the chilled water plant and adding redundant pumps will ensure the cooling systems will remain active for the building, while providing a more efficient operation.

Several chiller and tower technologies were evaluated during the IGA to determine the most feasible replacement option. We proposed replacing the existing 180-ton centrifugal chiller with a 180-ton variable speed screw. Centrifugal chillers that are older than 15 to 20 years provided peak efficiency in the range of 0.75 to 0.85 kilowatts (kW) per ton of cooling at the time of their purchase. Even when they are well maintained, those efficiencies decline with time, resulting in chillers with peak efficiencies in the range of 0.8 to 1.0 kW per ton. Modern chillers offer peak efficiencies less than 0.7 kW per ton. Replacing the aging forced draft cooling tower with an induced draft tower equipped with a variable speed fan will not only reduce connected fan horsepower, it will offer much higher operational efficiency and better part-load performance. Energy savings will be realized through more efficient heat transfer, higher efficiency motors, and modulating cooling tower fan control.

The following table identifies equipment quantity and sizes being upgraded:



Figure 11. Cooling Tower (top) and Chiller (bottom) at Hannah Caldwell are overdue for replacement

EQUIPMENT	EXISTING (QTY.) CAPACITY	–	NEW (QTY.) CAPACITY	–	EFFICIENCY UPGRADE
Water-cooled Chiller	(1) – 180 tons		(1) – 180 tons		Variable speed screw
Cooling Tower	(1) – 180 tons		(1) – 180 tons		Induced draft tower with variable speed fan
Chilled Water Pumps	(1) – 3 hp		(2) – 5 hp		Soft start VFDs; add standby pump
Condenser Water Pumps	(1) – 10 hp		(2) – 10 hp		Soft start VFDs; add standby pump

3.2 ECM Descriptions – Phase II

12. Solar Photovoltaic (PV) System

Overview

This measure involves the District installing & owning a solar photovoltaic (PV) system at each school. Every kWh produced onsite by the solar system will be used by the building, with no electric charges for this energy. These savings are realized for as long as the PV systems are producing power, which may be 25 years or more. Another significant impact of a direct-purchased solar PV system is the revenue stream from selling the Transition Renewable Energy Certificates (TRECs). For every MWh of solar PV energy produced, the district will receive one TREC. These TRECs can then be sold each month, and the sell price is a fixed \$152 per TREC for a fixed period of 15 years after PV production starts.

For example, Burnet is expected to consume 485,803 kWh in a given year after this ESIP project is implemented. The solar PV system is expected to produce 96.5% of that electric needed by the building. This means the District would only pay for 3.5% of the building's electric power, and the rest is generated onsite, which would be owned and used by the district. Please reference the table below to see the savings impact. The TREC revenue plus the PV savings can be used to fund other scope within the ESIP project. In addition to these financial benefits, there are many positive societal and environmental impacts as well. Not only will the district's carbon footprint be drastically reduced so each school's impact on the environment is smaller, but you can showcase to your students, teachers, faculty, parents, community, and neighboring school districts how advanced and efficient your District is.

Scope

Interconnection applications have already been approved by PSE&G for the PV systems at each building listed below. This is a critical step in the process and helps ensure that the utility provider accepts and approves of the plan to put certain-sized PV systems at each location, and that existing electrical infrastructure and utility-grid infrastructure are both able to handle the onsite power generation without the need for expensive upgrades. The following table summarizes the solar systems, which may be roof-mounted, rooftop ballasted, or carport structures.

Building	PV System Size (kW)	Post ESIP Baseline (kWh)	Expected PV Production (kWh)	PV% of Post ESIP Baseline	1 st Year PV Savings	1 st Year TREC Revenue
High School	1,158.9	1,543,611	1,412,980	91.5%	\$175,598	\$214,773
Burnet MS	398.5	503,233	485,803	96.5%	\$61,366	\$73,842
Kawameeh MS	219	270,625	267,058	98.7%	\$33,789	\$40,593
Jefferson CS	154.4	570,362	188,249	33.0%	\$23,741	\$28,614
Battle Hill ES	172.3	210,123	210,123	99.9%	\$27,049	\$31,939
CT Farms ES	174.6	213,429	212,918	99.8%	\$27,440	\$32,364
Franklin ES	88.9	233,518	108,388	46.4%	\$13,636	\$16,475
Hannah Caldwell ES	454.7	554,428	554,428	100.0%	\$68,902	\$84,273
Livingston ES	111.3	196,519	135,698	69.1%	\$17,488	\$20,626
Washington ES	78.6	207,776	96,777	46.5%	\$12,027	\$14,710
Total	3,011.2	4,503,624	3,672,421	81.5%	\$461,066	\$558,208

For solar panel layouts, please see the Appendix.

13. Roof Repair, Replacement, & Warranty Extension

Overview

This measure addresses the roof of the building and how well it is protecting the rest of the building from outdoor elements, particularly rain, wind, snow, and ambient temperatures and humidity. The roof is also home to almost all of a buildings’ heating, cooling, and ventilation equipment. A strong, weather-tight, properly draining, and dry roof is critical to maintaining a structurally sound, protective, and long-lasting building.

Roof repairs and upgrades fix roof leaks and water damage to the roof structure and roof insulation. Many roofs throughout the district are out of warranty, so any repair costs fall directly on the school district to remedy. As the roofs age, more and more leaks and issues arise, further driving up roof maintenance costs.

Our comprehensive onsite testing and analysis indicate the current condition of each roof section, including the condition and thickness of the roof insulation, the type of roof decking, and how many roofs are present. When leaks are present, roof insulation becomes wet, and when this occurs, it never dries out. Wet insulation provides no thermal protection, which renders the insulation useless. Repairing, upgrading, or replacing a roof will:

- Eliminate roof leaks and areas of poor roof drainage.
- Replace all areas of wet insulation.
- Reduce the time and costs associated with future roof repairs – the new roofs will be under warranty.
- Improve the insulation performance of the roof, thus requiring less energy to maintain indoor temperature set points and comfort.
- Reduce infiltration of unconditioned outside air with new flashings and weather-tight barriers.
- Allow for installation of roof-mounted solar PV

Scope

The following is a breakout of the existing roofs being considered for repair or replacement.

Building	Roof Area (sq. ft.)	Existing Roof Type	Warranty Status
High School - Partial	249,090	Built-up w/ asphalt flood coat and aggregate	Roof warranty expired
Burnet MS	82,840	Built-up w/ asphalt flood coat and aggregate	Roof warranty expired
Kawameeh MS – Warranty Extension	44,210	Built-up w/ asphalt flood coat and aggregate	Roof is 13 years old
Battle Hill ES	53,350	Built-up w/ asphalt flood coat and aggregate	Roof warranty expired
Jefferson – Warranty Extension Optional	40,550	Modified Bitumen, and built-up w/ asphalt flood coat and aggregate	Roof is 10 years old
Hannah Caldwell ES	52,211	Aluma-coat	Roof warranty expired
Washington ES (flat section)	18,200	Built-up w/ asphalt flood coat and aggregate	Roof warranty expired

For more information on roof conditions, please visit the Appendix.

14. Burnet MS Auditorium HVAC Renovation with Cooling Addition - Optional

Overview

This scope of work includes replacing the auditorium air handling unit with a new unit which will provide air conditioning to the space.

Scope

EQUIPMENT	EXISTING (QTY.) – CAPACITY	NEW (QTY.) – CAPACITY	DESCRIPTION
Split DX with Steam Heat – Auditorium + DDC Controls	(1) – 75 tons, Single-zone CV, steam heat	(1) – 75 tons, Single zone VAV with Steam Heat.	Serves Auditorium. New equipment is more energy efficient with VAV design and updated to current mechanical code.

The following items are included:

- Disconnect/reconnect existing electrical feeders to AHU, reuse existing AHU disconnect switch
- Disconnect/reconnect existing electrical feeders to rooftop equipment, install new NEMA-3R disconnect switch on roof
- Remove, reinstall, and reconnect existing duct smoke detector
- Remove existing steam supply and condensate return piping as needed to access equipment pad
- Refrigerant recovery
- Remove AHU, condensing unit, and all associated refrigerant piping
- Install new AHU, condensing unit, and refrigerant piping, gas piping
- Minor duct modifications to connect new AHU to existing ductwork
- Testing and balancing
- Local temperature control, and remote temperature control through BAS

15. Steam Boiler Plant Replacement with Controls

Overview

This ECM addresses heating plants at five (5) schools. The following summarizes the current state of the existing plants:

Franklin ES

This plant consists of two (2) 80 HP, 78% efficient firetube steam boilers. These boilers are at the end of their useful life.

Connecticut Farms ES

This plant consists of two (2) 150 HP, 79% efficient firetube steam boilers. These boilers are at the end of their useful life.

Kawameeh MS

This plant consists of two (2) 325 HP, 80% efficient firetube steam boilers. These boilers are at the end of their useful life.

Union HS

The High School is served by several stand-alone heating plants consisting of both steam and hot water boilers. These boiler plants are in good working order and are not being considered for replacement as part of this project. One of the classroom wings that includes the auxiliary gym is served by an aging steam-to-hot water heat exchanger fed from the main steam boiler plant. The exchanger and hot water distribution pumps are at the end of their useful life.

Hannah Caldwell ES

The main building utilizes a dual temperature system for heating and cooling. The heating plant consists of two (2) 6,000 MBH input firetube hot water boilers. The boilers are nearing the end of their useful life.

Scope

This measure involves replacing or upgrading the steam & hot water generation components at each school. The existing boilers are at the end of their useful like and operate inefficiently with decreasing reliability. The installation of new boilers to replace the current, antiquated boilers will improve operating efficiency over all loading conditions.

New steam boilers will be sized to more closely match the building load to minimize boiler cycling extend equipment life. Consistent with the current installation, 100% heating redundancy (N+1) will be provided. Improved boiler turndown will help maintain a consistent steam pressure supply to improve occupant comfort. New boilers will be equipped with PLC controls, parallel positioning system, O₂ trim, and variable speed blower.



Figure 12. Franklin Steam Boiler

The following table identifies equipment quantity and sizes being upgraded at each school:

SCHOOL	EXISTING (QTY.) – CAPACITY	NEW (QTY.) – CAPACITY	EFFICIENCY UPGRADE
Franklin ES - Optional	(2) – 80 hp	(2) – 72 hp	PLC Control, Parallel Positioning, O2 Trim, Variable Speed Blower
Connecticut Farms ES - Optional	(2) – 150 hp	(2) – 72 hp	
Kawameeh MS – Optional	(2) – 325 hp	(2) – 125 hp	

Hannah Caldwell Elementary School – Optional

This measure will add one (1) new 3,000 MBH high efficiency condensing boiler to the existing non-condensing boiler plant. This boiler will provide approximately one-third of the total plant capacity. This boiler will improve overall plant efficiency and take a significant load off the conventional boilers, helping to extend their useful life. The new condensing boiler will serve as the lead boiler. As heating load increases and the lead boiler approached 100% capacity, the hot water supply temperature will be reset upward, and additional non-condensing boilers will be staged on to meet building demand.

3.3 Optional ECMs

In addition to the areas noted above in red as optional, the following opportunities have been identified during the Investment Grade Audit but are not currently included in the Energy Savings Plan.

1. **Roof Replacement** – Full HS Roof
2. **Window Replacement** – BMS, BHES, CFES, FES, WES, Hamilton
3. **Window AC Unit Replacement** – Various Locations
4. **HVAC Upgrade #1- Upgrade all unit ventilators to incorporate DX Cooling with upgraded electrical feeds and DDC Controls on all units** – BMS, CFES, LES, FES, WES
5. **HVAC Upgrade #2 - Add Window AC Units** – BHES, CFES
6. **Heating Plant Optimization, Add Suction Diffusers to HW Pumps** – BHES
7. **Building Automation Controls** – BHES, LES, KMS, Admin
8. **Packaged Unit Replacement** – JES
9. **Secondary Transformer Upgrade** – HCES
10. **Uninterruptable Power Supply (UPS) Upgrade** – High School
11. **Backup Generator for IT Closet** – High School
12. **Telecommunications Procurement** – All
13. **Energy Procurement (Electric & Gas Contracts)** – All sites

4.0 Energy Savings

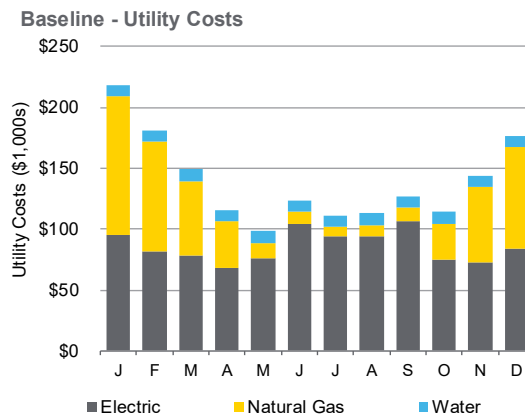
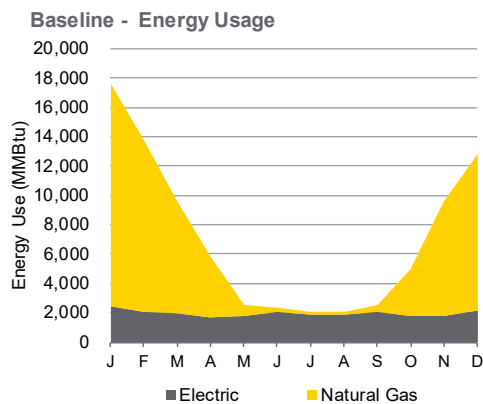
4.1 Baseline Energy Use

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

Month <i>mmm</i>	Electricity			Natural Gas		Water		Total	
	Energy Use <i>kWh</i>	Energy Demand <i>kW</i>	Cost <i>\$</i>	Energy Use <i>Therm</i>	Cost <i>\$</i>	Water Use <i>kgal</i>	Cost <i>\$</i>	Energy Use <i>MMBtu</i>	Cost <i>\$</i>
Jan	705,101	1,723	\$94,887	151,847	\$114,649	722	\$8,804	17,591	\$218,341
Feb	604,279	1,656	\$82,168	116,797	\$89,918	808	\$9,366	13,742	\$181,452
Mar	570,474	1,638	\$77,958	76,638	\$61,585	886	\$9,859	9,611	\$149,402
Apr	487,143	1,824	\$68,388	42,710	\$37,668	827	\$9,445	5,934	\$115,502
May	534,923	2,174	\$75,625	7,092	\$12,551	986	\$10,482	2,535	\$98,658
Jun	599,920	2,243	\$104,355	3,019	\$9,678	885	\$9,807	2,349	\$123,840
Jul	545,171	1,953	\$93,808	1,586	\$8,655	679	\$8,286	2,019	\$110,750
Aug	554,289	1,884	\$94,121	1,588	\$8,653	1,020	\$10,297	2,051	\$113,070
Sept	596,418	2,441	\$106,604	4,643	\$10,841	880	\$9,493	2,500	\$126,938
Oct	525,184	2,313	\$74,959	31,303	\$29,647	942	\$10,069	4,923	\$114,674
Nov	514,940	1,983	\$72,409	77,835	\$62,428	822	\$9,414	9,541	\$144,251
Dec	622,104	1,658	\$84,382	106,562	\$82,702	820	\$9,456	12,779	\$176,540
Year	6,859,945	23,490	\$1,029,665	621,619	\$528,976	10,277	\$114,779	85,575	\$1,673,419

Indices	Electricity			Natural Gas		Water		Total	
	kBtu/sf	W/sf	\$/sf	kBtu/sf	\$/sf	gal/sf	\$/sf	kBtu/sf	\$/sf
	20.6	2.2	\$0.91	54.8	\$0.47	9.1	\$0.10	75.4	\$1.48



Site Name Union High School

Project square footage 1,134,465
 Total building square footage 358,161
 Percentage of Total site area 32%

Total Energy Usage Index 60.7
 Total Utility Cost Index \$1.267

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	2,209,748 kWh	5,890 kW	\$314,172	69%
Natural Gas	13,569 MCF		\$116,421	26%
Water	2,683 kGal		\$23,235	5%
Total	21,743 MMBtu	5,890 kW	\$ 453,828	

Site Name Burnet Middle School

Project square footage 1,134,465
 Total building square footage 167,163
 Percentage of Total site area 15%

Total Energy Usage Index 73.5
 Total Utility Cost Index \$1.244

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	737,082 kWh	2,465 kW	\$111,828	54%
Natural Gas	9,457 MCF		\$84,106	40%
Water	980 kGal		\$11,974	6%
Total	12,294 MMBtu	2,465 kW	\$ 207,908	

Site Name Kawameeh Middle School

Project square footage 1,134,465
 Total building square footage 105,202
 Percentage of Total site area 9%

Total Energy Usage Index 66.1
 Total Utility Cost Index \$1.232

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	482,186 kWh	1,958 kW	\$75,802	59%
Natural Gas	5,114 MCF		\$43,643	34%
Water	700 kGal		\$10,120	8%
Total	6,956 MMBtu	1,958 kW	\$ 129,565	

Site Name Jefferson Elementary School

Project square footage 1,134,465
 Total building square footage 68,940
 Percentage of Total site area 6%

Total Energy Usage Index 64.8
 Total Utility Cost Index \$1.922

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	704,917 kWh	2,293 kW	\$106,230	80%
Natural Gas	1,986 MCF		\$20,986	16%
Water	298 kGal		\$5,268	4%
Total	4,470 MMBtu	2,293 kW	\$ 132,484	

Site Name Battle Hill Elementary School

Project square footage 1,134,465
 Total building square footage 57,375
 Percentage of Total site area 5%
 Total Energy Usage Index 66.2
 Total Utility Cost Index \$1.379

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	301,447 kWh	1,434 kW	\$48,253	61%
Natural Gas	2,692 MCF		\$23,792	30%
Water	573 kGal		\$7,083	9%
Total	3,799 MMBtu	1,434 kW	\$ 79,128	

Site Name Connecticut Farms Elementary School

Project square footage 1,134,465
 Total building square footage 57,740
 Percentage of Total site area 5%
 Total Energy Usage Index 103.8
 Total Utility Cost Index \$1.679

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	293,760 kWh	1,330 kW	\$45,888	47%
Natural Gas	4,892 MCF		\$43,554	45%
Water	637 kGal		\$7,505	8%
Total	5,992 MMBtu	1,330 kW	\$ 96,947	

Site Name Franklin Elementary School

Project square footage 1,134,465
 Total building square footage 58,635
 Percentage of Total site area 5%
 Total Energy Usage Index 92.3
 Total Utility Cost Index \$1.697

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	327,129 kWh	1,343 kW	\$53,562	54%
Natural Gas	4,144 MCF		\$37,107	37%
Water	503 kGal		\$8,817	9%
Total	5,412 MMBtu	1,343 kW	\$ 99,486	

Site Name Hannah Caldwell Elementary School

Project square footage 1,134,465
 Total building square footage 76,190
 Percentage of Total site area 7%
 Total Energy Usage Index 96.7
 Total Utility Cost Index \$2.398

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	865,540 kWh	2,497 kW	\$128,089	70%
Natural Gas	4,049 MCF		\$35,146	19%
Water	2,110 kGal		\$19,447	11%
Total	7,370 MMBtu	2,497 kW	\$ 182,682	

Site Name Livingston Elementary School

Project square footage 1,134,465
 Total building square footage 48,600
 Percentage of Total site area 4%
 Total Energy Usage Index 107.3
 Total Utility Cost Index \$1.833

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	293,525 kWh	1,334 kW	\$46,205	52%
Natural Gas	4,046 MCF		\$35,336	40%
Water	641 kGal		\$7,535	8%
Total	5,216 MMBtu	1,334 kW	\$ 89,076	

Site Name Washington Elementary School

Project square footage 1,134,465
 Total building square footage 64,615
 Percentage of Total site area 6%

Total Energy Usage Index 82.1
 Total Utility Cost Index \$1.444

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	331,166 kWh	1,189 kW	\$51,864	56%
Natural Gas	4,026 MCF		\$34,654	37%
Water	526 kGal		\$6,769	7%
Total	5,307 MMBtu	1,189 kW	\$ 93,287	

Site Name Hamilton Elementary School

Project square footage 1,134,465
 Total building square footage 35,328
 Percentage of Total site area 3%

Total Energy Usage Index 90.1
 Total Utility Cost Index \$1.216

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	99,850 kWh	479 kW	\$14,933	35%
Natural Gas	2,777 MCF		\$24,158	56%
Water	86 kGal		\$3,861	9%
Total	3,185 MMBtu	479 kW	\$ 42,952	

Site Name Field House

Project square footage 1,134,465
 Total building square footage 11,316
 Percentage of Total site area 1%

Total Energy Usage Index 85.6
 Total Utility Cost Index \$1.597

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	68,938 kWh	730 kW	\$11,878	66%
Natural Gas	676 MCF		\$6,191	34%
Water	327 kGal		\$0	0%
Total	969 MMBtu	730 kW	\$ 18,069	

Site Name Admin

Project square footage 1,134,465
 Total building square footage 25,200
 Percentage of Total site area 2%

Total Energy Usage Index 129.6
 Total Utility Cost Index \$1.905

Fuel Type <i>Fuel</i>	Utility Usage <i>Value</i>	Utility Demand <i>Value</i>	Utility Cost \$	Percentage of Total %
Electricity	144,655 kWh	549 kW	\$20,961	44%
Natural Gas	2,689 MCF		\$23,883	50%
Water	213 kGal		\$3,164	7%
Total	3,265 MMBtu	549 kW	\$ 48,008	

For a month to month baseline for each school, please see Appendix 7.1.

4.2 Energy Savings

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

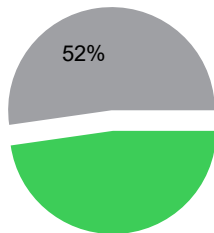
Executive Summary - Project Level

Total proposed project summary



Township of Union Schools - Project Summary

Energy Cost Savings



Energy and Water Indices			
	Energy <i>kBtu/sf</i>	Water <i>gal/sf</i>	Cost <i>\$/sf</i>
Baseline	75.4	9.1	\$1.48
Post Project	44.2	6.4	\$0.70
% Savings	41.3%	29.2%	52.3%

Project Summary				
Project <i>Phase</i>	Electricity Costs \$	Fossil Fuels Costs \$	Water Costs \$	Total Costs \$
Baseline	\$1,029,665	\$528,976	\$114,779	\$1,673,419
Post Project	\$284,424	\$419,477	\$94,942	\$798,843
Savings, Units	\$745,241	\$109,499	\$19,836	\$874,576
Percent Savings	72.4%	20.7%	17.3%	52.3%

To estimate savings from the proposed project, Schneider Electric utilized engineering formulas and energy modeling software. 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 energy simulation software called eQuest. eQuest was developed through funding by the United States Department of Energy (USDOE) and is the preferred tool for energy modeling in the energy performance contracting industry. Additionally, ELEMENT, a proprietary building modeling tool was 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 7.1.

4.3 Environmental Impact

The following graphic shows the environmental impact of the project.

Project Emissions Impact

Emissions summary



Township of Union Schools - Emissions Summary

Environmental Benefits			
	Scope 1	Scope 2	Total
Baseline Energy (MMBtu/yr)	62,162	23,413	85,575
Baseline Emissions (Tons CO2e/yr)	3,689	4,609	8,298
Savings (Tons CO2e/yr)	907	3,890	4,797
% Savings	24.6%	84.4%	57.8%



57.8%
% eTon Savings



4,797
eTons GHG



1,030
Cars Removed



619
Equivalent Houses



191,866
Equivalent Trees

*Emissions factors are derived from EPA eGrids database and represent the National average.

> Scope 1 Emissions include **direct** emissions from on-site fossil fuel combustion.

> Scope 2 Emissions result from **indirect** emissions from purchased generation of electric, chw or steam.

The following table identifies the values used to determine environmental benefits:

AVOIDED EMISSIONS (1)	(lbs) Saved per MWh	(lbs) Saved per Therm	Pounds Saved Total (Lbs)
NOX	0.83	0.0092	6,268
SO2	0.67	0	3,906
CO2	1292	11.7	9,349,600

5.0 Performance Assurance Support Services (PASS)

The purpose of Performance Assurance Support Services (PASS) is to measure, verify, and provide the necessary support services to sustain savings over time. Per NJ ESIP law, the PASS Agreement must be a separate contract from the ESIP Construction Contract. This section includes a description of the proposed measurement & verification plan.

5.1 Description of Services

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

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.

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.

On-site Visits

On-site visits include a review and reporting 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 District's energy and sustainability programs. Resource Advisor combines quality assurance and data capture capabilities of utility information into one energy management solution.

“Option A” Measurement and Verification

The International Performance Measurement & Verification Protocol (IPMVP) was created to determine standards and best practices in the measurement & verification of energy efficiency investments. The IPMVP Option A, Partial Retrofit Isolation, involves a pre and post measurement of a single variable used to determine energy savings. Option A is a good fit when savings represent a small portion of a building's energy baseline, or when savings for an ECM can be easily isolated from other measures.

“Option B” Measurement and Verification

The IPMVP Option B is a retrofit isolation or system level approach. The approach is intended for ECMs with performance factors (e.g., end-use capacity, demand, power) and operational factors (lighting operational hours, cooling ton-hours) that can be measured at the component or system level. It is similar to Option A but uses short-term, periodic, or continuous metering of all energy quantities, or all parameters needed to calculate energy, during the performance period.

“Option C” Measurement and Verification

The International Performance Measurement & Verification Protocol (IPMVP) was created to determine standards and best practices in the measurement & verification of energy efficiency investments. The IPMVP Option C, Whole Building Analysis, involves using utility meters and a weather normalized baseline to measure and verify savings. Option C is a good fit for buildings receiving comprehensive upgrades with a high degree of interactivity of the ECMs within this plan.

Commission and Verify (C&V)

This process is used to qualify and validate the installation, function, operation and performance of ECMs. The protocol consists of a planned process with a deliberate combination of steps which systematically identify, test and challenge various key aspects used to verify the performance objectives of an installed ECM against an established design criterion. Benefits include an improved controls interface, reduced energy demand and consumption, and improve occupancy comfort.

5.2 Measurement & Verification (M&V) Plan

The purpose of the Performance Assurance Support Services (PASS) program is to assist the District in sustaining savings over the long term. Based upon the scope of this project, we recommend a measurement & verification (M&V) program as described in the table below.

	1	2	3	4	5	6	7	8	9	10	11	12	13
Service	HS	BMS	KMS	Jeff	BH	CF	Frank	HC	Liv	Wash	Ham	FH	Admin
Performance Assurance Support Services													
1 Online Reporting: Resource Advisor	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
2 Remote System Monitoring & Reporting	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green			
3 Site Visits & Training	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green			
4 Remote Energy Management, Training & Technical Support	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green			
5 Energy Star Benchmarking	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green			
Measurement & Verification													
6 Solar PV: Option B Guarantee	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green			
7 Energy Efficiency: Option C Guarantee	Green	Green				Grey	Grey	Green	Grey	Grey			
8 Pay for Performance (P4P): Incentive #3								Green					

The guarantee is based upon Option B methodology for measuring and verifying the solar savings, and be based upon Option C methodology for the energy efficiency measures at Union High School, Burnet MS, and Hannah Caldwell ES. Each year after the initial term, the services can be eliminated or negotiated between SE & TUPS, to ensure the proper level of support and savings verification.

Services Included:	Install	Year 1	Year 2	Year 3
<ul style="list-style-type: none"> Commissioning & Verify ECMs Measurement & Verification of Savings Financial guarantee Quarterly Savings Reports On-site Energy Auditing & Consulting On-site Training Resource Advisor Building Automation System Reviews Remote Energy Management & Technical Support Complete P4P applications for the third incentive 	\$82,000	\$65,800	\$59,300	\$32,300

5.3 Ongoing Maintenance

Under the New Jersey ESIP legislation, all maintenance contracts are required to be procured separately from the ESIP. Schneider Electric will properly commission all equipment, provide training, review manufacturer maintenance requirements, and provide an owner's manual to ensure proper maintenance of the equipment.

ECM Category	O&M Impact
Lighting	Reduced O&M as lamps last much longer and ballasts are removed.
Water	Reduced O&M as internal diaphragm comes with 10 year material warranty.
Envelope	Routine, no different than current maintenance of building.
Steam Traps	No additional maintenance required outside of routine maintenance already being performed.
HVAC	No additional maintenance would be required outside of routine maintenance that is being done on existing equipment.
Building Automation System	Software upgrades as necessary.
Refrigerator Control	Software upgrades as necessary.
CHP	<p>Maintenance Contract is \$0.86 per run hour of CHP ~\$7,000 annually, which is accounted for in the project cashflow for ten years to be eligible for state incentives. O&M is provided by manufacturers.</p> <p>Includes the following:</p> <ul style="list-style-type: none"> • 24/7/365 live monitoring • Scheduled and Unscheduled maintenance • Labor and parts, including engine and generator replacement
Solar	Annual O&M contract is recommended. Cost of O&M is accounted for in Cashflow, but will need to be procured by the customer as a separate contract.

6.0 Implementation

6.1 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.

6.2 Assessment of Risks

This assessment of risks is meant to provide the District 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.
- The Walk-in Cooler and Freezer Controls must not be overridden or changed permanently to maintain energy savings.
- Water consuming fixtures must be maintained to maintain the water and energy savings. Replacement parts need to be of similar flow characteristics to maintain water and energy savings.
- Lighting systems will require maintenance as they age. Replacement parts need to be of similar energy efficiency to maintain savings.

7.0 Appendices

7.1 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 tools and approaches used for calculating savings.

ECM Name	Analysis Tool
BAS Red Wire	eQuest/ELEMENT
LED Lighting – Interior	eQuest/ELEMENT
LED Lighting – Exterior	eQuest/ELEMENT
Boiler Replacement	eQuest/ELEMENT
Envelope Upgrade	Spreadsheet Calculations (with BIN Data)
Water Fixture Improvements	Spreadsheet Calculations
Steam Trap Repair	Spreadsheet Calculations
Walk-in Refrigeration Controls	Spreadsheet Calculations
High Efficiency Transformers	Spreadsheet Calculations
Chiller Replacements	eQuest/ELEMENT
DX RTU Replacements	eQuest/ELEMENT
Cooling Tower Replacement	eQuest/ELEMENT
Combined Heat and Power	Spreadsheet Calculations
Solar Power Purchase Agreement	Spreadsheet Calculations
Hot Water Reset/Boiler Plant Optimization	ELEMENT

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

TUPS - Battle Hill ES

Infiltration

Building Data	
Building Name	Battle Hill ES
Weather City	NJ, Newark
Building Height, ft	18
Building Orientation, deg	0
Building LW Ratio	3.0
Internal Draft Coefficient	0.7

Building Operating Conditions	
Occupied Set Point Temp, oF	72.0
Cooling Setup Temp, oF	78.0
Percent of Building Cooled, %	100%
Cooling Seasonal Efficiency, %	290%
Heating Setback Temp, oF	60.0
Percent of Building Heated, %	80%
Heating Seasonal Efficiency, %	88%

Shelter Characteristics		
Direction	Shelter Class	Terrain Category
North	3	3
East	3	3
South	3	3
West	3	3

Building Crack Definitions

Penetration Name	Type Select	H ft	Qty #	Length ft	Gap inches	% Open %	Total Area sqft	Wall Only sqft
AC Unit Weatherization	Roof	9.0	1	352	1/8	100%	4.9	0.0
AC Unit Weatherization2	Roof	9.0	1	12	1/8	100%	0.1	0.0
Caulking	Wall	0.0	1	808	1/32	100%	2.1	2.1
Door Weather Stripping	Door	-6.0	1	302	1/8	100%	3.1	3.1
f-wall intersection air seal	Roof-Wall	9.0	1	177	1/8	100%	1.8	1.8
f-wall intersection air seal	Roof-Wall	9.0	1	12	1/12	100%	0.1	0.1
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)		-0.2					12.2	7.2

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

Effective Building Coefficients		Site Parameters	
Shelter Coefficient	0.7	Average Wind Speed, mph	9.9
Wind Shear Exponent	0.14	Site Corrected Wind Speed, mph	9.1
Boundary Layer Thickness, ft	900	Model Wind Coefficient	0.26
Wall Pressure Coefficient	0.11	Draft Factor	0.13
Roof Pressure Coefficient	-0.30	Volume Factor, ft/min (in-wg) ^{0.5}	2.603

Energy Engineering Calculations

Ref	Temperature Bin Hours				Schedule1			Calculated Infiltration Rates			Energy Transfer		Energy Savings	
	Mid Pt Temp oF	MCWB oF	Density lb/ft3	Enthalpy Btu/lb	Occupied hrs/yr	Unocc hrs/yr	Wall cfm	Roof cfm	Unoccupied Wall cfm	Roof cfm	Occupied Load kBTU/yr	Unocc Load kBTU/yr	Cooling Savings kBTU/yr	Heating Savings kBTU/yr
	2	-0.7	0.086	0.7	0	7	868	1,181	880	987	0	-1,323	0	1,203
3	6	3.7	0.085	2.0	10	13	868	1,113	880	903	-2,471	-2,176	0	4,224
4	10	8.4	0.084	3.4	8	37	868	1,039	880	811	-1,778	-5,376	0	6,503
5	14	12.5	0.083	4.6	23	67	868	963	879	711	-4,591	-8,388	0	11,799
6	19	16.3	0.083	5.9	56	83	868	883	879	598	-9,989	-8,811	0	17,091
7	23	19.9	0.082	7.1	90	137	868	796	879	459	-14,194	-11,932	0	23,751
8	27	23.6	0.081	8.5	196	230	868	698	879	255	-26,802	-15,092	0	38,086
9	31	28.0	0.080	10.2	244	262	867	580	879	294	-27,677	-15,119	0	38,905
10	36	31.2	0.080	11.4	234	294	867	445	879	474	-22,063	-17,065	0	35,571
11	40	34.9	0.079	12.9	212	297	867	235	879	606	-14,941	-15,542	0	27,712
12	44	39.0	0.078	14.7	255	349	867	301	879	716	-16,335	-14,712	0	28,224
13	48	43.0	0.077	16.6	205	301	867	486	879	811	-12,647	-8,895	0	19,583
14	53	46.6	0.077	18.4	289	316	867	615	879	894	-15,725	-4,971	0	18,815
15	57	51.4	0.076	21.0	288	352	867	731	879	978	-11,241	2,046	0	8,359
16	61	55.1	0.075	23.2	280	408	867	823	876	1,004	-6,809	0	0	6,190
17	65	59.1	0.074	25.8	226	328	867	909	872	999	-1,139	0	0	1,035
18	70	62.2	0.074	27.9	254	426	867	983	867	994	3,153	0	1,087	0
19	74	65.3	0.073	30.2	232	418	867	1,051	863	989	7,385	0	2,547	0
20	78	67.9	0.072	32.2	237	400	867	1,111	861	1,010	11,805	7,392	6,620	0
21	82	67.9	0.072	32.2	213	126	867	1,150	861	1,053	10,700	2,338	4,496	0
22	87	69.9	0.071	33.8	146	61	867	1,201	861	1,108	9,539	1,984	3,973	0
23	91	70.6	0.071	34.4	88	18	867	1,241	860	1,151	6,283	685	2,403	0
24	95	74.8	0.070	38.2	26	6	866	1,303	860	1,218	2,788	432	1,110	0
25	99	76.0	0.069	39.2	9	1	866	1,342	860	1,259	1,061	82	394	0
26	104		0.000	0.0	0	0	0	0	0	0	0	0	0	0
					3,821	4,938							22,630	287,052

Savings Summary

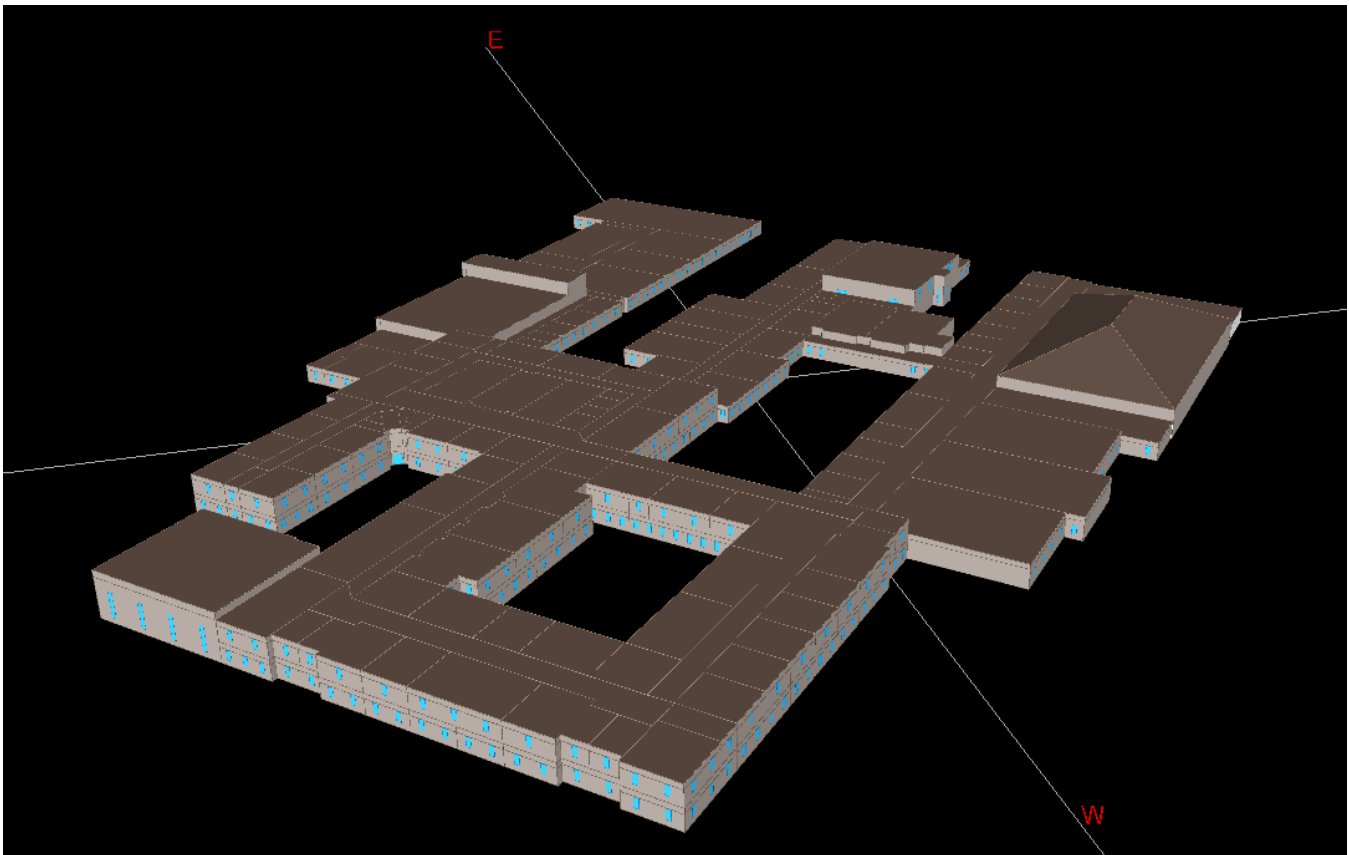
Type	Savings	Units	Utility Type
Cooling	6,631	kWh	Electricity
Heating	2,871	Therm	Natural Gas - Therm

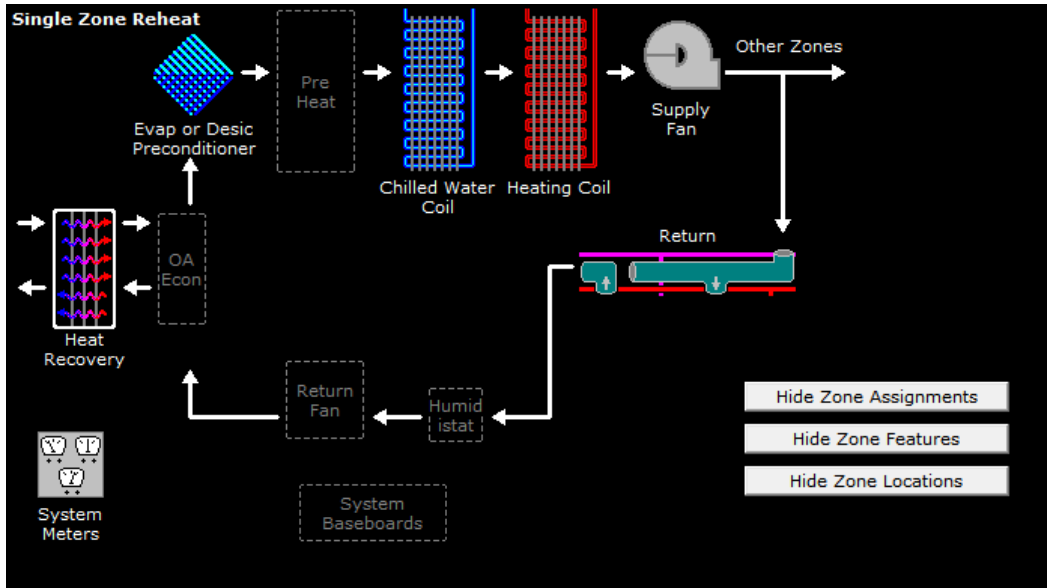
46
Proprietary & Confidential

Savings Methods – eQuest

To estimate savings for key buildings, Schneider Electric modeled energy use of buildings using eQuest. eQuest was developed through funding by the United States Department of Energy (USDOE) and is used as the preferred tool for energy modeling in the industry. This modeling tool provides the unique ability to model current conditions, including combined heat and power, and proposed retrofits in order to assess energy savings.

Spaces are defined by their construction to determine thermal conductivity and mass for heat loss/gain calculations. Also included are ventilation rates, lighting, equipment, and occupant loads and schedules. Individual spaces or groups of spaces are assigned to thermal zones that are served by an air distribution system. A thermal zone is defined by the conditioned area that is served by one thermostat controlling one terminal device (if applicable). Systems may include either a central air handler or distributed equipment such as water source heat pumps. Systems are then assigned to a loop that serves heating and/or cooling coils. Loops can include chillers, cooling towers, boilers, ground source wells, and all associated pumps. Plants are then assigned to a building. Below is a screen shot of the eQuest model for Union High School.





Defining accurate schedules is imperative to creating an accurate model. Schedules are used to describe when and to what capacity the building is operated and occupied. Varying load levels and runtime for lighting, electrical equipment, occupancy, ventilation, fans, and temperature set-points are all modeled using schedules. Below are two screen shots showing a typical lighting schedule.

Schedule Properties

Annual Schedules | Week Schedules | Day Schedules

Currently Active Day Schedule: **Lighting Wkd** Type: Fraction

Day Schedule Name: **Lighting Wkd**
Type: **Fraction**

Hourly Values

Mdnt - 1:	0.1000 ratio	8-9 am:	0.9800 ratio	4-5 pm:	0.9800 ratio
1-2 am:	0.1000 ratio	9-10 am:	0.9800 ratio	5-6 pm:	0.3500 ratio
2-3 am:	0.1000 ratio	10-11 am:	0.9800 ratio	6-7 pm:	0.3500 ratio
3-4 am:	0.1000 ratio	11-noon:	0.9800 ratio	7-8 pm:	0.3500 ratio
4-5 am:	0.1000 ratio	noon-1:	0.9800 ratio	8-9 pm:	0.3500 ratio
5-6 am:	0.1000 ratio	1-2 pm:	0.9800 ratio	9-10 pm:	0.3500 ratio
6-7 am:	0.6500 ratio	2-3 pm:	0.9800 ratio	10-11 pm:	0.1000 ratio
7-8 am:	0.8587 ratio	3-4 pm:	0.9800 ratio	11-Mdnt:	0.1000 ratio

Done

Schedule Properties ? X

Annual Schedules | Week Schedules | Day Schedules

Currently Active Day Schedule: Lighting Wke Type: Fraction

Day Schedule Name: Lighting Wke
Type: Fraction

Hourly Values

Mdnt - 1: 0.1000 ratio	8-9 am: 0.5000 ratio	4-5 pm: 0.1000 ratio
1-2 am: 0.1000 ratio	9-10 am: 0.5000 ratio	5-6 pm: 0.1000 ratio
2-3 am: 0.1000 ratio	10-11 am: 0.5000 ratio	6-7 pm: 0.1000 ratio
3-4 am: 0.1000 ratio	11-noon: 0.5000 ratio	7-8 pm: 0.1000 ratio
4-5 am: 0.1000 ratio	noon-1: 0.5000 ratio	8-9 pm: 0.1000 ratio
5-6 am: 0.1000 ratio	1-2 pm: 0.5000 ratio	9-10 pm: 0.1000 ratio
6-7 am: 0.1000 ratio	2-3 pm: 0.5000 ratio	10-11 pm: 0.1000 ratio
7-8 am: 0.1000 ratio	3-4 pm: 0.5000 ratio	11-Mdnt: 0.1000 ratio

Done

Calibrating the Model

To accurately predict the energy and demand savings of the project, the model must be calibrated to replicate closely the energy and demand use profiles of the baseline building. This is accomplished by first running the model as constructed. These results are then compared to the baseline energy consumption data described above to assess how closely the model matches the baseline. After examining the results, it becomes apparent where energy or demand is too high or too low and where adjustments may need to be made. The end goal is replicating all parameters such as electric energy, electric demand, and gas use to align simultaneously. These parameters typically involve adjusting operating schedules, internal loads, equipment efficiencies, and temperature set-points. The calibration process typically requires between fifteen and twenty iterations (possibly more for complex models) to achieve a satisfactorily calibrated model. The following graphic shows the output of the energy model vs. baseline for Hannah Caldwell ES.

eQuestrian

eQuest - TUPS - HCES - Building Name - Baseline

Baseline

ECM01

ECM02

ECM03

ECM04

ECM05

ECM06

ECM07

ECM08

ECM09

ECM10

Update Results

Energy Modeling Summary

Ref File Last Saved 7/16/2020 16:10
Ref File Last Imported 7/16/2020 16:21
Hourly Last Saved
Hourly Last Imported

Baseline Comments

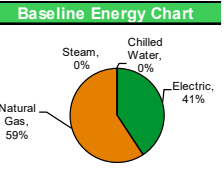
Provide key assumptions made to calibrate energy baseline.

Compress

Decompress

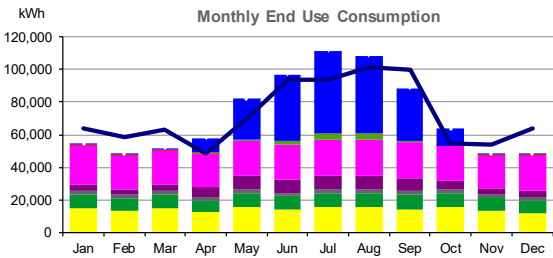
Baseline Energy			
Fuel	Pre	Units	EUI
Electric	861,303	kWh	38.6
Electric	2,525	kW	-
Natural Gas	42,741	Therm	56.1
Chilled Water	-	Ton-hrs	-
Steam	-	klb	-
Total	7,213,717	kBtu	94.7

Calibration	
Previous	Current
0%	0%
1%	1%
2%	2%
-	-
-	-

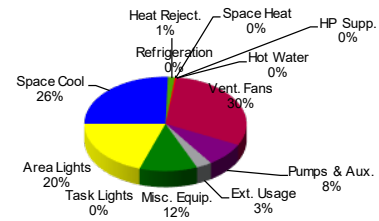


Electric Energy Data

1	Electric Consumption												kWh	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	1
Space Cool	357	275	1,382	9,136	25,080	40,849	50,935	47,680	32,158	10,318	865	283	219,320	Space Cool
Heat Reject.	0	0	0	130	551	2,100	3,892	3,848	1,462	140	0	0	12,122	Heat Reject.
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0	0	Refrigeration
Space Heat	720	546	346	141	0	0	0	0	0	72	329	556	2,708	Space Heat
HP Supp.	0	0	0	0	0	0	0	0	0	0	0	0	0	HP Supp.
Hot Water	0	0	0	0	0	0	0	0	0	0	0	0	0	Hot Water
Vent. Fans	23,747	20,611	21,183	21,022	22,071	21,690	22,325	22,254	21,550	21,152	20,302	22,067	259,972	Vent. Fans
Pumps & Aux.	4,090	3,555	3,591	5,651	8,238	7,970	8,259	8,266	7,977	5,663	3,343	3,842	70,445	Pumps & Aux.
Ext. Usage	2,272	2,052	2,272	2,199	2,272	2,199	2,272	2,272	2,199	2,272	2,199	2,272	26,755	Ext. Usage
Misc. Equip.	8,446	7,636	8,446	7,442	8,667	8,103	8,666	8,666	9,283	8,667	7,899	7,345	99,266	Misc. Equip.
Task Lights	0	0	0	0	0	0	0	0	0	0	0	0	0	Task Lights
Area Lights	14,806	13,392	14,806	12,410	15,384	14,142	15,384	15,384	14,142	15,384	13,565	11,918	170,717	Area Lights
Total	54,439	48,067	52,026	58,130	82,262	97,052	111,733	108,370	88,772	63,668	48,502	48,284	861,303	Total Model
Utility Baseline	64,074	58,800	63,068	48,432	70,000	93,840	93,840	101,633	99,529	54,355	53,929	64,040	865,540	Utility Baseline
Error	-15%	-18%	-18%	20%	18%	3%	19%	7%	-11%	17%	-10%	-25%	0%	



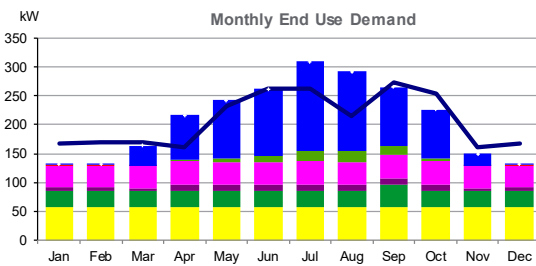
Annual Consumption End-Use Comparison



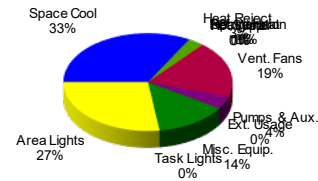
Township of Union Public Schools Energy Savings Plan

Electric Demand Data

Electric Demand													kW	
1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	1
Space Cool	1	1	35	78	101	115	155	137	102	86	21	1	836	Space Cool
Heat Reject.	0	0	0	2	6	11	19	19	15	4	0	0	77	Heat Reject.
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0	0	Refrigeration
Space Heat	1	1	0	0	0	0	0	0	0	0	0	1	4	Space Heat
HP Supp.	0	0	0	0	0	0	0	0	0	0	0	0	0	HP Supp.
Hot Water	0	0	0	0	0	0	0	0	0	0	0	0	0	Hot Water
Vent. Fans	38	38	38	40	39	39	40	40	40	40	38	38	468	Vent. Fans
Pumps & Aux.	6	6	5	11	11	11	11	11	11	11	5	6	106	Pumps & Aux.
Ext. Usage	0	0	0	0	0	0	0	0	0	0	0	0	0	Ext. Usage
Misc. Equip.	28	28	28	28	28	28	28	28	40	28	28	28	348	Misc. Equip.
Task Lights	0	0	0	0	0	0	0	0	0	0	0	0	0	Task Lights
Area Lights	57	57	57	57	57	57	57	57	57	57	57	57	686	Area Lights
Total	132	132	164	217	243	262	310	292	266	227	150	132	2,525	Total Model
Utility Baseline	168	170	170	161	233	262	262	215	274	253	161	168	2,497	Utility Baseline
Error	-22%	-23%	-4%	35%	4%	0%	18%	36%	-3%	-10%	-7%	-22%	1%	

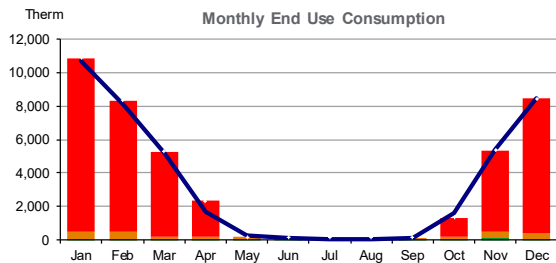


Annual Demand End-Use Comparison

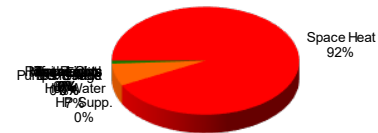


Natural Gas Energy Data

Natural Gas Consumption													Therm	
1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	100
Space Cool	0	0	0	0	0	0	0	0	0	0	0	0	0	Space Cool
Heat Reject.	0	0	0	0	0	0	0	0	0	0	0	0	0	Heat Reject.
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0	0	Refrigeration
Space Heat	10,374	7,890	5,083	2,121	0	0	0	0	0	1,154	4,878	8,009	39,509	Space Heat
HP Supp.	0	0	0	0	0	0	0	0	0	0	0	0	0	HP Supp.
Hot Water	460	434	176	176	164	139	138	131	120	136	357	427	2,859	Hot Water
Vent. Fans	0	0	0	0	0	0	0	0	0	0	0	0	0	Vent. Fans
Pumps & Aux.	0	0	0	0	0	0	0	0	0	0	0	0	0	Pumps & Aux.
Ext. Usage	0	0	0	0	0	0	0	0	0	0	0	0	0	Ext. Usage
Misc. Equip.	28	26	28	23	30	25	12	12	27	30	110	22	373	Misc. Equip.
Task Lights	0	0	0	0	0	0	0	0	0	0	0	0	0	Task Lights
Area Lights	0	0	0	0	0	0	0	0	0	0	0	0	0	Area Lights
Total	10,863	8,349	5,287	2,320	194	165	150	143	148	1,320	5,344	8,458	42,741	Total Model
Utility Baseline	10,721	8,082	5,220	1,697	276	145	73	65	149	1,580	5,391	8,473	41,870	Utility Baseline
Error	1%	3%	1%	37%	-30%	13%	106%	119%	-1%	-16%	-1%	0%	2%	



Annual Consumption End-Use Comparison



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.


Introduction


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.

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

ELEMENT





Baseline Calculation Inputs

Building Envelope				Internal Space Loads				Supply Fans				Heating and Cooling Systems			
58,635	Building Area, sqft	Medium	Building Weight	0.64	Peak Load	W /sqft	Lighting	14.25	Const kW	Variable kW	0.00	75%	Stm Blr - Forced Draft	System Type	
16.00	R_wall, hr-sqft-oF/Btu	31,710	Total Exterior Wall Area, sqft	0.50	Equipment	W /sqft	Equipment	Enabled	Speed Ctrl	Proportional		1.80	Fuel Efficiency, %		
Medium	Outside Surface Color	462	People	462	People	People	People	100%	Min Speed			0%	% Load Electric Heat		
Medium	Windows	0.811	People Activity Level	Medium Work								100%	Electric Efficiency, %		
Alum w/o Thermal Breaks	Frame Type	5.0	Outdoor Air									1.20	DX Cooling	System Type	
1/4 in. Gray Double	Glass Type	12.0	Infiltration	0.300	CFM / sqft of Exterior Wall Area	12.0	Average Ceiling Height, ft	72.0	72.0	64.0	oF	1.00	Cooling Efficiency, kW/ton		
5%	Exterior Shading Percentage	0.811	Air Change Per Hour, ACH	0.811	Air Change Per Hour, ACH	0.06	OA Rate, CFM per sqft	72.0	78.0	60.0	oF	65%	Oversize Factor		
11,099	Window Area, sqft	5.0	OA Rate, CFM per person	5.0	OA Rate, CFM per person	5,828	OA CFM Total	60.0	60.0	60.0	% RH	No	% Bldg Cooled		
30%	% North Facing	0.06	OA Rate, CFM per sqft	0.06	OA Rate, CFM per sqft	ON Night	OA Modulation Schedule						Remote Chilled Water?		
20%	% East Facing	5,828	OA CFM Total	5,828	OA CFM Total										
30%	% South Facing														
20%	% West Facing														
24.00	R-value, hr-sqft-oF/Btu														
30,802	Roof Area, sqft														
Medium	Outside Surface Color														
3.00	Plenum Height, ft														

Energy Modeling Calibration



Electric Calibration			
Modeled kWh	Utility kWh	Error %	
25,739	22,802	13%	
23,377	21,933	7%	
25,889	25,019	3%	
24,461	22,781	7%	
28,014	25,500	10%	
33,072	36,000	-8%	
37,187	38,166	-3%	
35,620	30,354	17%	
28,343	32,468	-13%	
26,361	26,613	-1%	
23,411	22,086	6%	
23,345	23,408	0%	
334,817	327,129	2.4%	

Fuel Calibration			
Modeled kBTU	Utility kBTU	Error %	
1,077,754	1,087,769	-1%	
811,080	857,172	-5%	
556,892	588,758	-5%	
352,518	251,355	40%	
56,112	42,216	33%	
19,284	13,887	39%	
8,964	9,290	-4%	
8,964	9,580	-6%	
27,769	12,515	122%	
230,894	167,373	38%	
531,821	509,096	4%	
814,076	736,422	11%	
4,496,129	4,285,434	4.9%	



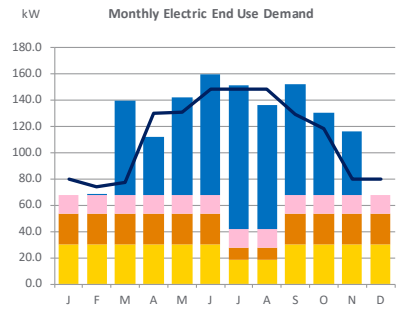
52
Proprietary & Confidential

Township of Union Public Schools Energy Savings Plan

Baseline Breakout Analysis

Month	Electric Consumption										Fuel Consumption							
	Internal Loads		Miscellaneous Loads			Fans and Pumps			Heating and Cooling				Miscellaneous Loads			Heating		
	Lighting 27.5% kWh	Equipment 19.7% kWh	terior Lightin 2.3% kWh	0 0.0% kWh	0 0.0% kWh	Fans 30.8% kWh	Clg Pumps 0.0% kWh	Htg Pumps 0.0% kWh	Heating 0.0% kWh	Cooling 19.7% kWh	Dehumid 0.0% kWh	Reheat 0.0% kWh	DHW 4.7% kBtu	Kitchen 0.0% kBtu	0 0.0% kBtu	Envelope 33.6% kBtu	Infiltration 36.1% kBtu	Ventilation 25.6% kBtu
1	8,212	6,412	656	0	0	10,459	0	0	0	0	0	21,277	0	0	367,643	407,204	281,630	0
2	7,457	5,822	593	0	0	9,504	0	0	0	0	0	19,229	0	0	271,460	303,479	216,911	0
3	7,902	6,170	656	0	0	9,917	0	0	0	1,243	0	20,398	0	0	193,374	198,646	144,475	0
4	7,632	5,592	635	0	0	9,048	0	0	0	1,553	0	17,940	0	0	118,528	124,028	92,022	0
5	8,522	6,654	656	0	0	7,467	0	0	0	4,716	0	21,867	0	0	12,945	12,492	8,807	0
6	7,525	5,435	635	0	0	6,868	0	0	0	12,609	0	17,349	0	0	697	718	520	0
7	7,682	3,726	656	0	0	7,068	0	0	0	18,054	0	8,964	0	0	0	0	0	0
8	7,682	3,726	656	0	0	7,068	0	0	0	16,487	0	8,964	0	0	0	0	0	0
9	7,322	5,350	635	0	0	6,939	0	0	0	8,096	0	17,349	0	0	3,678	3,982	2,759	0
10	7,902	6,170	656	0	0	8,877	0	0	0	2,755	0	20,590	0	0	78,444	78,088	53,772	0
11	7,237	5,651	635	0	0	9,405	0	0	0	483	0	19,024	0	0	180,377	193,452	138,968	0
12	7,057	5,144	656	0	0	10,487	0	0	0	0	0	16,952	0	0	282,051	301,926	213,148	0
	92,132	65,853	7,729	0	0	103,108	0	0	0	65,996	0	209,904	0	0	1,509,197	1,624,016	1,153,013	0

Month	Electric Demand											
	Internal Loads		Miscellaneous Loads			Fans and Pumps			Heating and Cooling			
	Lighting 23.4% kW	Equipment 17.5% kW	0.0% kW	0.0% kW	0.0% kW	Fans 11.9% kW	Clg Pumps 0.0% kW	Htg Pumps 0.0% kW	Heating 0.0% kW	Cooling 47.2% kW	Dehumid 0.0% kW	Reheat 0.0% kW
1	30.0	23.5	0.0	0.0	0.0	14.2	0.0	0.0	0.0	0.0	0.0	0.0
2	30.0	23.5	0.0	0.0	0.0	14.2	0.0	0.0	0.0	0.0	0.0	0.0
3	30.0	23.5	0.0	0.0	0.0	14.2	0.0	0.0	0.0	72.0	0.0	0.0
4	30.0	23.5	0.0	0.0	0.0	14.2	0.0	0.0	0.0	44.5	0.0	0.0
5	30.0	23.5	0.0	0.0	0.0	14.2	0.0	0.0	0.0	74.0	0.0	0.0
6	30.0	23.5	0.0	0.0	0.0	14.2	0.0	0.0	0.0	92.0	0.0	0.0
7	18.8	8.8	0.0	0.0	0.0	14.2	0.0	0.0	0.0	109.7	0.0	0.0
8	18.8	8.8	0.0	0.0	0.0	14.2	0.0	0.0	0.0	94.4	0.0	0.0
9	30.0	23.5	0.0	0.0	0.0	14.2	0.0	0.0	0.0	84.2	0.0	0.0
10	30.0	23.5	0.0	0.0	0.0	14.2	0.0	0.0	0.0	62.2	0.0	0.0
11	30.0	23.5	0.0	0.0	0.0	14.2	0.0	0.0	0.0	48.0	0.0	0.0
12	30.0	23.5	0.0	0.0	0.0	14.2	0.0	0.0	0.0	0.0	0.0	0.0
	338	252	0	0	0	171	0	0	0	681	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.

ECMs outside of Energy Model

Some ECMs because of their scope, impact, and nature do not fit well within the energy models. For example, savings from water fixture replacements cannot be calculated in the eQuest or ELEMENT modeling software. When this is the case, in-house built tools are used to accurately estimate savings.

Savings Methodology by ECM

Below are the Energy Conservation Measures that are being implemented at Township of Union Public Schools as part of this project.

1. LED Lighting Upgrades

Spreadsheet calculations were utilized to accurately define the savings for this measure. Pre and post lighting wattages were compared as well as burn hours. Projected savings were also run through eQuest models or ELEMENT for the sites listed below (except Field House) to ensure correctness and compliance.

Applicable To

Union High School

Burnet Middle School

Kawameeh Middle School

Jefferson Elementary School

Battle Hill Elementary School

Connecticut Farms Elementary School

Franklin Elementary School

Hannah Caldwell Elementary School

Livingston Elementary School

Washington Elementary School

Hamilton Building

Field House

Administration/BOE Building

2. Building Envelope Improvements

Schneider Electric uses typical meteorological year (TMY) weather data, draft pressure, internal space temperatures (both occupied and unoccupied), and crack size to conduct savings calculations. Schneider Electric follows ASTM E1186-03 Standard Practices for air leakage in building envelope. ASHRAE Fundamentals 16.23-48 was used to calculate the flow rate and crack method for all envelope calculations.

Applicable To

Union High School

Burnet Middle School

Kawameeh Middle School

Jefferson Elementary School

Battle Hill Elementary School

Connecticut Farms Elementary School

Franklin Elementary School

Hannah Caldwell Elementary School

Livingston Elementary School

Washington Elementary School

Hamilton Building

Field House

Administration/BOE Building

3. Water Fixture Recommissioning

Schneider Electric used excel spreadsheets to compare pre and post flow rates to generate water savings for the following sites;

Applicable To

Union High School

Burnet Middle School

Kawameeh Middle School

Jefferson Elementary School

Battle Hill Elementary School

Connecticut Farms Elementary School

Franklin Elementary School

Hannah Caldwell Elementary School

Livingston Elementary School

Washington Elementary School

Hamilton Building

Administration/BOE Building

4. High Efficiency Transformers

Schneider Electric partnered with Powersmiths to determine savings for this measure. Spreadsheet based calculations were used by Powersmiths to generate kWh savings, which were reviewed by Schneider Electric.

Applicable To

Union High School

Hannah Caldwell Elementary School

5. Walk-In Refrigeration Controls

Schneider Electric partnered with National Resource Management, Inc to generate savings for the walk-in freezer and refrigerator retrofits. Spreadsheet based calculations were used by NRM to generate kWh savings, which were reviewed by Schneider Electric.

Applicable To

Union High School

Burnet Middle School

6. Solar Photovoltaic (PV) System

Energy savings for the solar were calculated in Excel by multiplying the current electric consumption charges by the anticipated production of the solar PV system.

$$Savings (\$) = Solar\ production\ (kWh) * \left(existing\ consumption\ only\ charges\ \left(\frac{\$}{kWh} \right) \right)$$

Applicable To

Union High School

Burnet Middle School

Kawameeh Middle School

Jefferson Elementary School

Battle Hill Elementary School

Connecticut Farms Elementary School

Franklin Elementary School

Hannah Caldwell Elementary School

Livingston Elementary School

Washington Elementary School

9. Steam Trap Upgrade

Schneider Electric generated savings for this measure internally using spreadsheet calculations. Several of these steam traps were failed open or were nonfunctional, replacing them will yield heating energy savings. The savings calculations were reviewed for accuracy and correctness.

Applicable To

Union High School

Burnet Middle School

Kawameeh Middle School

Connecticut Farms Elementary School

Franklin Elementary School

Livingston Elementary School

Washington Elementary School

10. Building Automation System (BAS) Upgrades

Schneider Electric estimated savings by utilizing eQuest. Using a parametric run, a change was made to the model to reflect new setback and setup temperature schedules. Setups and setbacks are proposed to reduce the energy used by empty spaces after normal school hours. This same method was used with ELEMENT for applicable schools/sites.

Applicable To

Union High School

Burnet Middle School

Kawameeh Middle School

Battle Hill Elementary School

Connecticut Farms Elementary School

Franklin Elementary School

Hannah Caldwell Elementary School

Livingston Elementary School

Washington Elementary School

Administration/BOE Building

11. Rooftop Unit & Split System Replacement

Schneider Electric generated savings for this measure internally using eQuest modelling software and ELEMENT. Several of the units being replaced were either in poor shape or near end of life (EOL), these will be replaced with new efficient and environmentally friendly units. The savings calculations were reviewed for accuracy and correctness.

Applicable To

Union High School

Burnet Middle School

Kawameeh Middle School

Franklin Elementary School

Hannah Caldwell Elementary School

12. Combined Heat and Power (CHP)

Combined heat and power (CHP) systems can generate both heating energy as well as electrical power. Such systems can significantly reduce electric load of a building on the grid. The savings for this measure were calculated and reviewed internally.

Applicable To

High School

13. New Chiller, Cooling Tower, and Pumps with Controls

This measure will replace antiquated chillers with new, higher efficiency systems to improve the overall performance of the cooling plant. The new chiller plant will be correctly sized to the load.

Applicable To

Hannah Caldwell Elementary School

14. Boiler Replacement

The existing hot water boiler plant is nearing the end of its useful life and would benefit from replacement with new, high efficiency boilers sized with overall operating efficiency in mind. At the high school, the Steam to hot water convertor will be replaced with a new condensing boiler system.

Applicable To

Union High School

Kawameeh Middle School

Connecticut Farms Elementary School

Franklin Elementary School

Hannah Caldwell Elementary School

7.2 Lighting Line-by-Line

Please see the Appendices Box folder.

7.3 Direct Install Reports

Please see the Appendices Box folder.

7.4 Preliminary Solar Layouts

Please see the Appendices Box folder.

7.5 Roof Inspection Reports

Please see the Appendices Box folder.

7.6 Preliminary Mechanical Designs

Please see the Appendices Box folder for preliminary mechanical designs.

7.7 Sample School Calendar

2019-2020 School Calendar

TOWNSHIP OF UNION PUBLIC SCHOOLS
2369 Morris Avenue
Union, New Jersey 07083
(Phone) 908.851.6400
(Fax) 908.851.6421

July 2019						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

August 2019						
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

September 2019						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

October 2019						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

November 2019						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

December 2019						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

School Days: 185

***NOTE:** 185 School Days incorporates 5 days into the calendar for anticipated school closings due to inclement weather. If more days are needed, the emergency closing days will be made up as follows:

<u>Closed</u>	<u>Make Up</u>
6th day	April 17
7th day	April 16
8th day	April 15

June 23rd is confirmed as High School Graduation

1st Remaining Day:
School Closed - Friday, May 22nd

2nd Remaining Day:
School Closed - Thursday, May 21st

3rd Remaining Day:
School Closed - Tuesday, May 26th

4th Remaining Day:
School Closed - Wednesday, May 27th

5th Remaining Day:
School Closed - Thursday, May 28th

Legend

- School Closed
- Half Day
- Half Day - Students Only
- First & Last Day of School

January 2020						
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Days: 21

February 2020						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

Days: 19

March 2020						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Days: 22

April 2020							
S	M	T	W	T	F	S	
				1	2	3	4
5	6	7	8	9	10	11	
12	13	14	15	16	17	18	
19	20	21	22	23	24	25	
26	27	28	29	30			

Days: 16

May 2020						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Days: 20

June 2020						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Days: 18

2-Hour Delay		
UHS	9:35am	11:35am
MIDDLE	10:03am	12:00pm
JEFF	10:10am	12:20pm
ELEM.	10:45am	1:00pm
PRE-K	no am class	11:30am

7.8 Local Government Energy Audit (LGEA)

Please find the Local Government Energy Audit reports for all facilities located under “Union Township Public Schools” on the following page:

<https://njcleanenergy.com/commercial-industrial/programs/local-government-energy-audit/local-government-energy-audit/reports/T-Z>

7.9 Third Party Review & Approval Report

Please see the following pages for a copy of the Third-Party Review Report.

TOWNSHIP OF UNION PUBLIC SCHOOLS

TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

August 3, 2020

Final Revised August 12, 2020

**Prepared by: DLB Associates
(dlb # 15061)**



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

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TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

SECTION 1: EXECUTIVE SUMMARY



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

1.1 Executive Summary

1.1.1 Overview

DLB Associates has been commissioned by the Township of Union Public Schools to provide a Third-Party Review of an Energy Savings Plan (ESP) for conformance with State requirements for thirteen (13) of the Board's facilities. State requirements are set forth in P.L. 2009, Chapter 4, "Energy Savings Improvement Program" and Local Finance Notices 2009-11 and 2011-17. Amendments to P.L. 2009, Chapter 4, are included in P.L. 2012, Chapter 55.

DLB's review includes an analysis of the Energy Savings Plan for conformance with the New Jersey Board of Public Utilities (BPU) Standards and for verification that all required sections were submitted in the ESP Report. A review of the calculations methodology and plan savings as specified by the BPU protocol also was performed.

This report includes the summary and conclusions of DLB's Third-Party Review of the submitted Energy Savings Plan prepared by Schneider Electric and dated July 22, 2020.

1.1.2 Energy Savings Plan Review

The ESP appears to be complete and contains the required components. DLB has indicated items for further review and expect that the comments can be incorporated without affecting the ESP results significantly.

1.1.3 Energy Savings Calculations Review

The review of the energy savings calculations included within the ESP concluded that the calculations were performed in accordance with industry standard practice and utilizing the intent of the BPU protocol. Spreadsheet analyses were used to calculate Energy Conservation Measure (ECM) savings. The equations used to determine savings follow the protocol's calculation methods for energy efficient construction, but DLB recommends a few areas be clarified as identified in this report.

1.1.4 Conclusion

Both the ESP and the associated calculations appear to be completed with satisfactory effort and in accordance with P.L. 2012, Chapter 55, Amendments to "Energy Savings Improvement Program" and Local Finance Notices 2009-11 and 2011-17. A few calculations and concepts should be verified as indicated within the body of this report and revisions should be reviewed and addressed prior to adoption by the Township of Union Public Schools. Overall, DLB comments should have a low impact on the predicted savings.

DLB comments have been addressed in the attached Appendix by Schneider Electric, sent to DLB August 7, 2020, and have been incorporated into the revised ESP. The Energy Savings Plan is ready for review and adoption by the Township of Union Schools.

We have reviewed the revised Township of Union Schools Energy Savings Plan dated August 7, 2020, as submitted by Schneider Electric in accordance with P.L. 2012, c. 55 (2009 c.4.).



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

According to this legislation, an independent third party must review the plan and certify that the plan savings were properly calculated pursuant to the Board of Public Utilities protocols and / or the International Performance Measurement and Verification Protocol.

As a qualified New Jersey licensed engineer and in accordance with good engineering principles, we have reviewed each calculation outlined in the plan along with the associated energy conservation measure described. Our review indicates that the plan was established and compiled with sound measurement and verification protocols and in compliance with established standards set by the NJBPU.



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

SECTION 2: ENERGY SAVINGS PLAN REVIEW



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

2.1 Executive Summary

2.1.1 Energy Savings Plan Overview

The ESP reviewed by DLB Associates was prepared by Schneider Electric and dated July 22, 2020. The ESP Report includes an analysis for the following thirteen (13) facilities:

FACILITY INFORMATION	
Building Name	Street Address
Union High School	2350 N 3rd St, Union, NJ 07083
Burnet Middle School	1000 Caldwell Ave, Union, NJ 07083
Kawameeh Middle School	490 David Terrace, Union, NJ 07083
Jefferson Elementary School	155 Hilton Ave, Vauxhall, NJ 07088
Battle Hill Elementary School	2600 Killian Pl, Union, NJ 07083
Connecticut Farms Elementary School	875 Stuyvesant Ave, Union, NJ 07083
Franklin Elementary School	1550 Lindy Terrace, Union, NJ 07083
Hannah Caldwell Emanatory School	1120 Commerce Ave, Union, NJ 07083
Washington Elementary School	301 Washington Ave, Union, NJ 07083
Hamilton Elementary School	Burnet Ave, Union, NJ 07083
Field House	
Admin	960 Midland Blvd, Union, NJ 07083



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

SECTION 3: ENERGY SAVINGS PLAN REVIEW



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

3.1 Energy Savings Plan Review

3.1.1 Plan Components – Required By P.L. 2012, C.55

The Energy Savings Plan is the core of the Energy Savings Implementation Program (ESIP) process. Planned ECMs are described and the cost calculations supporting how the plan will pay for itself in reduced energy costs are provided. Under the law, the ESP must address the following elements:

- Energy audit results
- Energy conservation measure descriptions
- Greenhouse gas reduction calculations based on energy savings
- Design and compliance issue identification and identification of who will provide these services
- Risk assessment for the successful implementation of the plan
- Identification of eligibility, costs and revenues for demand response and curtailable service activities
- Schedules showing calculations of all costs of implementing the proposed energy conservation measures and the projected energy savings
- Maintenance requirements necessary to ensure continued energy savings
- Description and cost estimates for energy services company (ESCO) savings guarantee



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

3.1.2 Plan Components – Submitted Plan Review

The submitted ESP, dated October 24, 2019, is the basis for the Third-Party Review. The table below lists the required elements of the ESP as required by the law, whether the items were addressed satisfactorily in the ESP, and any associated comments.

ENERGY SAVINGS PLAN COMPONENT REVIEW			
Plan Component	Included In Plan	Location In Plan	Comments
Energy Audit Results	Yes	Entire Plan	See Below
ECM Descriptions	Yes	Section 3, Pages 11 – 33	See Section 4 of this Report
Greenhouse Gas Calculations	Yes	Section 4.3	See Section 4.1.6 of this Report
Design and Compliance Issues	Yes	Section 6, Pages 42	None
Implementation Risk Assessment	Yes	Section 6, Page 42	None
Demand Response Program / Curtailable Energy Services	Yes	Section 2.4, Page 10	None
Implementation Costs	Yes	Section 2, Page 6-8	See Section 4.1.5 of this Report
Projected Energy Savings	Yes	Section 2, Page 6	See Section 4 of this Report
Maintenance Requirements	Yes	Section 5.3, Page 54	Could be expanded to include recommended maintenance impacts
Savings Guarantee Information	No	Not found	Includes Performance Assurance Support Services but does not specifically note Savings Guarantee in section 5.
Measurement and Verification Plan	Yes	Section 5.2, Pages 41	None



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

SECTION 4: ENERGY SAVINGS CALCULATIONS REVIEW



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

4.1 Energy Savings Calculations Review

4.1.1 Methodology of Submitted Calculations

The Energy Savings Improvement Plan included calculations that utilized BPU-acceptable equations and spreadsheet analyses.

The fourteen (14) ECMs analyzed and accepted in the base project include:

1. LED Lighting updates - All
2. Building Envelop Improvements - All except CFES
3. Water Fixture Recommissioning – All schools
4. High Efficiency Transformers - HS
5. Walk-in Refrigeration Controls – HS, BMS
6. Solar Photovoltaic (OPV) systems – All Schools
7. Roof Repair, Replacement & Warranty Extension – HCES, BMS, HS, BHES, KMS, WES
8. Drop Ceiling installation – BMS, BHES
9. Steam Trap Replacement – HS, BMS, KMS, CFES, FES, LES, WES
10. Building Automation System *(BAS) with Demand Control Ventilation- All Schools except JES
11. Rooftop Unit & Split System Replacement – HS, KMS, FES, HCES< LES, Admin
12. New Gym Air Handling Units w/ AC, HW Converter Replacement & CHP - HS
13. New Chiller, Cooling Tower and Pimps with Controls - HCES
14. Steam Boiler Plant Replacement with Controls – FES, CFES

4.1.2 General Calculation Quality

The quality of the energy savings calculations is satisfactory and representative sample sets were checked for accuracy. Spreadsheet analyses were provided by Schneider Electric as separate appendix files and have been spot-checked by DLB.



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

The approach and equations used were summarized broadly in the body of the report with no results given in the ECM description sections. References for equations were listed for some ECMs in the report body. The report body could be expanded to include more details on methodology and results for clarity, but they are included in the Appendix sections.

DLB notes the following comments for the overall report:

1. Any ECMs which propose to modify temperature setpoints or operation schedules of any equipment, including, but not limited to, HVAC equipment, equipment connected to plug load control devices, walk-in freezers or coolers or computing equipment, should be confirmed with the District to ensure there will be no detrimental operations impacts.
2. eQuest was noted as being used to calculate savings for certain ECMs and it is suggested that the eQuest baseline variables such as temperature settings and schedule be included for these ECMs to back up savings calculations.

4.1.3 Mechanical and Electrical Energy Conservation Measures

ECMs were evaluated using spreadsheet analyses. The ECMs submitted agree with Standard Industry Practice and BPU protocol requirements.

DLB notes the following possible issues with the ECM analysis:

ECM 2 – Building Envelope Improvements (All except CFES)

1. It would be helpful to add additional detail on how the amount (LF, SF) of cracks, caulking, etc were calculated. Were these field measured or are they based on typical for a certain quantity of units/ size of school.
2. It also appears that some of the savings relates to added insulation (CF, Frank, Liv and Wash) but the description or the appendix calculations do not appear to include information on this, would recommend to add.

ECM 3 – Water Fixture Improvements (All)

3. Confirm that total savings for this measure is estimated at ~ \$ 21,000 and the total water utility costs for the district is ~ \$ 114,000, this represents an approximate 20% savings.
4. Measure description notes water closet flush valves and table below includes counts for sink deaerators. Would update the description to include the sinks if they are part of the ECM for clarity.
5. Measure description notes that some of the older fixtures are 3.5 gallon water closets. Would recommend that it is confirmed that they are compatible with valve refurbishment without being replaced.



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

6. The calculations note that the existing 1.6 gpf tank toilets valves are being replaced but do not note the gpf of the replacement flushometer. It may be beneficial to add this and has it been verified that these replacement flushometers are compatible with the fixtures being used in.

ECM 4 – High Efficiency Transformers (HS)

1. It would be beneficial to define where the “Baseline Transformer Losses” are based on. Not sure if these are manufacturer published data or field measured.
2. The age of the existing transformers to be replaced should be included in the report.
3. It appears Transformer replacement is being recommended for the HS which has been targeted for P4P incentives. Have the savings been double checked that they match P4P typical annual loss table for transformers if being used for P4P incentives.
4. A number of cells in the backup calculations are not tabulating correctly. Would recommend these be checked and adjusted when added to the final report. For example, the 75kva transformer in the HS that is recommended for replacement lists a \$ 0 savings.
5. Would be good to verify what incentive / rebates are tied to another transformer upgrade ECM.

ECM 5 – Walk-in Refrigeration Controls (HS and BMS)

1. Calculations for EC motor replacement utilized an “Estimated Reduction in Motor Load” of 65%. It is recommended to add additional information on how this factor was derived.
2. It would be helpful to note how baseline electric consumption values were determined is provided, uncertain if they were measured or estimated.

ECM 6 – Solar Power Purchase Agreement (All)

1. It appears that Solar PPA consists of 90% of the estimated annual savings for this ESIP as noted on Table 2.1. It may be beneficial to include additional information such as if a PPA provider is on board or including additional information in the appendix since it is the prime generator of energy savings.
2. If the new solar panels are proposed to be installed on sections of the roof of various buildings of various ages and roof materials, have structural modifications required to support the weight of the new solar panels been included in the associated costs.
3. It is unclear if maintenance access was taken into account in the general panel layout which should be considered for any roof top equipment.
4. Also, it may be worthwhile to highlight any system downtime incorporated in the estimated production values.
5. It may also be worthwhile to note if any of the PV production exceeds 80% of the existing building infrastructure and if so if any costs to update infrastructure have been included in the project cost.



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

ECM 7 – Roof Repair, Replacement & Warranty Extension (HCES, BMS, HS, BHES, KMS, WES)

1. The report includes a nominal savings for this ECM and it is recommend that the description include calculations of how this was calculated.
2. The overview notes “reduce infiltration” and want to double check that this savings does not overlap with ECM 2 Building Envelope Improvements.
3. This ECM does not appear on the Appendix 7analysis tool table and recommend adding the tool used to calculate savings.

ECM 8 – Drop Ceiling installation (BMS, BHES)

1. There is no savings for this Energy Conservation Measure, can you confirm that this is a capital improvement project that is requested by the district.
2. The report notes that removal or modification of all other devices such as clocks, cameras, fire alarms, etc. will be coordinated by the district. Are sprinkler system modifications needed as well to accmodate the new ceiling?
3. Is the lighting replacement portion of the scope of this part of ECM 1 LED Lighting Upgrades or are the fixtures and replacement included in this ECM.

ECM 9 – Steam Trap Replacement (HS, BMS, KMS, CFES, FES, LES, WES, BHES)

1. Appendix calculation include System Heating hours and Space Hours that are the same for each school. Are these estimated values or are they the districts heating plant operating hours.
2. Appendix calculation also includes Steam Boiler combustion efficiency and pressure for the existing boilers, are these nameplate values or estimated values based on their age?
3. Is there any overlap in the savings from this ECM and ECM 14 Steam Boiler replacement?

ECM 10 – Building Automation System (BAS) with Demand Control Ventilation (All Schools except JES)

1. ECM description includes central boiler plant, terminal units and common area AHU units for most of the schools. Clarify if any Exhaust Fans are included in the DDC control scope (if applicable).
2. It may be helpful to add a description to the EQuest calculation output runs. Can you confirm the BAS Re Wire calculations include occupied/ unoccupied control beyond what is currently controlled in the baseline run.
3. Also can you confirm savings for this ECM is a combination of the 2 EQuest runs (BAS Red Wire and DCV)
4. Are there any schools that contain existing pneumatic control systems? And if so has rewiring and device replacement been included in the scope of this ECM to accommodate these older systems.



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

ECM 11 – Rooftop Unit & Split System Replacement (Various Schools):

1. Provide calculation data for all proposed equipment replacements.
2. Schneider Electric should confirm that the new RTUs will include code-required economizer functionality.
3. Confirm that this ECM falls under the current Direct Install Program, this program has been significantly changing each year.

ECM 12 – New Gym Air Handling Units with AC, HW Converter Replacement and CHP (HS)

1. Note: The payback period and energy savings resulting from the replacement are not enough for this ECM to be counted as an energy conservation measure. This can be considered a capital improvement project instead.
2. Will the air handling unit operation change due to current events (COVID-19) moving forward? Consider more hours of operation due to potential for increased air change rates during occupied hours.
3. ESP calls for the installation of a 35 kW CHP. It may be beneficial to include the equipment information on this unit to further detail performance, operational requirements, and maintenance of the system.
4. This ECM is listed to have a 58 year payback and it appears to be included to allow financing over 20 years.
5. Please confirm if the maintenance costs / contract is included in overall cost for this ECM. CHP systems typically have a very rigorous maintenance schedule.
6. It appears that the total expected operating hours that the CHP Plant is planned to be run for the majority of the year and it is to be located near the gym. It would be good to confirm if these hours and the installation location will not cause any noise issues.
7. Since this is integral to the payment terms, it may be beneficial to confirm with the facility personnel that there is enough space at the site for the CHP system and the connections to the existing heating hot water system.
8. Please confirm if the operation of the rental AC units was included in the baseline model.

ECM 13 – New Chiller, Cooling Tower, and Pumps with Controls (HCES)

1. Confirm the baseline and proposed chiller efficiencies.
2. Was condenser water reset included?
3. Were variable flow chilled and condenser water systems considered?

ECM 14 – Steam Boiler Plant Replacement with Controls (FES, CFES)



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

1. Additional information about the existing boilers, including age and model number, would be beneficial to include so that savings can be verified.
2. The boiler calculations were not provided.
3. Confirm if stated efficiencies of existing boilers are based on nameplate data or onsite measurements.
4. Will redundant boilers be run in low fire, warm mode to allow rapid switch between units?

4.1.4 Lighting Energy Conservation Measures

Lighting improvement savings calculations were performed in a satisfactory manner using a spreadsheet analysis and reviewed in a spot-check fashion.

DLB notes the following potential issues with the lighting ECM analysis:

ECM 1 – LED Lighting Upgrades (All)

1. Would there be a need to re-evaluate the installation costs due to current events (COVID-19) and how this will impact costs?
2. KWh savings in the line x line do not match the total provided in the savings per site document for some schools. Adjust for consistency.
3. The ECM lists the schools that qualify for the direct install program for this ECM, is this all the schools that LED lighting upgrades are being considered at?
4. Light fixture upgrades for the High School are shown in the savings per site document and it is not listed in the ECM description. Can you confirm that LED Lighting is being implemented at the High School under the P4P program?.
5. It may be beneficial to include details on the recommended model for the replacement lamp – not sure if lamp or line voltage upgrade kits are being proposed.
6. If line voltage upgrade kits, we would suggest model information is included to make sure the recommended retrofit maintains the UL listing of the light fixtures.
7. For lamp replacement projects, is a maintenance savings taken into account for extended life?
8. The quantity of fixtures being replaced should be identical and should be checked. In the “Lighting Line by Line” Table there appears to be a few locations where the quantity numbers differ but may be situations where lamps were burnt out since some of these have a slight increase in energy use.
9. Confirm that this LED lighting ECM does not include lighting control upgrades.
10. In section 7.0 it is noted that LED Lighting was calculating using EQuest but the calculations included a lighting line by line calculation and wanted to verify if this table is correct.



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

4.1.5 Financial Calculations

The financial calculations included within the ESP incorporate a 2.7% interest rate for the loan.

The recommended plan includes fourteen (14) ECMs and is analyzed over a 20-year financing term.

DLB notes the following potential issues with the financial calculations:

1. A note should be added to confirm the Cash Flow Form in section 2.3 uses the BPU-required 2.2% electric and 2.4% natural gas and fuel oil utility escalation.
2. Cash Flow Form shown in section 2.3 of the report shows an installation year savings of ~ \$ 246, 845 and a total year 1 savings of ~ \$ 329,127. The total savings shown in the cost summary in section 2.1 is ~ \$ 1,388,437. It would be beneficial include an explanation added to define the lower installation year savings value.
3. Cash Flow Form includes a total of \$ 37,276 Energy Rebates / Incentives to be received in installation year. Confirm the schedule; some of these rebates are issued after ECMs are installed which may be in year 1.
4. LFN 2009-11 requires that any capital improvements be paid through other appropriations (i.e., bonds or capital improvement funds), not energy savings obligations. DLB recommends confirming that any capital improvements are planned to be funded appropriately.

4.1.6 Greenhouse Gas Calculations

Greenhouse Gas Calculations are provided but the factors used to calculate savings are not clearly called out in the report. The factors should included and revised if needed to meet the current BPU guidelines, shown on page 13 of the protocol:

- 1,292 lbs. CO₂ per MWh saved
- 0.83 lbs. NO_x per MWh saved
- 0.67 lbs. SO₂ per MWh saved
- 11.7 lbs. CO₂ per therm saved
- 0.0092 lbs. NO_x per therm saved



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SECTION 5: REVIEW DISCLAIMER



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

5.1 Review Disclaimer

DLB Associates, as part of the Third-Party Review services, is providing our professional opinion in the evaluation of the energy savings calculations, ESP, and any other supporting documentation provided.

This evaluation is not a guarantee that the savings and assumptions stated are valid. DLB Associates will not be responsible for any failure in achieving the predicted energy and cost savings detailed.

Our intention is to complete our due diligence in verifying the energy savings calculations in accordance with the BPU protocols; however, it is impractical to review all inputs in detail. As a result, bottom line numbers and a limited number of parameters have been verified to conclude validity of savings.



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

SECTION 6: ATTACHMENT



TOWNSHIP OF UNION PUBLIC SCHOOLS

TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

August 3, 2020

August 7, 2020: SE Responses

Prepared by: DLB Associates
(dlb # 15061)

dlb associates | confidential and proprietary

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TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

3.1.2 Plan Components – Submitted Plan Review

The submitted ESP, dated October 24, 2019, is the basis for the Third-Party Review. The table below lists the required elements of the ESP as required by the law, whether the items were addressed satisfactorily in the ESP, and any associated comments.

ENERGY SAVINGS PLAN COMPONENT REVIEW			
Plan Component	Included In Plan	Location In Plan	Comments
Energy Audit Results	Yes	Entire Plan	See Below
ECM Descriptions	Yes	Section 3, Pages 11 – 33	See Section 4 of this Report
Greenhouse Gas Calculations	Yes	Section 4.3	See Section 4.1.6 of this Report
Design and Compliance Issues	Yes	Section 6, Pages 42	None
Implementation Risk Assessment	Yes	Section 6, Page 42	None
Demand Response Program / Curtailable Energy Services	Yes	Section 2.4, Page 10	None
Implementation Costs	Yes	Section 2, Page 6-8	See Section 4.1.5 of this Report
Projected Energy Savings	Yes	Section 2, Page 6	See Section 4 of this Report
Maintenance Requirements	Yes	Section 5.3, Page 54	Could be expanded to include recommended maintenance impacts
Savings Guarantee Information	No	Not found	Includes Performance Assurance Support Services but does not specifically note Savings Guarantee in section 5.
Measurement and Verification Plan	Yes	Section 5.2, Pages 41	None

Commented [DR1]: Additional detail has been added to Section 5.3

Commented [DR2]: Additional detail has been added under Section 5.2



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

The approach and equations used were summarized broadly in the body of the report with no results given in the ECM description sections. References for equations were listed for some ECMs in the report body. The report body could be expanded to include more details on methodology and results for clarity, but they are included in the Appendix sections.

DLB notes the following comments for the overall report:

1. Any ECMs which propose to modify temperature setpoints or operation schedules of any equipment, including, but not limited to, HVAC equipment, equipment connected to plug load control devices, walk-in freezers or coolers or computing equipment, should be confirmed with the District to ensure there will be no detrimental operations impacts.

We have discussed with the district and agreed to a Standards of Comfort values that coincide with setpoints and occupied schedules. SoC file has been added to Appendices Folder.

2. eQuest was noted as being used to calculate savings for certain ECMs and it is suggested that the eQuest baseline variables such as temperature settings and schedule be included for these ECMs to back up savings calculations.

Screenshot of variables have been provided in the Appendices documents.

4.1.3 Mechanical and Electrical Energy Conservation Measures

ECMs were evaluated using spreadsheet analyses. The ECMs submitted agree with Standard Industry Practice and BPU protocol requirements.

DLB notes the following possible issues with the ECM analysis:

ECM 2 – Building Envelope Improvements (All except CFES)

1. It would be helpful to add additional detail on how the amount (LF, SF) of cracks, caulking, etc were calculated. Were these field measured or are they based on typical for a certain quantity of units/ size of school.

These were all field measured.

2. It also appears that some of the savings relates to added insulation (CF, Frank, Liv and Wash) but the description or the appendix calculations do not appear to include information on this, would recommend to add.

This scope is included but was overlooked in our savings calculations; thus no savings were included for this aspect of the scope. The scope itself will still be implemented but no savings will be “officially” claimed for it.



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ECM 3 – Water Fixture Improvements (All)

3. Confirm that total savings for this measure is estimated at ~ \$ 21,000 and the total water utility costs for the district is ~ \$ 114,000, this represents an approximate 20% savings.

This has been confirmed.

4. Measure description notes water closet flush valves and table below includes counts for sink deaerators. Would update the description to include the sinks if they are part of the ECM for clarity.

China replacement is not part of the Sink scope; this refers only to the aerators associated with the sinks.

5. Measure description notes that some of the older fixtures are 3.5 gallon water closets. Would recommend that it is confirmed that they are compatible with valve refurbishment without being replaced.

Field assessments have been conducted and have determined that they are acceptable to refurbishment.

6. The calculations note that the existing 1.6 gpf tank toilets valves are being replaced but do not note the gpf of the replacement flushometer. It may be beneficial to add this and has it been verified that these replacement flushometers are compatible with the fixtures being used in.

1.6 gpf tank toilets will be rebuilt with all new internal components; replace the flapper, flow diverter ballcock assembly, and refill tube. As necessary, to ensure proper operation, contractor will remove and replace the trip lever and supply line. Per our field measurements, current flows on tank toilets average 2.25 gpf. Contractor will tune these to attain an average flow of 1.7 gpf.

ECM 4 – High Efficiency Transformers (HS)

1. It would be beneficial to define where the “Baseline Transformer Losses” are based on. Not sure if these are manufacturer published data or field measured.

The file “ECM 4 Transformer Savings.pdf” on page 9 it shows the losses that were measured. Not all pieces were measured, but a measurement was taken for different size transformers. All other measurements were estimated based on the measured losses.

2. The age of the existing transformers to be replaced should be included in the report.

Ages have been provided where known. Otherwise, estimates have been provided.

3. It appears Transformer replacement is being recommended for the HS which has been targeted for P4P incentives. Have the savings been double checked that they match P4P typical annual loss table for transformers if being used for P4P incentives.

HS does not have a P4P incentive. We only estimated HCES for P4P. P4P does accept custom calculations for transformers provided they are able to verify the background calculations. We have gone through the process for another project with the same transformer scope.

4. A number of cells in the backup calculations are not tabulating correctly. Would recommend these be checked and adjusted when added to the final report. For example, the 75kva transformer in the HS that is recommended for replacement lists a \$ 0 savings.

This is a subcontractor document, in which they use marginal or blended rates as part of their calculations. Thus, we have zero'd out their cost savings numbers and take their unit savings and run it through an actual



TOWNSHIP OF UNION PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

tariff simulation to provide an accurate prediction of the cost savings. This process allows for various tariff interactions and kw/kWh interaction such as summer demand and tiered kwh charges. The unit savings in the subcontractor document have been verified to be tabulating correctly.

5. Would be good to verify what incentive / rebates are tied to another transformer upgrade ECM.

Other than P4P at HCES, there are no other incentives that are tied to this ECM.

ECM 5 – Walk-in Refrigeration Controls (HS and BMS)

1. Calculations for EC motor replacement utilized an “Estimated Reduction in Motor Load” of 65%. It is recommended to add additional information on how this factor was derived.

Live Calculations have been provided for HS and BMS in the Appendices folder section 7.1

2. It would be helpful to note how baseline electric consumption values were determined is provided, uncertain if they were measured or estimated.

Live calculations have been provided for HS and BMS in the Appendices folder section 7.1

ECM 6 – Solar Power Purchase Agreement (All)

1. It appears that Solar PPA consists of 90% of the estimated annual savings for this ESIP as noted on Table 2.1. It may be beneficial to include additional information such as if a PPA provider is on board or including additional information in the appendix since it is the prime generator of energy savings.

A PPA RFP process was conducted, and six PPA bids were received for this specific scope of work. Based on an analysis of District-owned versus PPA option, we are recommending the District to own the PV system.

2. If the new solar panels are proposed to be installed on sections of the roof of various buildings of various ages and roof materials, have structural modifications required to support the weight of the new solar panels been included in the associated costs.

Structural analysis costs are included in the project cost. Thermography scans of each roof section for the buildings with roof work have already been performed to identify roof and deck types, the condition of existing roofing materials and insulation, and roof cores were taken as well. Each roof has only one roof layer.

3. It is unclear if maintenance access was taken into account in the general panel layout which should be considered for any roof top equipment.

Maintenance access has been considered in the PV module layouts. There is proper clearance to flat and sloped roof edges, rooftop equipment, and module row gaps for access, as required by code, on long continuous module sections (8' space every 150'). Layouts and setbacks have been reviewed and acknowledged by the customer.

4. Also, it may be worthwhile to highlight any system downtime incorporated in the estimated production values.

System downtime is not considered in the estimated production, but 0.5% system degradation is factored in each year. PVWatts was used to calculate estimated production.

5. It may also be worthwhile to note if any of the PV production exceeds 80% of the existing building



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infrastructure and if so if any costs to update infrastructure have been included in the project cost.

Interconnection applications for solar PV for each building have been approved with PSE&G. The High School was approved conditionally, with the requirement for real time metering, and all other buildings were approved without any conditions. The cost for real time metering at the High School has been included in the project. No modifications to existing electrical infrastructure is anticipated.

ECM 7 – Roof Repair, Replacement & Warranty Extension (HCES, BMS, HS, BHES, KMS, WES)

1. The report includes a nominal savings for this ECM and it is recommend that the description include calculations of how this was calculated.

Calculations have been provided in update documents in the Appendices folder.

2. The overview notes “reduce infiltration” and want to double check that this savings does not overlap with ECM 2 Building Envelope Improvements.

For buildings where savings were modeled, they were simulated separately from envelope improvements and should have no overlap of savings.

3. This ECM does not appear on the Appendix 7 analysis tool table and recommend adding the tool used to calculate savings.

It has been modified to include this ECM.

ECM 8 – Drop Ceiling installation (BMS, BHES)

1. There is no savings for this Energy Conservation Measure, can you confirm that this is a capital improvement project that is requested by the district.

Yes, this was requested specifically by the District for select areas in two schools: Burnet Middle School and Battle Hill Elementary School. The existing fixtures are not suitable for a retrofit, so while perhaps this could be considered a capital improvement, we would consider it part of the lighting ECM for these spaces. By that we mean that it is a required upgrade in order to facilitate the proper application of new LED lighting. Furthermore, the aesthetics of the hallways will be drastically improved with the installation of new drop ceiling.

2. The report notes that removal or modification of all other devices such as clocks, cameras, fire alarms, etc. will be coordinated by the district. Are sprinkler system modifications needed as well to accommodate the new ceiling?

Yes. A similar scope of work has been completed by the District on its own in other facilities. The District staff had coordinated these modifications on their own in the past, and they are comfortable utilizing their in-house staff to complete the modifications for lowering clocks, cameras, fire alarms, and sprinklers to the level of the new dropped ceiling level in order to complete the scope.

3. Is the lighting replacement portion of the scope of this part of ECM 1 LED Lighting Upgrades or are the fixtures and replacement included in this ECM.

The cost for the new lighting fixtures in these areas is included in ECM 1.



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ECM 9 – Steam Trap Replacement (HS, BMS, KMS, CFES, FES, LES, WES, BHES)

1. Appendix calculation include System Heating hours and Space Hours that are the same for each school. Are these estimated values or are they the districts heating plant operating hours.

These are plant operating hours similar to what is used in our energy models.

2. Appendix calculation also includes Steam Boiler combustion efficiency and pressure for the existing boilers, are these nameplate values or estimated values based on their age?

These are estimated values based on age. There is a level of degradation on these types of boilers and thus we took into account efficiency losses as they age past a certain period. These are provided in the Appendices section 7.1

3. Is there any overlap in the savings from this ECM and ECM 14 Steam Boiler replacement?

They have been calculated independently and have no savings overlap.

ECM 10 – Building Automation System (BAS) with Demand Control Ventilation (All Schools except JES)

1. ECM description includes central boiler plant, terminal units and common area AHU units for most of the schools. Clarify if any Exhaust Fans are included in the DDC control scope (if applicable).

Exhaust fans were not included.

2. It may be helpful to add a description to the EQuest calculation output runs. Can you confirm the BAS Red Wire calculations include occupied/ unoccupied control beyond what is currently controlled in the baseline run.

Descriptions have been added to the outputs for eQuest. HCES has DDC ECM that we have modeled savings based on changing both occ/unocc temps as well as reduced run schedules. For UHS, we have simulated red wire controls by only changing the fan run times with no change in occ/unocc temps. The run schedule aligns with the Standards of Comfort document with a few extra run hours as cushion.

3. Also can you confirm savings for this ECM is a combination of the 2 EQuest runs (BAS Red Wire and DCV)

The savings have been calculated independently for the Red Wire Upgrade vs DCV. But the scope has been provided as a combined measure thus the savings have been tabulated together for purposes of the report.

4. Are there any schools that contain existing pneumatic control systems? And if so has rewiring and device replacement been included in the scope of this ECM to accommodate these older systems.

The approach for the BAS ECM's was to do "red-wire" control. This means that we would be enabling/disabling power to either the unit itself or the controller/thermostat for the unit. Any existing pneumatic control device would remain in place. For any ECM where the air handling equipment is being replaced with a new unit, all the control devices associated with the new unit would be DDC. For any DCV ECM, if we are applying DCV to an existing unit that has a pneumatic damper actuator, we would be replacing the actuator with a new electronic actuator. The HCES DDC upgrades will be replacing pneumatic end devices with new DDC controls.



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ECM 11 – Rooftop Unit & Split System Replacement (Various Schools):

1. Provide calculation data for all proposed equipment replacements.

Savings for RTU/SS replacements that are being installed by SE have been shown under each individual ELEMENT/eQuest pdf file, wherever applicable. Sites that have DI installed systems, savings were calculated from the DI contractor using the Direct Install program requirements. SE took the unit savings from DI and ran them through an actual tariff simulation to show true impact on energy bills instead of a blended rate.

2. Schneider Electric should confirm that the new RTUs will include code-required economizer functionality.

As required under ASHRAE 90.1-2016, all new RTUs with a cooling capacity of 54,000 Btu/h and larger will include economizer functionality.

3. Confirm that this ECM falls under the current Direct Install Program, this program has been significantly changing each year.

This ECM contains a mix of unitary replacements included via Direct Install and unitary replacements included in the construction contract with Schneider Electric. We have verified all Direct Install eligible equipment with the DI contractor.

ECM 12 – New Gym Air Handling Units with AC, HW Converter Replacement and CHP (HS)

1. Note: The payback period and energy savings resulting from the replacement are not enough for this ECM to be counted as an energy conservation measure. This can be considered a capital improvement project instead.

Based upon the definition below, we would consider this improvement an ECM. While the payback period is long, there are still energy savings associated with it. Furthermore, this ECM also has maintenance savings by eliminating a rental chiller every year (\$30,000 for the rental alone). Furthermore, providing air conditioning to the HS gym is a high priority for this customer.

ESIP Law, P.L. 2012 ch.55:

- 8 "energy conservation measure" means an improvement that
- 9 results in reduced energy use, including, but not limited to,
- 10 installation of energy efficient equipment; demand response
- 11 equipment; combined heat and power systems; facilities for the
- 12 production of renewable energy; water conservation measures,
- 13 fixtures or facilities; building envelope improvements that are part
- 14 of an energy savings improvement program; and related control
- 15 systems for each of the foregoing;
- 16 "energy related capital improvement" means a capital
- 17 improvement that uses energy but does not result in a reduction of
- 18 energy use;

If there is a separate ECM/capital improvement definition that we should consider, please provide the reference.



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2. Will the air handling unit operation change due to current events (COVID-19) moving forward? Consider more hours of operation due to potential for increased air change rates during occupied hours.

Based on the existing system, it is only being utilized during heating season. So ventilation rates are dropping significantly when heating is not required. The new AHU will allow for ventilation throughout the occupied hours regardless of heating or cooling mode, thus the ACHs will be increased significantly over the existing conditions. It is unsure how the school will truly operate the space and when school will even start before a viable vaccine is readily available. It seems that to take an additional penalty when they may be only operating in an increased air flow rate for a short period of time would not be beneficial to the customer.

3. ESP calls for the installation of a 35 kW CHP. It may be beneficial to include the equipment information on this unit to further detail performance, operational requirements, and maintenance of the system.

Unit Specifications have provided in the Appendices Folder 7.7.

4. This ECM is listed to have a 58 year payback and it appears to be included to allow financing over 20 years.

Correct. This ECM serves multiple purposes: 1) provides improved HVAC to an important area for the District (the HS gym), 2) replaces an outdated HW converter that is in need of replacement, 3) provides an alternate power source, and 4) allows project term to be 20 years. The payback period does not include the maintenance savings (\$30,000/year for a rental chiller for graduation).

5. Please confirm if the maintenance costs / contract is included in overall cost for this ECM. CHP systems typically have a very rigorous maintenance schedule.

The maintenance contract costs have been accounted for in the project financials, but this contract will be executed between the District and the OEM.

6. It appears that the total expected operating hours that the CHP Plant is planned to be run for the majority of the year and it is to be located near the gym. It would be good to confirm if these hours and the installation location will not cause any noise issues.

The CHP unit location, specification, and decibel level have been reviewed and approved by the District. The unit specs are provided in Appendices folder 7.1, which shows a decibel level of 60-65.

7. Since this is integral to the payment terms, it may be beneficial to confirm with the facility personnel that there is enough space at the site for the CHP system and the connections to the existing heating hot water system.

These have been field verified and considered in the design.

8. Please confirm if the operation of the rental AC units was included in the baseline model.

Confirmed, it was factored in the baseline model.

ECM 13 – New Chiller, Cooling Tower, and Pumps with Controls (HCES)

1. Confirm the baseline and proposed chiller efficiencies.

The eQuest printout has been updated with this information. The baseline and proposed efficiencies of the chiller scope is 0.653 kw per ton / 0.615 kw per ton.



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2. Was condenser water reset included?

Variable speed drives are included on the cooling tower fans so condenser water reset can be implemented.

3. Were variable flow chilled and condenser water systems considered?

Variable chilled water flow was considered but deemed to be cost-prohibitive as it would necessitate a change-out of all zone valves to 2-way modulating. Variable condenser water flow was not considered since the chiller will be equipped with a variable speed compressor. Best overall efficiency is normally obtained with maximum compressor speed reduction, compared to reduced speed condenser pump operation.

ECM 14 – Steam Boiler Plant Replacement with Controls (FES, CFES)

1. Additional information about the existing boilers, including age and model number, would be beneficial to include so that savings can be verified.

Franklin Boilers: Two (2) Pacific Steel Fire Tube with Industrial Combustion gas burner, built in 1958. Efficiency = 78%

Connecticut Farms Boilers: Two (2) National Steel Forced Draft with Industrial Combustion gas burner, built in 1941. Efficiency = 79%

2. The boiler calculations were not provided.

The calculations are provided in the following file names:

“ELEMENT Modeled Baseline and ECMS – Franklin ES.pdf”

“ELEMENT Modeled Baseline and ECMs – Connecticut Farms.pdf”

3. Confirm if stated efficiencies of existing boilers are based on nameplate data or onsite measurements.

Efficiencies used in savings calculations used the above-mentioned values and applied a derate using the NJ BPU approved P4P guideline 4.6.4.7. Max age for derate allowed is 20 years for a boiler as per appendix B of the same guideline which brings the efficiencies down to ~75% for both schools as shown in the ELEMENT printouts.

4. Will redundant boilers be run in low fire, warm mode to allow rapid switch between units?

The boilers have been sized with N+1 redundancy, with duty/standby changeover occurring approximately every other week. We do not anticipate the need to run the standby boiler in warm mode as boiler startup time for these small boilers is estimated to only be around 30 minutes. A pre-heat feed water system will be provided to eliminate cold water startups.

4.1.4 Lighting Energy Conservation Measures

Lighting improvement savings calculations were performed in a satisfactory manner using a spreadsheet analysis and reviewed in a spot-check fashion.

DLB notes the following potential issues with the lighting ECM analysis:



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ECM 1 – LED Lighting Upgrades (All)

1. Would there be a need to re-evaluate the installation costs due to current events (COVID-19) and how this will impact costs?

Contractor has confirmed that no re-evaluation necessary to address requirements of COVID-19.

2. KWh savings in the line x line do not match the total provided in the savings per site document for some schools. Adjust for consistency.

The lighting LxL were used as guides for determining connected load reduction. The kW difference was used as the Lighting Power Density in our models. The burn hours presented by the DI program are inflated and thus SE felt it necessary to show the true impact of the savings by using more realistic burn hours that our models were tuning out to when compared to baseline utility data. The LxL savings also does not include cooling/fan energy savings and heating penalties which the model simulated. See Comment #10 for more information.

3. The ECM lists the schools that qualify for the direct install program for this ECM, is this all the schools that LED lighting upgrades are being considered at?

All buildings qualify for Direct install except the High School; however, the District did an energy project in the past 3-4 years that upgraded most of the lighting in the HS to LED. There are a few remaining fixtures at the HS (exterior lights, rooms that were missed) that will be upgraded through the ESIP project.

4. Light fixture upgrades for the High School are shown in the savings per site document and it is not listed in the ECM description. Can you confirm that LED Lighting is being implemented at the High School under the P4P program?

See response to #3. Since lighting is already done, it will not be done under the P4P program.

5. It may be beneficial to include details on the recommended model for the replacement lamp – not sure if lamp or line voltage upgrade kits are being proposed.

Specifications of recommended lamps have been included in the Appendices folder. No line voltage upgrade kits are included in the project.

6. If line voltage upgrade kits, we would suggest model information is included to make sure the recommended retrofit maintains the UL listing of the light fixtures.

No line voltage upgrade kits are included in the project.

7. For lamp replacement projects, is a maintenance savings taken into account for extended life?

O&M savings are accounted for based on receipts provided by the customer, but only for the first 5 years and only on material.

8. The quantity of fixtures being replaced should be identical and should be checked. In the “Lighting Line by Line” Table there appears to be a few locations where the quantity numbers differ but may be situations where lamps were burnt out since some of these have a slight increase in energy use.

Where counts differ, new fixtures will replace a fixtures that contain multiple bulbs which is why the quantity numbers differ in those few areas.

9. Confirm that this LED lighting ECM does not include lighting control upgrades.



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No lighting control upgrades are proposed.

10. In section 7.0 it is noted that LED Lighting was calculating using EQuest but the calculations included a lighting line by line calculation and wanted to verify if this table is correct.

The lighting line by line was provided by the Direct Install program. The savings projected in that line by line are based on the guidelines of the DI program. The burn hours used as a default by the DI program felt higher than actually occurring, and thus we took the connected load reductions and ran them through our models to predict more realistic savings projections.

4.1.5 Financial Calculations

The financial calculations included within the ESP incorporate a 2.7% interest rate for the loan.

The recommended plan includes fourteen (14) ECMs and is analyzed over a 20-year financing term.

DLB notes the following potential issues with the financial calculations:

1. A note should be added to confirm the Cash Flow Form in section 2.3 uses the BPU-required 2.2% electric and 2.4% natural gas and fuel oil utility escalation.

This has been added.

2. Cash Flow Form shown in section 2.3 of the report shows an installation year savings of ~ \$ 246, 845 and a total year 1 savings of ~ \$ 329,127. The total savings shown in the cost summary in section 2.1 is ~ \$ 1,388,437. It would be beneficial include an explanation added to define the lower installation year savings value.

This has been added.

3. Cash Flow Form includes a total of \$ 37,276 Energy Rebates / Incentives to be received in installation year. Confirm the schedule; some of these rebates are issued after ECMs are installed which may be in year 1.

The incentive value of \$37,276 includes the P4P incentive #1, the CHP incentive #1, and the Smart Start rebates. Based on our anticipated construction schedule and our experience with these incentives on past projects, we are confident that the \$37,276 will be received prior to the end of the installation term.

4. LFN 2009-11 requires that any capital improvements be paid through other appropriations (i.e., bonds or capital improvement funds), not energy savings obligations. DLB recommends confirming that any capital improvements are planned to be funded appropriately.

Confirmed.

4.1.6 Greenhouse Gas Calculations

Greenhouse Gas Calculations are provided but the factors used to calculate savings are not clearly called out in the report. The factors should included and revised if needed to meet the current BPU guidelines, shown on page 13 of the protocol:

- 1,292 lbs. CO₂ per MWh saved
- 0.83 lbs. NO_x per MWh saved



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- 0.67 lbs. SO₂ per MWh saved
- 11.7 lbs. CO₂ per therm saved
- 0.0092 lbs. NO_x per therm saved

The below factors have been added to the proposal

AVOIDED EMISSIONS (1)	(lbs) Saved per MWh	(lbs) Saved per Therm	Pounds Saved Total (Lbs)
NOX	0.83	0.0092	6,268
SO2	0.67	0	3,906
CO2	1292	11.7	9,349,600



7.10 Board of Public Utilities (BPU) Approval

Please see the following pages for a copy of the BPU letter of approval.