# Township of Union Public Schools

Energy Savings Plan

January 6, 2021

Schneider Electric

# Table of Contents

# 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

Manuel Vieira, Business Administrator
Barry Loessel, Director of Buildings & Grounds
Dale Costleigh, Maintenance Department
Virginia Frain, Buildings & Grounds
Antonella Melchionna, Business Office
Lisa Gorab, Bond Counsel, Wilentz
Robbi Acompora, Financial Advisor, Phoenix Advisors

Daniel Riggle, Account Executive
Bunty Dharamsi, Project Development Engineer
Scott Purdy, Project Development Engineer
Adam Taylor, Solar Specialist
Weston Ernst, Regional Manager
Brad Hamm, Construction Services Manager
Willem Pennings, Project Manager
Paul Kutsko, Senior Automation Engineer
Paul Ciamaglia, Mechanical Engineer
Bob Loprete, Senior Estimator
Gopal Chaudhary, Energy Engineer
Jason Mikula, Energy Engineer

## Next Steps

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

1. The Energy Savings Plan will be reviewed and approved by the BPU
2. Following BPU approval, financing will be securing for the remaining portion (Phase II) of the project

## 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 |
|---|---|---|
| LED lighting upgrades | Upgrades to heating, ventilation, and air conditioning systems | Roof repair & replacement |
| Solar installations | Centralized air conditioning for Union High School gym | Upgrading chiller, cooling tower, and boilers |
| Water conservation | New building management system for temperature control | Electrical upgrades |
| Insulation & weatherproofing | | |

## 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 **$15+ million in capital improvements**
- No increase in the budget and no impact to taxpayers
- Generate energy & operational cost **savings of over $1 million per year**
- Secure **$1.1 million in rebates and incentives** for energy efficiency upgrades
- **Boost the local economy** by creating an estimated 234 jobs and $67 million in total economic activity

**ESIP Highlights:**

| | |
|---|---|
| $1,066,845 | Annual energy & operational savings |
| $1,117,208 | Funding from rebates & incentives |
| $14,070,123 | Total Project Cost |

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## 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:**

| | |
|---|---|
| Green | Included in ESIP |
| Gray | Optional |
| (blank) | 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 | Included | Included | Included | Included | Included | Included | Included | Included | Included | Included | Included | Included | Included |
| 2 | Building Envelope Improvements | Included | Included | Included | Included | Included | Optional | Included | Included | Included | Included | Included | Included | Included |
| 3 | Water Fixture Recommissioning | Included | Included | Included | Included | Included | Included | Included | Included | Included | Included | | Included | Included |
| 4 | High Efficiency Transformers | Included | | | | | | | Optional | | | | | |
| 5 | Walk-in Refrigeration Controls | Included | Included | | | | | | | | | | | |
| 6 | Drop Ceiling Installation | | Included | | | Included | | | | | | | | |
| | **Heating, Ventilation, and Air Conditioning (HVAC) Systems** | | | | | | | | | | | | | |
| 7 | Steam Trap Replacement | Included | Included | Included | | | Included | Included | | Included | Included | | | |
| 8 | Building Automation System (BAS) w/ Demand Controlled Ventilation (DCV) | Included | Included | Included | | Included | Included | Included | Included | Included | Included | | | Included |
| 9 | Rooftop Unit & Split System Replacement | Included | Included | Included | Optional | | | Included | Included | Included | Included | | | Included |
| 10 | New Gym Air Handling Units w/ AC, HW Converter, & CHP | Included | Optional | Optional | | | | | | | | | | |
| 11 | New Chiller, Cooling Tower, and Pumps with Controls | | | | | | | | Included | | | | | |
| | ***Phase II*** | | | | | | | | | | | | | |
| 12 | Solar Photovotaic (PV) System | Included | Included | Included | Included | Included | Included | Included | Included | Included | Included | | | |
| 13 | Roof Repair, Replacement, & Warranty Extension | Optional | Included | Included | Optional | Included | | | Included | | Included | | | |
| 14 | Burnet Auditorium HVAC Renovation with Cooling Addition | | Included | | | | | | | | | | | |
| 15 | Steam Boiler Plant Replacement with Controls | | | Optional | | | Optional | Included | Optional | | | | | |

*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 Costs1 ($) | Estimated Annual Savings ($) |
|---|---|---|---|---|
| | **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 | 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 Costs1 ($) | Estimated Annual Savings ($) |
|---|---|---|---|---|
| 12 | Solar Photovoltaic (PV) System - PPA | All schools | | $ 380,740 |
| 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** | **$ 4,965,001** | **$ 382,842** |
| Turn-key with ESCO | $ 1,102,471 | |
| Roofing Contractor | $ 3,862,520 | |

## 2.2 Financial Summary

With this project, TUPS will be able to realize over $15 million in improvements to the District with no increase in the budget and no impact on taxpayers. This figure does not include the third-party owned solar that will be installed as part of a power purchase agreement (PPA). The project will be 100% funded by incentives and 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, the roofing upgrades, and the solar PV system which the District will contract directly for.

| | Phase I | Phase II | |
|---|---|---|---|
| Fee Category | Fees (1) Dollar ($) Value | Fees (1) Dollar ($) Value | Percentage of Hard Costs |
| Estimated Value of Hard Costs (2): | $ 6,805,804 | $ 1,102,471 | |
| Project Service Fees | | | |
| Investment Grade Energy Audit | $ 153,131 | $ 24,806 | 2.25% |
| Design Engineering Fees | $ 255,218 | $ 41,343 | 3.75% |
| Administration | $ 306,261 | $ 49,611 | 4.50% |
| System Commissioning | $ 68,058 | $ 11,025 | 1.00% |
| Equipment Initial Training Fees | $ 34,029 | $ 5,512 | 0.50% |
| ESCO Overhead | $ 442,377 | $ 71,661 | 6.50% |
| ESCO Profit | $ 408,348 | $ 66,148 | 6.00% |
| ESCO Termination Fee | $ - | $ - | 0.00% |
| Project Service Fees Sub Total | $ 816,696 | $ 132,297 | 12.00% |
| TOTAL FINANCED PROJECT COSTS: | $ 8,473,225 | $ 1,372,576 | 24.50% |
| | | | |
| TOTAL FINANCED PROJECT COSTS (BOTH PHASES) | $ 9,845,802 | | |

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.

## 2.3 Cash Flow Analysis – Phase I Only

**UNION BOE - ENERGY SAVING IMPROVEMENT PROGRAM**

**ESCO Name:** Schneider Electric

Note: Respondents must use the following assumptions in all financial calculations:

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

1. Term of Agreement:
2. Construction Period [(2)] (months): 15
3. Cash Flow Analysis Format:

| | | | | | |
|---|---|---|---|---|---|
| Turn-key ESCO Cost: | $8,473,225 | Term (Years): | 20 | Dated: | 12/17/2020 |
| Contingency: | $86,361 | Interest Rate (NIC): | 2.350% | 1st interest: | 8/15/2021 |
| Direct Install (Customer share): | $361,792 | | | 1st principal: | 8/15/2021 |
| Legal & Financing Costs: | $163,607 | | | Last principal: | 8/15/2040 |
| Total Financed: | **$9,084,985** | | | | |

| Year | Year | Annual Energy Savings | Annual Natural Gas Savings | Water Savings | Annual O&M Savings | CHP O&M Costs | Energy Rebates/ Incentives | Annual Service Costs | Total Annual Savings | Projected Payments | Net Cash-Flow to Client | Cumulative Cash Flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Installation | Installation | $116,326 | $40,045 | $7,602 | | | $18,638 | | $182,612 | | **$182,612** | |
| 1 | 6/30/2022 | 426,530 | 146,832 | 27,875 | $73,008 | -$7,534 | 108,532 | -$129,100 | 646,142 | $625,288 | **20,854** | $203,465 |
| 2 | 6/30/2023 | 317,028 | 109,349 | 20,759 | 74,614 | -7,534 | 51,694 | -60,960 | 504,951 | 501,700 | **3,251** | 206,716 |
| 3 | 6/30/2024 | 324,003 | 111,974 | 21,257 | 76,255 | -7,534 | 5,600 | -29,500 | 502,056 | 493,100 | **8,956** | 215,671 |
| 4 | 6/30/2025 | 331,131 | 114,661 | 21,768 | 77,933 | -7,534 | 5,600 | | 543,559 | 538,400 | **5,159** | 220,830 |
| 5 | 6/30/2026 | 338,416 | 117,413 | 22,290 | 79,647 | -7,534 | | | 550,232 | 547,200 | **3,032** | 223,863 |
| 6 | 6/30/2027 | 345,861 | 120,231 | 22,825 | | -7,534 | | | 481,383 | 476,800 | **4,583** | 228,446 |
| 7 | 6/30/2028 | 353,470 | 123,116 | 23,373 | | -7,534 | | | 492,425 | 487,200 | **5,225** | 233,671 |
| 8 | 6/30/2029 | 361,246 | 126,071 | 23,934 | | -7,534 | | | 503,717 | 496,800 | **6,917** | 240,588 |
| 9 | 6/30/2030 | 369,193 | 129,097 | 24,508 | | -7,534 | | | 515,265 | 510,500 | **4,765** | 245,353 |
| 10 | 6/30/2031 | 377,316 | 132,195 | 25,096 | | -7,534 | | | 527,074 | 523,200 | **3,874** | 249,227 |
| 11 | 6/30/2032 | 385,617 | 135,368 | 25,699 | | | | | 546,683 | 539,800 | **6,883** | 256,110 |
| 12 | 6/30/2033 | 394,100 | 138,617 | 26,315 | | | | | 559,032 | 555,200 | **3,832** | 259,943 |
| 13 | 6/30/2034 | 402,770 | 141,944 | 26,947 | | | | | 571,661 | 569,400 | **2,261** | 262,204 |
| 14 | 6/30/2035 | 411,631 | 145,350 | 27,594 | | | | | 584,575 | 582,400 | **2,175** | 264,379 |
| 15 | 6/30/2036 | 420,687 | 148,839 | 28,256 | | | | | 597,782 | 594,200 | **3,582** | 267,961 |
| 16 | 6/30/2037 | 429,942 | 152,411 | 28,934 | | | | | 611,287 | 604,800 | **6,487** | 274,448 |
| 17 | 6/30/2038 | 439,401 | 156,069 | 29,628 | | | | | 625,098 | 619,100 | **5,998** | 280,447 |
| 18 | 6/30/2039 | 449,068 | 159,814 | 30,340 | | | | | 639,222 | 636,900 | **2,322** | 282,768 |
| 19 | 6/30/2040 | 458,947 | 163,650 | 31,068 | | | | | 653,665 | 648,200 | **5,465** | 288,234 |
| 20 | 6/30/2041 | 469,044 | 167,577 | 31,813 | | | | | 668,435 | 663,000 | **5,435** | 293,669 |
| | | | | | | | | | | | | |
| **Totals** | | $7,921,729 | $2,780,624 | $527,880 | $381,457 | -$75,336 | $190,064 | -$219,560 | $11,506,856 | $11,213,188 | **$293,669** | |

## 2.4 Cash Flow Analysis – Phase II Only

**UNION BOE - ENERGY SAVING IMPROVEMENT PROGRAM - PHASE II**

**ESCO Name:** Schneider Electric

Note: Respondents must use the following assumptions in all financial calculations:

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

1. Term of Agreement:
2. Construction Period [2] (months): 15
3. Cash Flow Analysis Format:

| | | | | | |
|---|---|---|---|---|---|
| Turn-key ESCO Cost: | $1,372,576 | Term (Years): | 15 | Dated: | 3/17/2021 |
| Contingency: | $500,000 | Interest Rate (NIC): | 1.700% | 1st interest: | 8/15/2021 |
| Roofing Contractor | $3,862,530 | | | 1st principal: | 8/15/2021 |
| Legal & Financing Costs: | $125,000 | | | Last principal: | 8/15/2036 |
| Total Financed: | **$5,860,106** | | | | |

| Year | Year | Annual Energy Savings | Annual Natural Gas Savings | Water Savings | ESIP Solar Savings | Savings from Phase I | Annual Service Costs | Total Annual Savings | Projected Payments | Net Cash-Flow to Client | Cumulative Cash Flow |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Installation | Installation | | | | | $182,612 | | | | **$182,612** | |
| 1 | 6/30/2022 | | $2,103 | | $390,499 | $20,854 | | $413,455 | $390,918 | **22,537** | $205,149 |
| 2 | 6/30/2023 | | 2,153 | | 397,532 | 3,251 | | 402,936 | 395,000 | **7,936** | 213,084 |
| 3 | 6/30/2024 | | 2,205 | | 404,689 | 8,956 | | 415,849 | 401,300 | **14,549** | 227,634 |
| 4 | 6/30/2025 | | 2,258 | | 411,971 | 5,159 | | 419,387 | 411,900 | **7,487** | 235,121 |
| 5 | 6/30/2026 | | 2,312 | | 419,380 | 3,032 | | 424,724 | 416,800 | **7,924** | 243,045 |
| 6 | 6/30/2027 | | 2,367 | | 426,918 | 4,583 | | 433,868 | 426,000 | **7,868** | 250,913 |
| 7 | 6/30/2028 | | 2,424 | | 434,589 | 5,225 | | 442,238 | 434,400 | **7,838** | 258,752 |
| 8 | 6/30/2029 | | 2,482 | | 442,394 | 6,917 | | 451,794 | 442,000 | **9,794** | 268,545 |
| 9 | 6/30/2030 | | 2,542 | | 450,335 | 4,765 | | 457,642 | 448,800 | **8,842** | 277,387 |
| 10 | 6/30/2031 | | 2,603 | | 458,415 | 3,874 | | 464,891 | 459,700 | **5,191** | 282,578 |
| 11 | 6/30/2032 | | 2,665 | | 466,636 | 6,883 | | 476,185 | 464,700 | **11,485** | 294,063 |
| 12 | 6/30/2033 | | 2,729 | | 475,001 | 3,832 | | 481,563 | 473,800 | **7,763** | 301,826 |
| 13 | 6/30/2034 | | 2,795 | | 483,511 | 2,261 | | 488,567 | 481,900 | **6,667** | 308,492 |
| 14 | 6/30/2035 | | 2,862 | | 492,171 | 2,175 | | 497,208 | 493,900 | **3,308** | 311,800 |
| 15 | 6/30/2036 | | 2,930 | | 500,981 | 3,582 | | 507,493 | 499,800 | **7,693** | 319,494 |
| | | | | | | | | | | | |
| | **Totals** | $0 | $37,429 | $0 | $6,655,022 | $267,961 | $0 | $6,777,800 | $6,640,918 | **$319,494** | |

## 2.5 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

NEW JERSEY'S 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)

NEW JERSEY'S CLEAN ENERGY PROGRAM P4P PAY FOR PERFORMANCE

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.

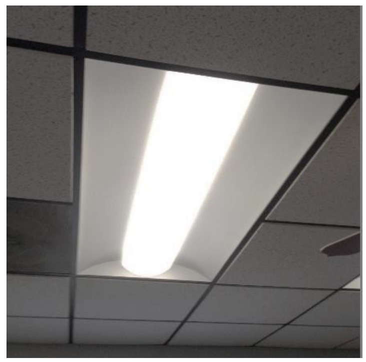


Figure 2. LED Door Kit Installed

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 Striping - 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 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Flushometer Fixtures | | | | | | Tank Toilets | | | Sinks | | |
| 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 | 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.


Figure 5. Existing Ceilings.
A new drop ceiling will improve aesthetics in Burnet MS and Battle Hill ES hallways.

### 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.

**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.

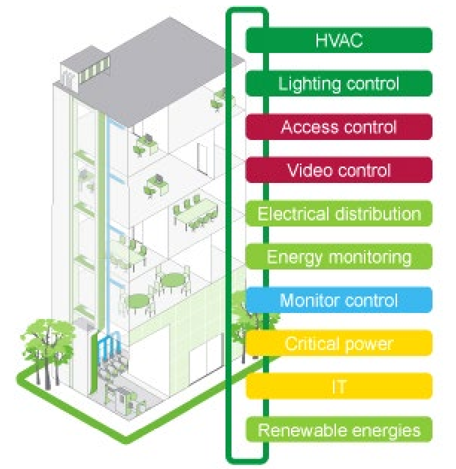



Figure 7. Building Automation System (BAS)

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.

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.

- **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 ($CO_2$ 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.

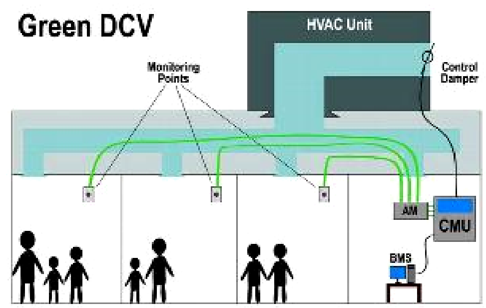



Figure 8. Example of Demand Controlled Ventilation

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

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.

### 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.

Figure 9. Union High School Rooftop Unit

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.

### 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 |

### 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

| 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.

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.

**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.

## 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.

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

The following table identifies equipment quantity and sizes being upgraded:

| 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 |

## 3.1 ECM Descriptions – Phase II

### 12. Solar PPA

#### Overview

This measure will involve the installation of solar panels at each of the schools, delivered through a solar power purchase agreement (PPA). The PPA will allow the District to produce renewable energy on-site with no upfront cost. The PPA will provide a rate change, and these savings will be utilized inside the ESIP to help fund other scope.

#### Scope

A PPA RFP was conducted and the results are identified below. Through interviews and review of the proposals, it is anticipated that Pfister Energy (Engineer, Procure, and Construct contractor or EPC) and Greenskies (Financier/PPA provider) will be the winning bid and thus the savings below have been developed with their PPA rate.

| Company Name | System Size (kW) | Expected Output (kWh) | Production Ratio | Guaranteed System Output (kWh) | PPA Price (Yr.1) | Total Annual Savings (Yr.1) | 15 Year Total Savings | PPA Price Escalator |
|---|---|---|---|---|---|---|---|---|
| Advanced Solar Products & Spano Partner Holdings | 3,033.9 | 3,755,706 | 1.238 | 3,380,138 | $0.0372 | $316,982 | $5,474,994 | 1.50% |
| Concord Management Services & Infiniti Energy Services | 3,103.4 | 3,679,307 | 1.186 | 3,311,376 | $0.0000 | $447,404 | $7,565,632 | 0.00% |
| HESP Solar & Brightcore | 3,263.6 | 3,875,153 | 1.187 | 3,487,638 | $0.0350 | $335,588 | $6,003,574 | 0.00% |
| Pfister Energy & Greenskies Clean Energy | 3,032.2 | 3,613,729 | 1.192 | 3,252,356 | $0.0175 | $376,189 | $6,414,070 | 1.50% |
| Sunlight General Capital | 3,398.8 | 4,005,268 | 1.178 | 3,604,741 | $0.0292 | $370,888 | $6,300,259 | 2.00% |

PPA Savings using $0.0175/kWh PPA Rate

| Building | PV System Size (kW DC) | Post ESIP Baseline (kWh) | Expected PV Production (kWh AC) | PV% of Post ESIP Baseline | 1st Year PV Savings |
|---|---|---|---|---|---|
| High School | 1,213.5 | 1,543,611 | 1,457,963 | 94.45% | $153,946 |
| Burnet MS | 422.3 | 503,233 | 490,672 | 97.50% | $51,810 |
| Kawameeh MS | 228.8 | 270,625 | 264,353 | 97.68% | $27,913 |
| Jefferson CS | 144.7 | 570,362 | 168,676 | 29.57% | $17,810 |
| Battle Hill ES | 169.7 | 210,123 | 206,942 | 98.49% | $22,473 |
| CT Farms ES | 167.3 | 213,429 | 185,312 | 86.83% | $20,124 |
| Franklin ES | 83.6 | 233,518 | 102,054 | 43.70% | $10,776 |
| Hannah Caldwell ES | 455.8 | 554,428 | 543,816 | 98.09% | $57,422 |
| Livingston ES | 87.7 | 196,519 | 101,116 | 51.45% | $10,981 |
| Washington ES | 59.0 | 207,776 | 70,886 | 34.12% | $7,485 |
| **Total** | **3,032.4** | **4,503,624** | **3,591,790** | **79.75%** | **$380,740** |

## 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,<br>Single-zone CV, steam heat | (1) – 75 tons,<br>Single zone VAV with Steam Heat. | Serves Auditorium.<br>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.

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

| School | Existing (Qty.) – Capacity | New (Qty.) – Capacity | Efficiency Upgrade |
|---|---|---|---|
| Franklin ES | (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.

## 3.2 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

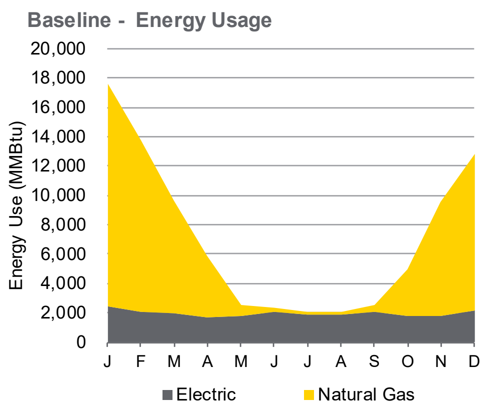
## 4.1 Baseline Energy Use

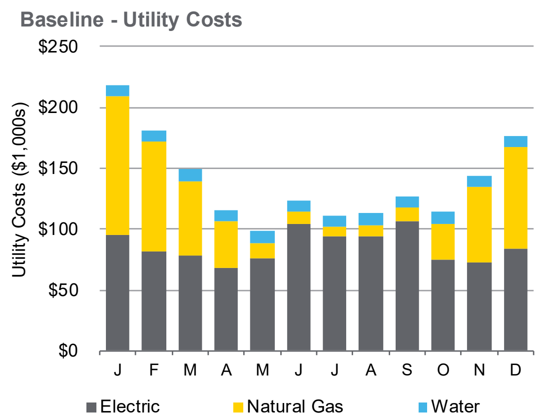
This baseline includes all facilities and was created by taking several years of utility data and utilizing the following:

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

| | Electricity | | | Natural Gas | | Water | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| Month | Energy Use | Energy Demand | Cost | Energy Use | Cost | Water Use | Cost | Energy Use | Cost |
| *mmm* | *kWh* | *kW* | *$* | *Therm* | *$* | *kgal* | *$* | *MMBtu* | *$* |
| 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** |

| | Electricity | | | Natural Gas | | Water | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| **Indices** | **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 | Total Energy Usage Index | 60.7 |
| Percentage of Total site area | 32% | Total Utility Cost Index | $1.267 |

| Fuel Type | Utility Usage | Utility Demand | Utility Cost | Percentage of Total |
|---|---|---|---|---|
| *Fuel* | *Value* | *Value* | *$* | *%* |
| 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 | Total Energy Usage Index | 73.5 |
| Percentage of Total site area | 15% | Total Utility Cost Index | $1.244 |

| Fuel Type | Utility Usage | Utility Demand | Utility Cost | Percentage of Total |
|---|---|---|---|---|
| *Fuel* | *Value* | *Value* | *$* | *%* |
| 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 | Total Energy Usage Index | 66.1 |
| Percentage of Total site area | 9% | Total Utility Cost Index | $1.232 |

| Fuel Type | Utility Usage | Utility Demand | Utility Cost | Percentage of Total |
|---|---|---|---|---|
| *Fuel* | *Value* | *Value* | *$* | *%* |
| 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 | Total Energy Usage Index | 64.8 |
| Percentage of Total site area | 6% | Total Utility Cost Index | $1.922 |

| Fuel Type | Utility Usage | Utility Demand | Utility Cost | Percentage of Total |
|---|---|---|---|---|
| *Fuel* | *Value* | *Value* | *$* | *%* |
| 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 | Total Energy Usage Index | 66.2 |
| Percentage of Total site area | 5% | Total Utility Cost Index | $1.379 |

| Fuel Type | Utility Usage | Utility Demand | Utility Cost | Percentage of Total |
|---|---|---|---|---|
| *Fuel* | *Value* | *Value* | *$* | *%* |
| 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 | Total Energy Usage Index | 103.8 |
| Percentage of Total site area | 5% | Total Utility Cost Index | $1.679 |

| Fuel Type | Utility Usage | Utility Demand | Utility Cost | Percentage of Total |
|---|---|---|---|---|
| *Fuel* | *Value* | *Value* | *$* | *%* |
| 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 | Total Energy Usage Index | 92.3 |
| Percentage of Total site area | 5% | Total Utility Cost Index | $1.697 |

| Fuel Type | Utility Usage | Utility Demand | Utility Cost | Percentage of Total |
|---|---|---|---|---|
| *Fuel* | *Value* | *Value* | *$* | *%* |
| 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 | Total Energy Usage Index | 96.7 |
| Percentage of Total site area | 7% | Total Utility Cost Index | $2.398 |

| Fuel Type | Utility Usage | Utility Demand | Utility Cost | Percentage of Total |
|---|---|---|---|---|
| *Fuel* | *Value* | *Value* | *$* | *%* |
| 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 | Total Energy Usage Index | 107.3 |
| Percentage of Total site area | 4% | Total Utility Cost Index | $1.833 |

| Fuel Type | Utility Usage | Utility Demand | Utility Cost | Percentage of Total |
|---|---|---|---|---|
| *Fuel* | *Value* | *Value* | *$* | *%* |
| 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 — Total Energy Usage Index 82.1
Percentage of Total site area 6% — Total Utility Cost Index $1.444

| Fuel Type *Fuel* | Utility Usage *Value* | Utility Demand *Value* | 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 — Total Energy Usage Index 90.1
Percentage of Total site area 3% — Total Utility Cost Index $1.216

| Fuel Type *Fuel* | Utility Usage *Value* | Utility Demand *Value* | 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 — Total Energy Usage Index 85.6
Percentage of Total site area 1% — Total Utility Cost Index $1.597

| Fuel Type *Fuel* | Utility Usage *Value* | Utility Demand *Value* | 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 — Total Energy Usage Index 129.6
Percentage of Total site area 2% — Total Utility Cost Index $1.905

| Fuel Type *Fuel* | Utility Usage *Value* | Utility Demand *Value* | 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** | |

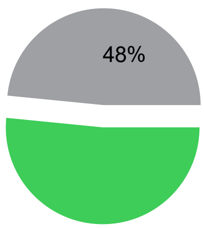
For a month to month baseline for each school, please see Appendix 7.1.

## 4.2 Energy Savings

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

**Township of Union Schools - Project Summary**

Energy Cost Savings




| Energy and Water Indices | Energy | Water | Cost |
|---|---|---|---|
| | *kBtu/sf* | *gal/sf* | *$/sf* |
| Baseline | 75.4 | 9.1 | $1.48 |
| Post Project | 44.1 | 6.4 | $0.76 |
| **% Savings** | **41.5%** | **29.2%** | **48.4%** |

**Project Summary by Site**

| Project *Phase* | Electricity Costs *$* | Fossil Fuels Costs *$* | Water Costs *$* | Total Costs *$* |
|---|---|---|---|---|
| **Baseline** | **$1,029,665** | **$528,976** | **$114,779** | **$1,673,419** |
| **Post Project** | **$345,399** | **$422,590** | **$94,942** | **$862,931** |
| **Savings** | **$684,266** | **$106,386** | **$19,836** | **$810,488** |
| **Percent Savings** | **66.5%** | **20.1%** | **17.3%** | **48.4%** |

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 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 | Energy Efficiency: Option C Guarantee | (green) | (green) | | | | (grey) | (grey) | (green) | (grey) | (grey) | | | |
| 7 | Pay for Performance (P4P): Incentive #3 | | | | | | | | (green) | | | | | |

The guarantee is based upon Option C methodology (as defined by IPMVP) 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 |
|---|---|---|---|---|
| • Commissioning & Verify ECMs<br>• Measurement & Verification of Savings<br>• Financial guarantee<br>• Quarterly Savings Reports<br>• On-site Energy Auditing & Consulting<br>• On-site Training<br>• Resource Advisor<br>• Building Automation System Reviews<br>• Remote Energy Management & Technical Support<br>• Complete P4P applications for the third incentive | $57,140 | $71,960 | $65,960 | $24,500 |

A solar production guarantee will be provided by the power purchase agreement (PPA) provider under a separate agreement.

## 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 | 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.<br>Includes the following:<br>• 24/7/365 live monitoring<br>• Scheduled and Unscheduled maintenance<br>• Labor and parts, including engine and generator replacement |
| Solar | PPA provider will provide all O&M activities related to Solar |

# 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 Non-Solar ECMs

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

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

**eCalcs: Energy Calculation Suite** — Life Is On Schneider Electric

**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 L/W 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 |
|---|---|---|
| *See Reference Tables for Descriptions* | | |
| North | 3 | 3 |
| East | 3 | 3 |
| South | 3 | 3 |
| West | 3 | 3 |

**Building Crack Definitions**

| Penetration | Type | H | Qty | Length | Gap | % Open | Total Area | Wall Only |
|---|---|---|---|---|---|---|---|---|
| *Name* | *Select* | *ft* | *#* | *ft* | *inches* | *%* | *sqft* | *sqft* |
| AC Unit Weatherization | Roof | 9.0 | 1 | 352 | 1/6 | 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 |
| of-wall intersection air seal | Roof-Wall | 9.0 | 1 | 177 | 1/8 | 100% | 1.8 | 1.8 |
| f-wall intersection air seali | 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**

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

**Site Parameters**

| | |
|---|---|
| Average Wind Speed, mph | 9.9 |
| Site Corrected Wind Speed, mph | 9.1 |
| Model Wind Coefficient | 0.26 |
| Draft Factor | 0.13 |
| Volume Factor, ft/min (in-wg)^0.5 | 2,603 |

**Energy Engineering Calculations**

| | Temperature Bin Hours | | | | | | Calculated Infiltration Rates | | | | Energy Transfer | | Energy Savings | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Schedule1 | | Occupied Rates | | Unoccupied Rates | | Occupied | Unocc | Cooling | Heating |
| | Mid Pt Temp | MCWB | Density | Enthalpy | Occupied | Unocc | Wall | Roof | Wall | Roof | Load | Load | Savings | Savings |
| *Ref* | *oF* | *oF* | *lb/ft3* | *Btu/lb* | *hrs/yr* | *hrs/yr* | *cfm* | *cfm* | *cfm* | *cfm* | *kBtu/yr* | *kBtu/yr* | *kBtu/yr* | *kBtu/yr* |
| 1 | 2 | -0.7 | 0.086 | 0.7 | 0 | 7 | 868 | 1,181 | 880 | 987 | 0 | -1,323 | 0 | 1,203 |
| 2 | 6 | 3.7 | 0.085 | 2.0 | 10 | 13 | 868 | 1,113 | 880 | 903 | -2,471 | -2,176 | 0 | 4,224 |
| 3 | 10 | 8.4 | 0.084 | 3.4 | 8 | 37 | 868 | 1,039 | 880 | 811 | -1,778 | -5,376 | 0 | 6,503 |
| 4 | 14 | 12.5 | 0.083 | 4.6 | 23 | 67 | 868 | 963 | 879 | 711 | -4,591 | -8,388 | 0 | 11,799 |
| 5 | 19 | 16.3 | 0.083 | 5.9 | 56 | 83 | 868 | 883 | 879 | 598 | -9,989 | -8,811 | 0 | 17,091 |
| 6 | 23 | 19.9 | 0.082 | 7.1 | 90 | 137 | 868 | 796 | 879 | 459 | -14,194 | -11,932 | 0 | 23,751 |
| 7 | 27 | 23.6 | 0.081 | 8.5 | 196 | 230 | 868 | 698 | 879 | 255 | -26,802 | -15,092 | 0 | 38,086 |
| 8 | 31 | 28.0 | 0.080 | 10.2 | 244 | 262 | 867 | 580 | 879 | 294 | -27,677 | -15,119 | 0 | 38,905 |
| 9 | 36 | 31.2 | 0.080 | 11.4 | 234 | 294 | 867 | 445 | 879 | 474 | -22,063 | -17,065 | 0 | 35,571 |
| 10 | 40 | 34.9 | 0.079 | 12.9 | 212 | 297 | 867 | 235 | 879 | 606 | -14,941 | -15,542 | 0 | 27,712 |
| 11 | 44 | 39.0 | 0.078 | 14.7 | 255 | 349 | 867 | 301 | 879 | 716 | -16,335 | -14,712 | 0 | 28,224 |
| 12 | 48 | 43.0 | 0.077 | 16.6 | 205 | 301 | 867 | 486 | 879 | 811 | -12,647 | -8,895 | 0 | 19,583 |
| 13 | 53 | 46.6 | 0.077 | 18.4 | 289 | 316 | 867 | 615 | 879 | 894 | -15,725 | -4,971 | 0 | 18,815 |
| 14 | 57 | 51.4 | 0.076 | 21.0 | 288 | 352 | 867 | 731 | 879 | 978 | -11,241 | 2,046 | 0 | 8,359 |
| 15 | 61 | 55.1 | 0.075 | 23.2 | 280 | 408 | 867 | 823 | 876 | 1,004 | -6,809 | 0 | 0 | 6,190 |
| 16 | 65 | 59.1 | 0.074 | 25.8 | 226 | 329 | 867 | 909 | 872 | 999 | -1,139 | 0 | 0 | 1,035 |
| 17 | 70 | 62.2 | 0.074 | 27.9 | 254 | 426 | 867 | 983 | 867 | 994 | 3,153 | 0 | 1,087 | 0 |
| 18 | 74 | 65.3 | 0.073 | 30.2 | 232 | 418 | 867 | 1,051 | 863 | 989 | 7,385 | 0 | 2,547 | 0 |
| 19 | 78 | 67.9 | 0.072 | 32.2 | 237 | 400 | 867 | 1,111 | 861 | 1,010 | 11,805 | 7,392 | 6,620 | 0 |
| 20 | 82 | 67.9 | 0.072 | 32.2 | 213 | 126 | 867 | 1,150 | 861 | 1,053 | 10,700 | 2,338 | 4,496 | 0 |
| 21 | 87 | 69.9 | 0.071 | 33.8 | 146 | 61 | 867 | 1,201 | 861 | 1,108 | 9,539 | 1,984 | 3,973 | 0 |
| 22 | 91 | 70.6 | 0.071 | 34.4 | 88 | 18 | 867 | 1,241 | 860 | 1,151 | 6,283 | 685 | 2,403 | 0 |
| 23 | 95 | 74.8 | 0.070 | 38.2 | 26 | 6 | 866 | 1,303 | 860 | 1,218 | 2,788 | 432 | 1,110 | 0 |
| 24 | 99 | 76.0 | 0.069 | 39.2 | 9 | 1 | 866 | 1,342 | 860 | 1,259 | 1,061 | 82 | 394 | 0 |
| 25 | 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 |

### Savings Methods – Spreadsheet Calculations Solar

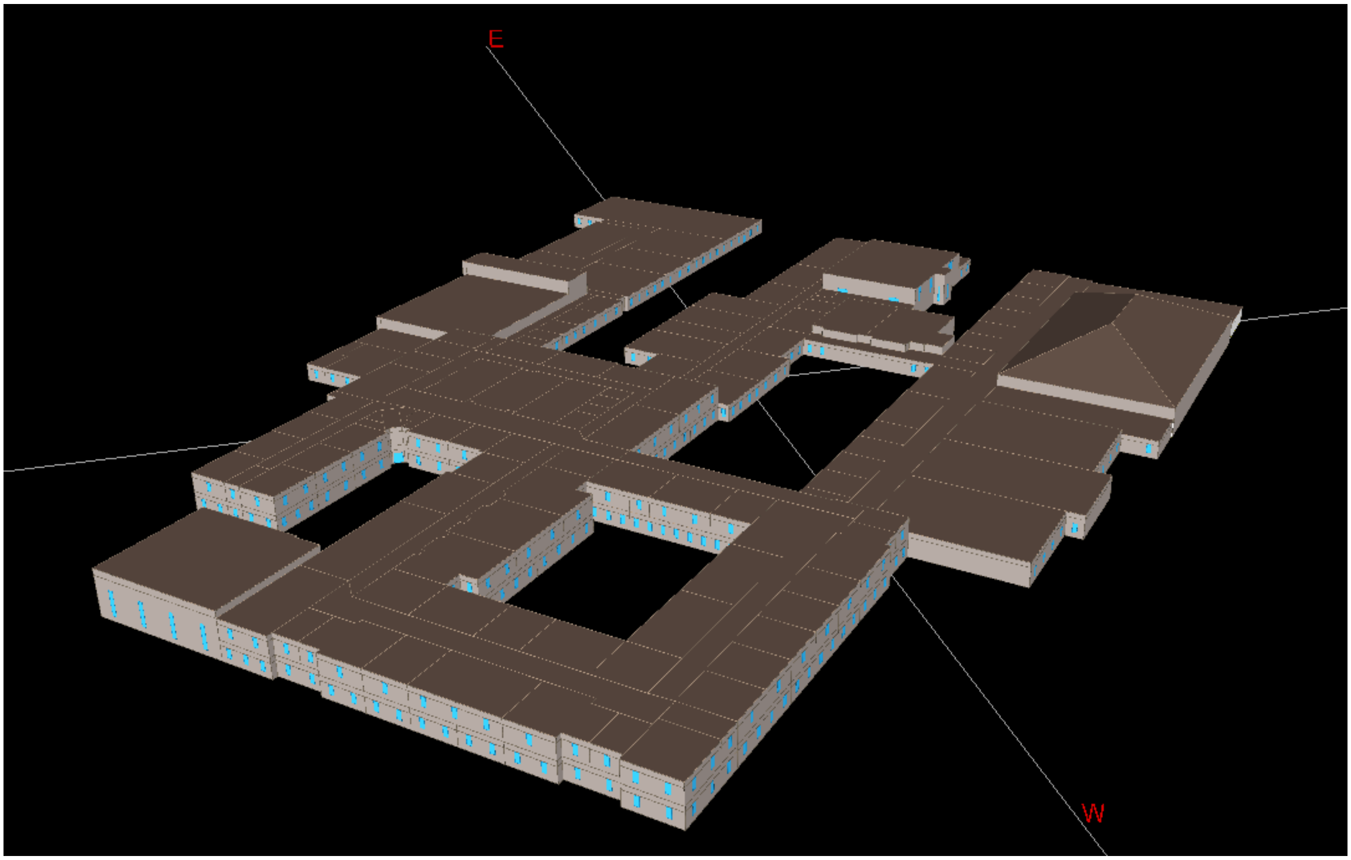
| Site | Solar Production (kWh) | Solar Savings from Utility ($) | PPA Cost Impact ($) | Net Solar Savings ($) |
|---|---|---|---|---|
| Washington ES | 70,886 | $8,725 | -$1,241 | $7,485 |
| Union High School | 1,457,963 | $179,461 | -$25,514 | $153,946 |
| Livingston ES | 101,116 | $12,750 | -$1,770 | $10,981 |
| Kawameeh MS | 264,353 | $32,539 | -$4,626 | $27,913 |
| Jefferson ES | 168,676 | $20,762 | -$2,952 | $17,810 |
| Hannah Caldwell ES | 543,816 | $66,938 | -$9,517 | $57,422 |
| Franklin ES | 102,054 | $12,562 | -$1,786 | $10,776 |
| Conneticut Farms ES | 185,312 | $23,367 | -$3,243 | $20,124 |
| Burnett MS | 490,672 | $60,397 | -$8,587 | $51,810 |
| Battle Hill ES | 206,942 | $26,094 | -$3,621 | $22,473 |
| **Totals** | **3,591,790** | **$443,596** | **-$62,856** | **$380,740** |

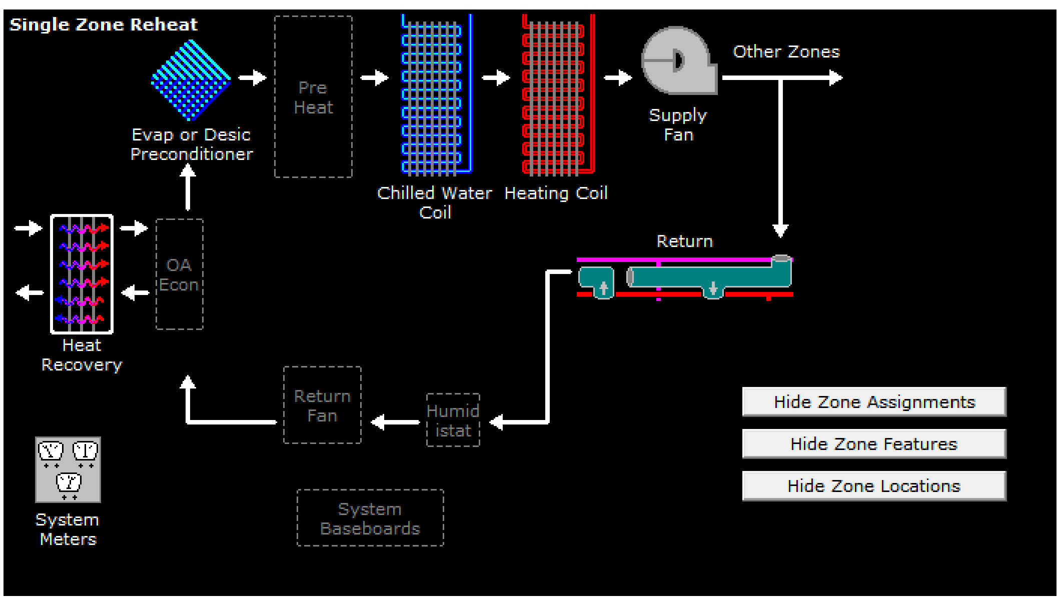
| | |
|---|---|
| PPA Rate/kWh | $0.0175 |

### Savings Methods – eQuest

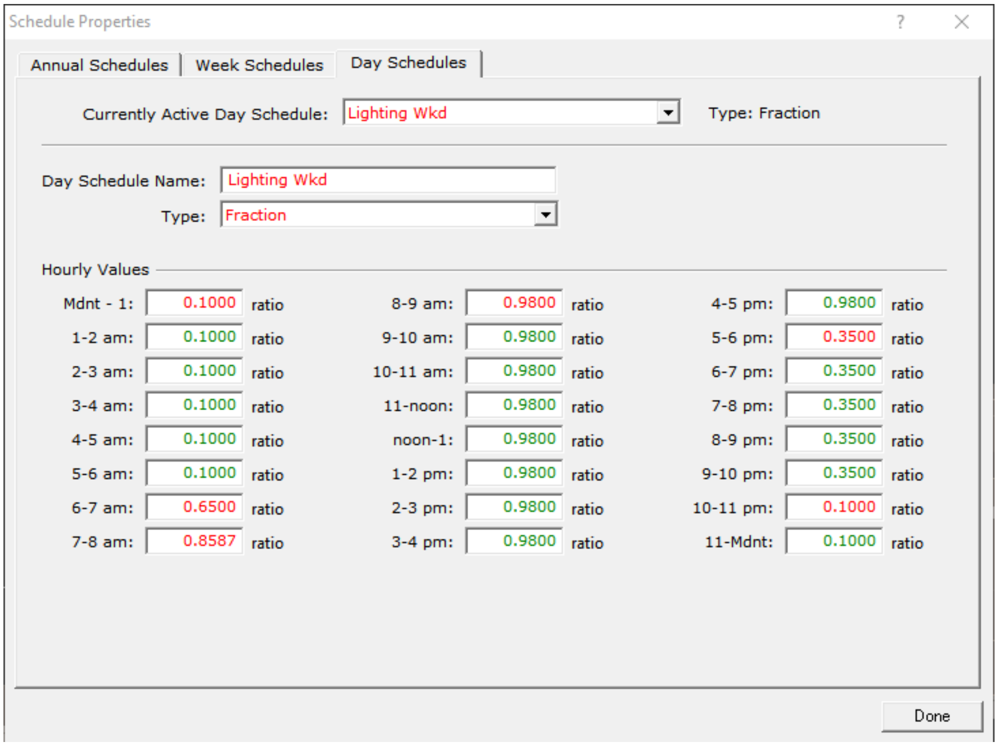
To estimate savings for key buildings, Schneider Electric modeled energy use of buildings using eQuest. eQuest was developed through funding by the United States Department of Energy (USDOE) and is used as the preferred tool for energy modeling in the industry. This modeling tool provides the unique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

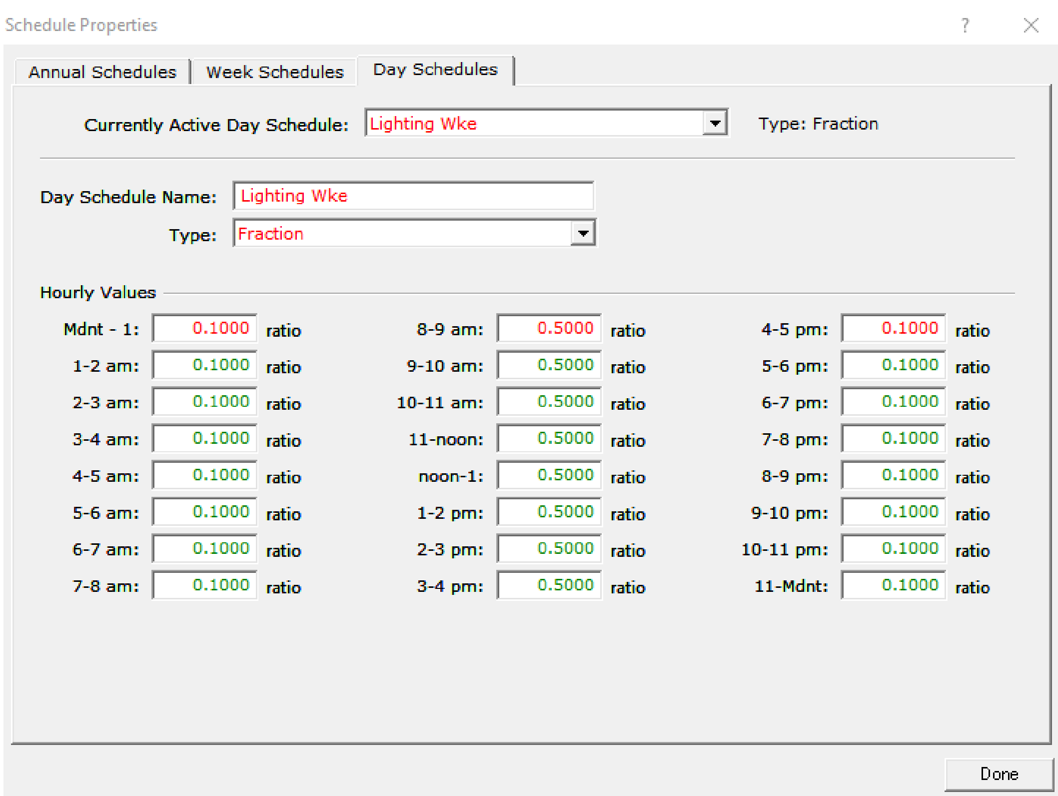
Spaces are defined by their construction to determine thermal conductivity and mass for heat loss/gain calculations. Also included are ventilation rates, lighting, equipment, and occupant loads and schedules. Individual spaces or groups of spaces are assigned to thermal zones that are served by an air 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.



### 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**

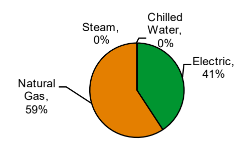
Provide key assumptions made to calibrate energy baseline.

Compress

Decompress

| Baseline Energy | | | | Calibration | |
|---|---|---|---|---|---|
| Fuel | Pre | Units | EUI | Previous | Current |
| Electric | 861,303 | kWh | 38.6 | 0% | 0% |
| Electric | 2,525 | kW | - | 1% | 1% |
| Natural Gas | 42,741 | Therm | 56.1 | 2% | 2% |
| Chilled Water | - | Ton-hrs | - | - | - |
| Steam | - | klb | - | - | - |
| Total | 7,213,717 | kBtu | 94.7 | | |

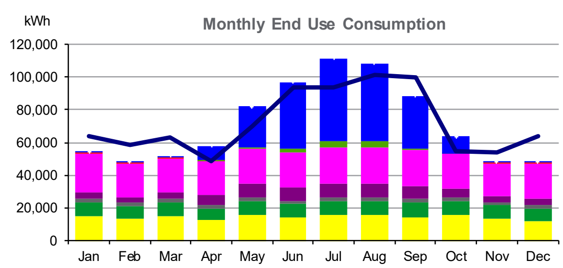
**Baseline Energy Chart**

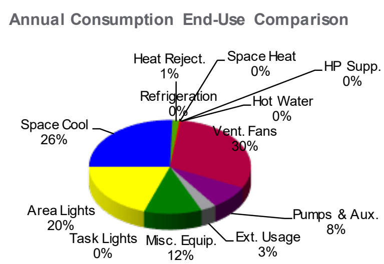



### Electric Energy Data

| 1 | 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% | |

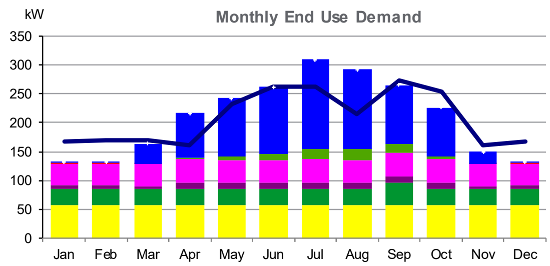
Electric Consumption kWh

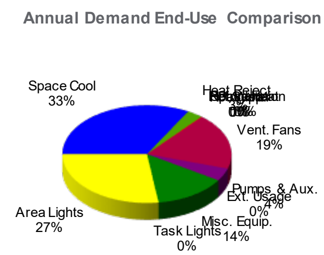


## Electric Demand Data

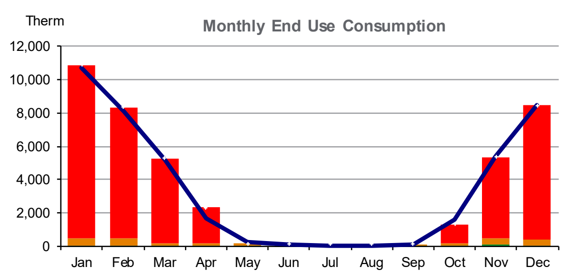
| Electric Demand | | | | | | | | | | | | | | kW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total | 1 |
| Space Cool | 1 | 1 | 35 | 78 | 101 | 115 | 155 | 137 | 102 | 86 | 21 | 1 | 836 | Space Cool |
| 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% | |

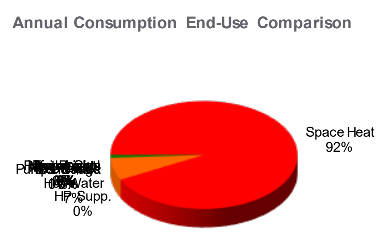



## Natural Gas Energy Data

| 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% | |



## Savings Methods – ELEMENT

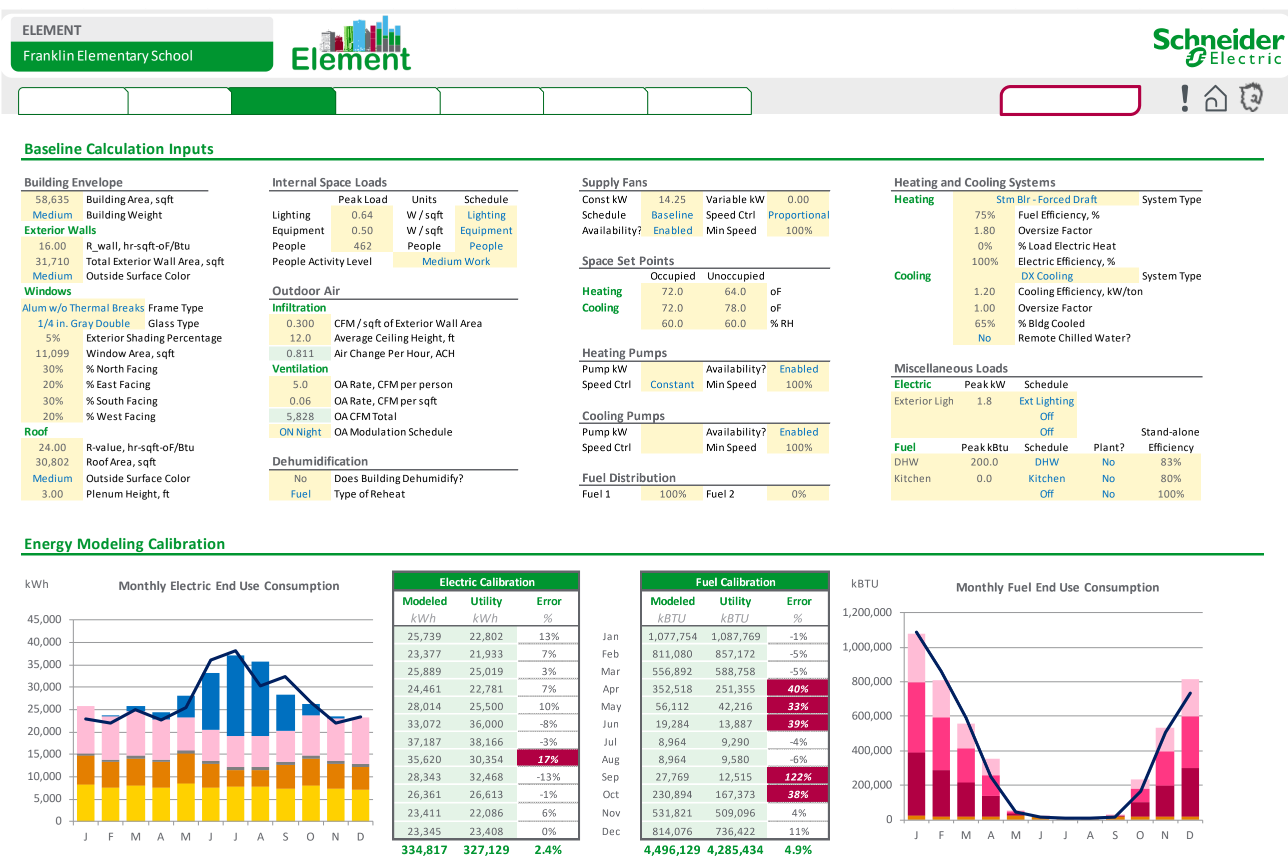
The ELEMENT tool was developed to provide transparency into the end use breakdown of energy consumption for each fuel type. The simplified building inputs and schedules are used in a powerful hourly load analysis to provide quick building calibrations. Energy saving scenarios can be run quickly to see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




| | Electric Calibration Modeled (kWh) | Electric Calibration Utility (kWh) | Error (%) | Fuel Calibration Modeled (kBTU) | Fuel Calibration Utility (kBTU) | Error (%) |
|---|---|---|---|---|---|---|
| Jan | 25,739 | 22,802 | 13% | 1,077,754 | 1,087,769 | -1% |
| Feb | 23,377 | 21,933 | 7% | 811,080 | 857,172 | -5% |
| Mar | 25,889 | 25,019 | 3% | 556,892 | 588,758 | -5% |
| Apr | 24,461 | 22,781 | 7% | 352,518 | 251,355 | 40% |
| May | 28,014 | 25,500 | 10% | 56,112 | 42,216 | 33% |
| Jun | 33,072 | 36,000 | -8% | 19,284 | 13,887 | 39% |
| Jul | 37,187 | 38,166 | -3% | 8,964 | 9,290 | -4% |
| Aug | 35,620 | 30,354 | 17% | 8,964 | 9,580 | -6% |
| Sep | 28,343 | 32,468 | -13% | 27,769 | 12,515 | 122% |
| Oct | 26,361 | 26,613 | -1% | 230,894 | 167,373 | 38% |
| Nov | 23,411 | 22,086 | 6% | 531,821 | 509,096 | 4% |
| Dec | 23,345 | 23,408 | 0% | 814,076 | 736,422 | 11% |
| | 334,817 | 327,129 | 2.4% | 4,496,129 | 4,285,434 | 4.9% |

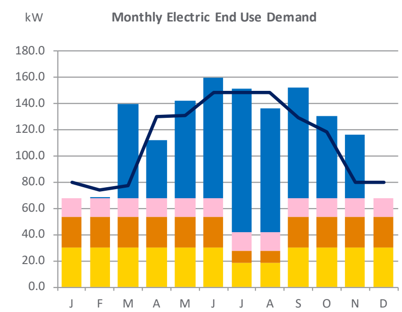
### Baseline Breakout Analysis

**Electric Consumption** / **Fuel Consumption**

| Month | Internal Loads: Lighting 27.5% kWh | Internal Loads: Equipment 19.7% kWh | Miscellaneous Loads: Exterior Lighting 2.3% kWh | Miscellaneous Loads: 0 0.0% kWh | Miscellaneous Loads: 0 0.0% kWh | Fans and Pumps: Fans 30.8% kWh | Fans and Pumps: Clg Pumps 0.0% kWh | Fans and Pumps: Htg Pumps 0.0% kWh | Heating and Cooling: Heating 0.0% kWh | Heating and Cooling: Cooling 19.7% kWh | Heating and Cooling: Dehumid 0.0% kWh | Heating and Cooling: Reheat 0.0% kWh | Miscellaneous Loads: DHW 4.7% kBtu | Miscellaneous Loads: Kitchen 0.0% kBtu | Miscellaneous Loads: 0 0.0% kBtu | Heating: Envelope 33.6% kBtu | Heating: Infiltration 36.1% kBtu | Heating: Ventilation 25.6% kBtu | Heating: Reheat 0.0% kBtu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8,212 | 6,412 | 656 | 0 | 0 | 10,459 | 0 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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** | **0** | **209,904** | **0** | **0** | **1,509,197** | **1,624,016** | **1,153,013** | **0** |

**Electric Demand**

| Month | Internal Loads: Lighting 23.4% kW | Internal Loads: Equipment 17.5% kW | Miscellaneous Loads: Exterior Lighting 0.0% kW | Miscellaneous Loads: 0 0.0% kW | Miscellaneous Loads: 0 0.0% kW | Fans and Pumps: Fans 11.9% kW | Fans and Pumps: Clg Pumps 0.0% kW | Fans and Pumps: Htg Pumps 0.0% kW | Heating and Cooling: Heating 0.0% kW | Heating and Cooling: Cooling 47.2% kW | Heating and Cooling: Dehumid 0.0% kW | Heating and Cooling: 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 difference of the PPA Rate vs Utility Rate by the anticipated production of the solar PV system.

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

| 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 PV Information

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

### Annual Calendar of Events

Provided below is a table summarizing the annual calendar of events that will be used as a basis in calculations (taken from the 2019-2020 School Calendar), unless otherwise specified. In the event that there are any changes or deviations to this annual calendar, an appropriate adjustment will be made. Note that this calendar/schedule reflects a typical school calendar/schedule where instruction occurs in the classroom.

| Date(s) | Event |
|---|---|
| Sept 2 | Closed - Labor Day |
| Sept 5 | First day of School |
| Sept 30 | Closed - Rosh Hashanah |
| Oct 9 | Closed - Yom Kippur |
| Oct 14 | Closed - Columbus Day |
| Oct 23 | Half Day - Staff Development |
| Nov 5 | Closed - Election Day |
| Nov 7-8 | Closed - NJEA Convention |
| Nov 27 | Half Day - Thanksgiving Recess |
| Nov 28-29 | Closed - Thanksgiving Recess |
| Dec 11 | Half Day - Staff Development |
| Dec 20 | Half Day - Christmas Recess |
| Dec 23-31 | Closed - Christmas Recess |

| Date(s) | Event |
|---|---|
| Jan 1 | Closed - New Year's Day |
| Jan 8 | Half Day - Staff Development |
| Jan 20 | Closed - Martin L King Jr. Day |
| Jan 22-28 | Half Days (UHS Only) |
| Feb 12 | Half Day - Staff Development |
| Feb 17 | Closed - President's Day |
| Mar 18 | Half Day - Staff Development |
| Apr 10 | Closed - Good Friday |
| Apr 13-17 | Closed - Spring Recess |
| May 22 | Half Day - Memorial Day Weekend |
| May 25 | Closed - Memorial Day |
| June 19-24 | Last 4 Half Days |
| June 24 | Last Day of School |

Calendar plans for 185 School Days including 5 anticipated school closing due to inclement weather.

### Building Occupancy Schedules

Provided below is a table summarizing the building occupancy schedules used within the calculations, unless otherwise specified. In the event that there are any changes or deviations to this occupancy schedule, an appropriate adjustment will be made in accordance with the Adjustment Schedule set forth in Schedule 5. Note that this calendar/schedule reflects a typical school calendar/schedule where instruction occurs in the classroom.

| Facility | Day Type | Daily Schedule |
|---|---|---|
| *Admin Building* | | |
| Offices/Admin | Monday-Friday | 7:00 AM - 5:00 PM |
| | Weekend/Holiday | No Operation |

| Facility | Day Type | Daily Schedule |
|---|---|---|
| *High School* | | |
| Classroom | Monday-Friday | 7:00 AM - 5:00 PM |
| | Weekend/Holiday | No Operation |
| Gym | Monday-Friday | 7:00 AM - 5:00 PM |
| | Weekend | 10:00 AM - 3:00 PM |
| | Holiday | No Operation |
| Cafeteria | Monday-Friday | 7:00 AM - 7:00 PM |
| | Weekend | 10:00 AM - 3:00 PM |
| | Holiday | No Operation |
| Auditorium | Monday-Friday | 7:00 AM - 7:00 PM |
| | Weekend | 10:00 AM - 3:00 PM |
| | Holiday | No Operation |
| Library | Monday-Friday | 7:00 AM - 5:00 PM |
| | Weekend/Holiday | No Operation |
| Offices/Admin | Monday-Friday | 7:00 AM - 5:00 PM |
| | Weekend/Holiday | No Operation |

| Facility | Day Type | Daily Schedule |
|---|---|---|
| *All Middle Schools* | | |
| Classroom | Monday-Friday<br>Weekend/Holiday | 7:00 AM - 4:00 PM<br>No Operation |
| Gym | Monday-Friday<br>Weekend<br>Holiday | 7:00 AM - 5:00 PM<br>10:00 AM - 2:00 PM<br>No Operation |
| Cafeteria | Monday-Friday<br>Weekend<br>Holiday | 7:00 AM - 5:00 PM<br>10:00 AM - 2:00 PM<br>No Operation |
| Auditorium | Monday-Friday<br>Weekend<br>Holiday | 7:00 AM - 5:00 PM<br>10:00 AM - 2:00 PM<br>No Operation |
| Library | Monday-Friday<br>Weekend (Kawahmee Only)<br>Holiday | 7:00 AM - 5:00 PM<br>10:00 AM - 2:00 PM<br>No Operation |
| Offices/Admin | Monday-Friday<br>Weekend/Holiday | 7:00 AM - 5:00 PM<br>No Operation |

| Facility | Day Type | Daily Schedule |
|---|---|---|
| *All Elementary Schools* | | |
| Classroom | Monday-Friday<br>Weekend/Holiday | 7:00 AM - 4:00 PM<br>No Operation |
| Gym | Monday-Friday<br>Weekend/Holiday | 7:00 AM - 4:00 PM<br>No Operation |
| Cafeteria | Monday-Friday<br>Weekend/Holiday | 7:00 AM - 4:00 PM<br>No Operation |
| Auditorium | Monday-Friday | 7:00 AM - 4:00 PM |

| | | |
|---|---|---|
| | Weekend/Holiday | No Operation |
| Media Center | Monday-Friday<br>Weekend/Holiday | 7:00 AM - 4:00 PM<br>No Operation |
| Offices/Admin | Monday-Friday<br>Weekend/Holiday | 7:00 AM - 4:00 PM<br>No Operation |

HVAC systems will be engaged prior to start of occupied times in order to meet occupied setpoints by start times listed above. All No Operation days above will be set at unoccupied temperatures.

### Standards of Service and Comfort

Provided below is a table summarizing the temperature setpoints used within the calculations, unless otherwise specified. Customer agrees to operate the conditioned spaces in the facilities within the temperature ranges scheduled in the table below. In the event that there are any changes or deviations to these standards of service and comfort, an appropriate adjustment will be made.

| | Heating | Cooling |
|---|---|---|
| Occupied | 70°F | 74°F |
| Unoccupied | 55°F | 85°F |

## 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*

*Final Revised January 5, 2021*

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

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

## Table of Contents

# 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.

*DLB Reviewed the Solar PPA in the Revised Energy Savings Plan prepared by Schneider Electric dated December 14,2020. The ECMs were renumbered but remain the same with the addition of a capitol improvement project ECM 14 and ECM 12 changing from Owner Purchased to Power Purchase Agreement. The updated report includes these updates with adjusted Estimated Installed Hard Costs and Annual Savings.*

### 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 the revised report dated December 14,2020 and comments have been incorporated into the revised ESP. The Energy Savings Plan is ready for review and adoption by the Township of Union Schools.*

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

*We have reviewed the revised Township of Union Schools Energy Savings Plan dated December 14, 2020, as submitted by Schneider Electric in accordance with P.L. 2012, c. 55 (2009 c.4.).*

*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.*

# 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 |

# 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

### 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 |

# SECTION 4: ENERGY SAVINGS CALCULATIONS 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
12. Solar Photovoltaic *(PPA)* systems – All Schools
13. Roof Repair, Replacement & Warranty Extension – HCES, BMS, HS, BHES, KMS, WES
6. Drop Ceiling installation – BMS, BHES
7. Steam Trap Replacement – HS, BMS, KMS, CFES, FES, LES, WES
8. Building Automation System *(BAS) with Demand Control Ventilation- All Schools except JES
9. Rooftop Unit & Split System Replacement – HS, KMS, FES, HCES< LES, Admin
10. New Gym Air Handling Units w/ AC, HW Converter Replacement & CHP - HS
11. New Chiller, Cooling Tower and Pimps with Controls - HCES
15. Steam Boiler Plant Replacement with Controls – FES, CFES
14. *Burnet Auditorium HVAC Renovation with Cooling Addition*

### 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.

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 quantiy 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.

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 *( Changed to ECM 12 )* – 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.
1. 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.
2. It is unclear if maintenance access was taken into account in the general panel layout which should be considered for any roof top equipment.
3. Also, it may be worthwhile to highlight any system downtime incorporated in the estimated production values.
4. 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.

**ECM 7 *( Changed to ECM 13 )* – 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 7analasis tool table and recommend adding the tool used to calculate savings.

**ECM 8 *( Changed to ECM 6 )* – 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 *( Changed to ECM 7 )* – 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 *( Changed to ECM 8 )* – 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.

**ECM 11 *( Changed to ECM 9 )* – 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 *( Changed to ECM 10 )* – 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 *( Changed to ECM 11 )* – 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 *( Changed to ECM 15 )* – 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.
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.

### 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. $CO_2$ per MWh saved
- 0.83 lbs. $NO_x$ per MWh saved
- 0.67 lbs. $SO_2$ per MWh saved
- 11.7 lbs. $CO_2$ per therm saved
- 0.0092 lbs. $NO_x$ per therm saved

# 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.

# SECTION 6: ATTACHMENT

# 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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### 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.

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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.

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*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.*

# 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 |

# SECTION 3: 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

### 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 |

# SECTION 4: ENERGY SAVINGS CALCULATIONS 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.

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 quantiy 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.

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.

**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 7analasis 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.

**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)**

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.

### 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. $CO_2$ per MWh saved
- 0.83 lbs. $NO_x$ per MWh saved
- 0.67 lbs. $SO_2$ per MWh saved
- 11.7 lbs. $CO_2$ per therm saved
- 0.0092 lbs. $NO_x$ per therm saved

# SECTION 5: REVIEW DISCLAIMER

## 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.

# 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)

### 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

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.

**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 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

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.

**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.

**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:

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

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

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.

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:

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

**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.

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. $CO_2$ per MWh saved
- 0.83 lbs. $NO_x$ per MWh saved

- 0.67 lbs. $SO_2$ per MWh saved
- 11.7 lbs. $CO_2$ per therm saved
- 0.0092 lbs. $NO_x$ per therm saved

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.