# Energy Savings Improvment Plan (ESIP)
# Newark Board of Education

**May 18, 2021 - FINAL**

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Johnson Controls

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# Appendix Dcouments

# Section 1. Executive Summary

Johnson Controls has evaluated various Energy Conservation Measures (ECMs) during the Development Phase of this Energy Savings Improvement Plan (ESIP) program. We have performed field verifications, collected data and taken field measurements to ensure the development of the most cost-effective solutions as well as accurate savings calculations. Various solutions were reviewed with Newark Public Schools administration to develop a set of ECMs that allow the school district to address the facility's priority items while reducing the total annual energy spend. This study expands upon the original energy audit conducted by CHA. The original audit was used for building descriptions as well as an overall indication of the school district needs.

Priority items include:

- Upgrade interior and exterior lighting with LED retrofits
- Lighting lens replacement program
- Building envelope improvements – weatherization
- Pipe and valve insulation improvements
- Domestic water conservation upgrades
- Building controls upgrades paired with an enterprise management system
- Replacing air-handling units, heating and ventilating units and packaged units with the addition of indoor air quality improvements at nine schools
- Replacing rooftop units and split units with the addition of indoor air quality improvements at nine schools
- Chiller replacements at four schools
- Boiler replacements at 13 schools including converting the electric boilers at Alma Flagg and Harold Wilson to gas fired hot water boilers, converting the oil-fired boilers at Lafayette to natural gas and converting the steam boilers at Gladys Hillman-Jones to hot water boilers
- Boiler burner upgrades at four schools
- Replacing/refurbishing equipment supporting the pools at ECC-South and John F. Kennedy School, including a new pool heater at ECC-South and a new PoolPak unit at JFK
- Steam trap replacements
- High-efficiency motor replacements and variable speed drives on pumps
- Energy-efficient transformer replacements at five schools
- 35 kW Combined Heat and Power (CHP) units at Science Park and East Side High
- Two (2) stand-alone Aris wind turbines located at Newark Schools Stadium
- Solar Power Purchase Agreement delivering $34M in benefits over 15 years with $5M of roofing upgrades included
- An additional $7.5M of roofing upgrades executed directly through the ESIP
- Kitchen hood fan controls at ten of the schools with active cooking kitchens
- Refrigeration compressor controllers
- Plug load controls with a focus on window air-conditioning units

- Student Engagement & Teacher Professional Development Programs along with a hands-on HVAC Training Center provided to the school district at no cost through the ESIP
- Various Incentive/Rebate Programs such as Direct Install, Smart Start Rebates, Pay for Performance and Combined Heat and Power Incentives

Energy saving calculations performed in the development of this ESIP (Energy Calculation Workbook) were completed using Microsoft Excel worksheets with Bin Weather Data to accurately model the building systems. Additional spreadsheets were used for measures that are not affected by the weather, such as lighting. Energy savings have been provided in the Appendix for ease of review.

## Benefits

The measures investigated in this ESP would result in an annual utility savings of 13,165,944 kWh of electricity with a 35,260 kW reduction and the facility will save a total of 1,561,864 therms of natural gas. The natural gas savings include the purchase of approximately 12,391 therms of natural gas due to the CHP usage. The facility will save 20,346 gallons of #2 fuel oil from the conversion of oil-fired boiler to natural gas fired boiler in Lafayette Avenue School and save 29,933,798 kgal of water from domestic water conservation. The total net utility cost savings are $83,609,553 over the life of the project (20 years) with a construction period savings of $4,541,371 plus $2,063,792 in operational savings and $2,274,127 in project incentives. Additionally, the project also leverages $34,011,154 in solar PPA savings. These energy savings will result in a net reduction of greenhouse gases and will reduce the Newark Public Schools' carbon footprint by 35,646,669 lbs. of $CO_2$ annually. All these savings are achieved while improving the classroom environment and replacing many items that have been in service beyond their useful life expectancy.

| Energy Savings Plan Project Summary | |
|---|---|
| Total Value of Building Infrastructure Improvements[(1)(3)] | $143,980,354 |
| Total ESIP Project Value to Newark Public Schools [(2)(3)] | $104,557,028 |
| Total Financed Project | $98,166,313 |
| Term of the Project | 20 years |
| Indicative Interest Rate | 2.25% |
| Type of Financing | Local Finance Board Bond Issuance |
| Number of Energy Conservation Measures | 28 |
| Total Energy Savings (including construction period) | $88,150,924 |
| Total Solar PPA Savings | $34,011,154 |
| Total Incentives, Rebates, and Instant Discounts Projected | $3,664,843 |
| Net Positive Cash to NPS over 20 years | $535,315 |

Notes:

(1) Total Value of Building Infrastructure Improvements includes installed cost of the solar PV assets (not cost responsibility of Newark Public Schools)

(2) The difference between the Total ESIP Project Value and Total Financed Project is due to the following:

- ~$1.4M of instant cost buydown benefit obtained through the NJ Direct Install program
- Inclusion of $5M of roofing upgrades within the solar PV PPA (not cost responsibility of Newark Public Schools)

(3) Above figures do not include any impact from supplemental ESSER funding

# Section 2. Project Description

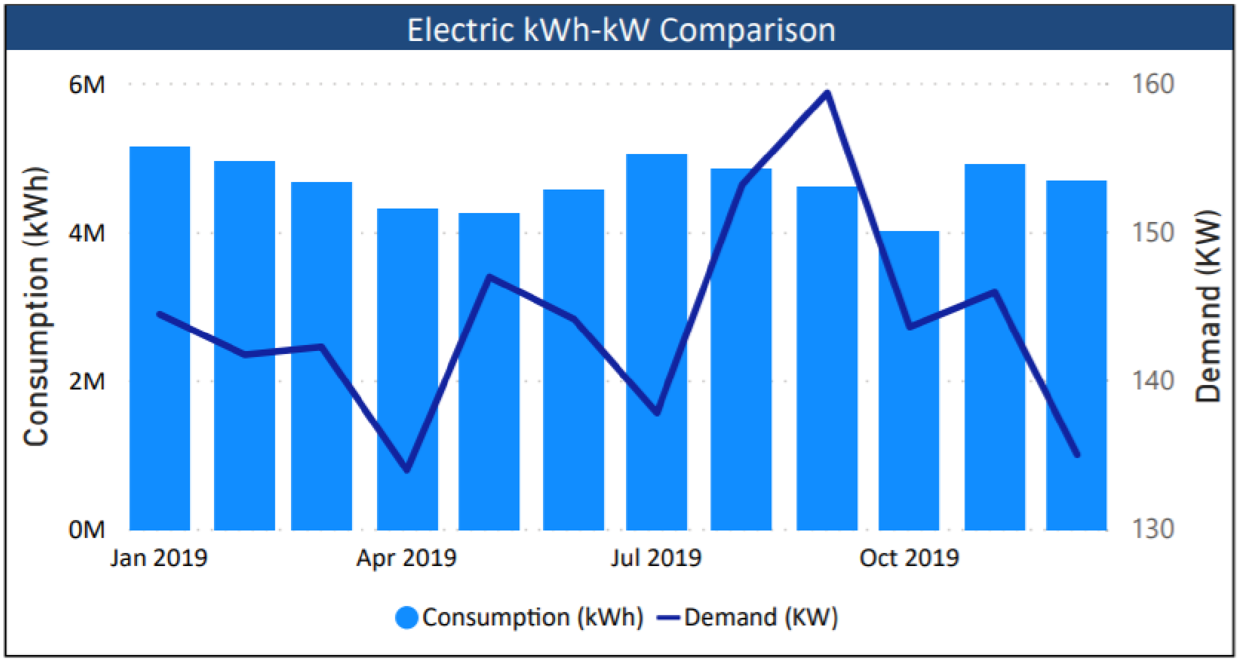
## Facility Descriptions

Refer to Appendix for facilities descriptions.

## Utility Baseline Analysis

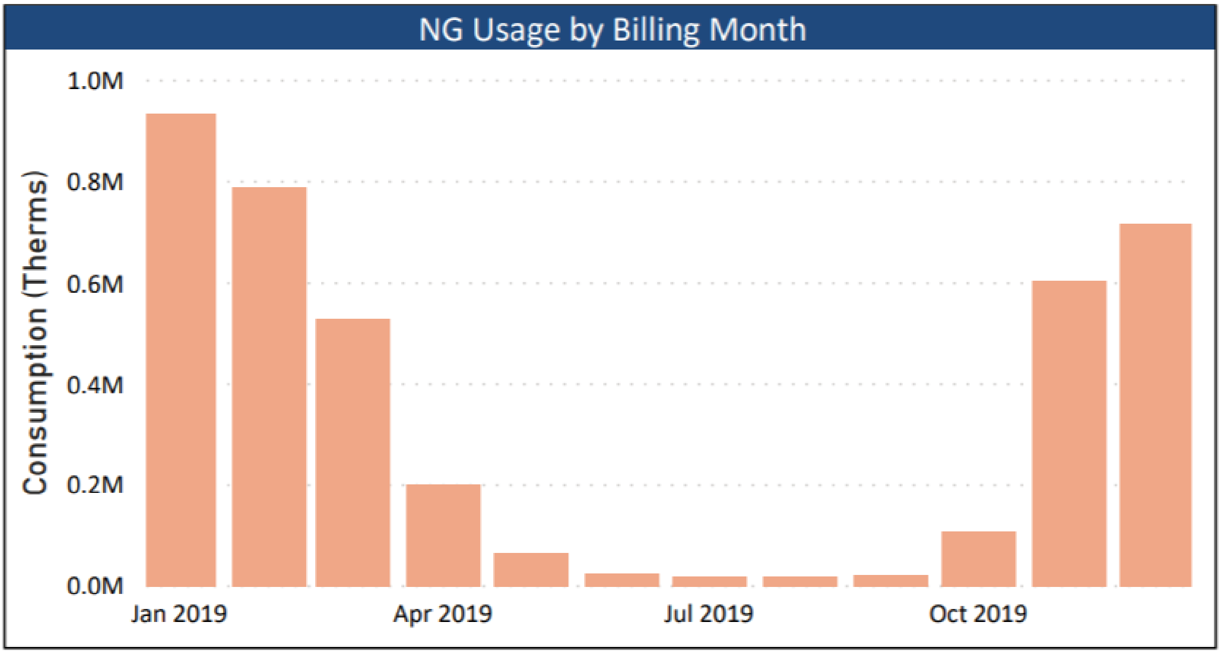
### Electric Utility

Electrical energy is delivered to Newark Public Schools through PSE&G. The electric utility measures consumption in kilowatt-hours (kWh) and maximum demand in kilowatts (kW). One kWh usage is equivalent to 1,000 watts running for one hour. One kW of electric demand is equivalent to 1,000 watts running at any given time. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges. The baseline period for electric utility is January to December of 2019.



## Natural Gas

Newark Public Schools acquires natural gas from PSE&G. The natural gas utility company measures consumption in therms. The baseline period for natural gas utility is January 2019 to December 2019.




## Fuel Oil

Fuel oil is used by the boilers in Lafayette Street School. The fuel oil consumption is measured in gallons. The baseline period is from LGEA report which is between March 2013 and February 2014 as the consumption of the calendar year 2019 is not available.

## Water

Newark Public Schools acquires water from City of Newark and pays water and sewer to City of Newark Water Department. The water consumption is measured in CCF. The baseline period for water utility is January 2019 to December 2019.

The following table shows the schools' building names and utility account numbers considered for the baseline of this ESIP.

| Building | PSE&G Electric Account No. | PSE&G Natural Gas Account No. | City of Newark Water & Sewer Account No. |
|---|---|---|---|
| Abington Avenue School | 4250102106 | 4250102106 | 45019 |
| American History High School | 4200860600 | 4200860600 | 6989 |
| Ann Street School | 6604782409<br>6714361106<br>6930902802 | 6604782409<br>6714361106<br>6930902802 | 10293 |
| Arts High School | 4200103400<br>4236400308 | 6932774100 | 38191 |
| Avon Avenue Elementary School | 6714362218 | 6714362218 | 7172 |
| Bard Early College High School | 4200056607 | 4200056607 | n/a |
| Barringer High School | 4200400804<br>6604783200 | 4200400804 | 44986 |

| Building | PSE&G Electric Account No. | PSE&G Natural Gas Account No. | City of Newark Water & Sewer Account No. |
|---|---|---|---|
| Belmont Runyon School | 4200575809 | 4200575809 | n/a |
| Benjamin Franklin School | 4250600106 | 4250600106 | 45071 |
| Boylan Early Childhood Center | 6677899500 | 6677899500 | 6854 |
| Bragaw Avenue School | 6932608502 | n/a | 7174 |
| Branch Brook School | 6547432009 | 6547432009 | 44987 |
| Camden Street School | 4201029603 | 6668245307 | 6985 |
| Central High School | 4207551018 | 6932681005 | 6867 |
| Chancellor Avenue School | 4201023400 | n/a | 7176 |
| Cleveland Elementary School | 6932580705 | 6519800201 | 6984 |
| Dr. E. Alma Flagg School | 4200453401 | n/a | 45079 |
| Dr. Marion A. Bolden Student Center | 4241501818 | 4241501818 | 43390 |
| Dr. William H. Horton School | 6501282500<br>6571473607<br>6581655805 | 6501282500<br>6581655805 | 45099<br>45102 |
| Early Childhood Center - Central | 4200884801 | 4200884801 | n/a |
| Early Childhood Center - North | 4200001004 | 4200001004 | n/a |
| Early Childhood Center - South | 6932440008 | 6728994904 | 7165 |
| Early Childhood Center - West | 6501281008<br>6677387305<br>6707726404 | 6501281008 | 3366<br>3367 |
| East Side High School | 4200102803<br>6932910500 | 4200102803 | 10373 |
| East Ward Elementary School | 6666104609 | 6666104609 | 20341<br>52164 |
| Elliott Street School | 4236850303<br>6932149702 | 4236850303 | 44988 |
| First Avenue School | 4200305909 | 4200305909 | 38083<br>45018<br>52340 |
| Fourteenth Avenue School | 6604787001 | 6604787001 | 6986 |
| George Washington Carver School | 4200439301 | 4200439301 | 7170<br>16238 |
| Harold Wilson School | 4200419408 | n/a | 7012 |
| Harriet Tubman School | 6677899004<br>6718486108 | 6677899004<br>6718486108 | 3399<br>6903 |
| Hawkins Street School | 4253203906<br>6932859807 | 4253203906 | 17115<br>17123 |
| Hawthorne Avenue School | 6629696603<br>6747314409 | 6629696603<br>6747314409 | 3509<br>7168 |
| Ivy Hill Elementary School | 6512835018<br>6932494302 | 6512835018 | n/a |
| John F. Kennedy School | 4200805804 | 4200805804 | 3303 |

| Building | PSE&G Electric Account No. | PSE&G Natural Gas Account No. | City of Newark Water & Sewer Account No. |
|---|---|---|---|
| Lafayette Street School | 6932139200 | 6932139200 | 10466<br>31532 |
| Lincoln School | 6604785009<br>6606130905 | 6606130905 | 3273 |
| Louise A. Spencer School | 4200720507<br>6931801309 | 6714363303 | 10487 |
| Luis Muñoz Marin School | 4200954206 | 4200954206 | n/a |
| Malcolm X Shabazz High School | 4200804905<br>4200805006<br>6548391500 | 4200804905<br>6664767007 | 3540<br>7154<br>7156<br>52134 |
| McKinley Elementary School | 4207551204<br>6931484702 | 6574050006 | 45067<br>45070 |
| Mount Vernon School | 4201058107 | 4201058107 | 3279 |
| Newark Schools Stadium | 4213250202<br>6932741504 | 4213250202 | 45101 |
| Newark Vocational High School | 4200439409 | 4200439409 | n/a |
| NJ Regional Day School | 4200010208 | n/a | 7096 |
| Oliver Street School | 4237650405 | 4237650405 | 37967 |
| Park Elementary School | 4207551107<br>6930957518 | 4207551107 | 27708 |
| Peshine Avenue School | 4225952207 | 4225952207 | 7181<br>21796 |
| Quitman Street School | 4200071509 | 4200071509 | 3466<br>20260 |
| Rafael Hernandez Elementary School | 4207551301 | 4207551301 | 43523 |
| Ridge Street School | 6710589609<br>6714365004 | 6710589609<br>6714365004 | 44956 |
| Ridge Street School Early Childhood Center | 6514081800 | 6514081800 | 44955 |
| Roberto Clemente Elementary School | 6606130018<br>6932631903 | 6710591301 | 44958 |
| Salomé Ureña Elementary School | 6932503301 | 6637267708<br>6753597603 | n/a |
| Science Park High School | 4200272709<br>4201203905<br>6932862018 | 4200272709 | n/a |
| Sir Isaac Newton Elementary School | 6536121007 | 6536121007 | 6960 |
| South 17th Street School | 6506904704<br>6753850007 | 6506904704<br>6639459906 | 6860<br>7166 |
| South Street School | 4250002004<br>6536119908 | 4250002004<br>6536119908 | 20301 |
| Speedway Avenue | 4207852700 | 4207852700 | 53356 |

| Building | PSE&G Electric Account No. | PSE&G Natural Gas Account No. | City of Newark Water & Sewer Account No. |
|---|---|---|---|
| Sussex Avenue School | 4200782103<br>6932182807 | 4200782103 | 34599<br>34600 |
| Technology High School | 4201014606 | 4201014606<br>6570111302<br>6933023400 | 24270 |
| Thirteenth Avenue School | 4200649004 | 4200649004 | 50676 |
| University High School | 4201022900 | 4201022900 | 7171 |
| Warehouse/ Motor Pool | 6509046202 | 6509046202 | 23102 |
| Weequahic High School | 4201023001<br>4212452707<br>6931807102<br>6984057108 | 4201023001<br>4212452707 | 7182 |
| West Side High School | 4200210703<br>6932506009 | 4200210703 | 6855 |
| Wilson Avenue School | 6571471809 | 6571471809 | 10294<br>30930 |
| Wilson Avenue School Annex | 6677385701 | 6677385701 | 10292 |

## Energy & Water Usage Summary

Based on Johnson Controls utility analysis, Newark Public Schools has a total spend of $9.9 million towards electric and natural gas utilities and $1.3 million for water and sewer. The energy and utility spend breakdown is provided below.

| Building Name | Electric Cost | Natural Gas Cost | Fuel Oil Cost | Water & Sewer Cost |
|---|---|---|---|---|
| Abington Avenue School | $59,057 | $31,738 | n/a | $10,216 |
| American History High School | $68,967 | $71,930 | n/a | $9,908 |
| Ann Street School | $53,051 | $54,678 | n/a | $11,900 |
| Avon Avenue Elementary School | $69,579 | $40,189 | n/a | $14,339 |
| Bard Early College High School | $123,676 | $79,514 | n/a | n/a |
| Barringer High School | $125,539 | $61,618 | n/a | 28,695 |
| Belmont Runyon School | $187,043 | $30,663 | n/a | n/a |
| Benjamin Franklin School | $37,482 | $38,182 | n/a | $12,703 |
| Boylan Early Childhood Center | $7,029 | $5,450 | n/a | $3,259 |
| Bragaw Avenue School | $41 | n/a | n/a | $5,772 |
| Branch Brook School | $25,418 | $20,460 | n/a | $3,473 |
| Camden Street School | $80,516 | $60,355 | n/a | $28,058 |
| Central High School | $302,309 | $5,365 | n/a | $26,601 |
| Chancellor Avenue School | $43,625 | n/a | n/a | $16,226 |
| Cleveland Elementary School | $34,277 | $48,045 | n/a | $10,012 |
| Dr. E. Alma Flagg School | $164,909 | n/a | n/a | $60,633 |
| Dr. Marion A. Bolden Student Center | $96,456 | $11,691 | n/a | $4,671 |
| Dr. William H. Horton School | $66,141 | $50,832 | n/a | $9,703 |
| Early Childhood Center - Central | $94,485 | $23,261 | n/a | n/a |
| Early Childhood Center - North | $113,503 | $41,991 | n/a | n/a |
| Early Childhood Center - South | $41,825 | $15,752 | n/a | $6,161 |
| Early Childhood Center - West | $51,375 | $34,474 | n/a | $7,984 |
| East Side High School | $167,854 | $145,186 | n/a | $67,274 |
| East Ward Elementary School | $42,106 | $61,016 | n/a | $8,028 |
| Elliott Street School | $175,975 | $40,073 | n/a | $31,333 |
| First Avenue School | $311,120 | $35,802 | n/a | $44,753 |
| Fourteenth Avenue School | $24,660 | $21,696 | n/a | $25,346 |
| George Washington Carver School | $162,030 | $89,397 | n/a | $11,798 |
| Harold Wilson School | $114,131 | n/a | n/a | $8,495 |
| Harriet Tubman School | $79,040 | $18,675 | n/a | $22,736 |
| Hawkins Street School | $55,123 | $32,949 | n/a | $12,295 |
| Hawthorne Avenue School | $75,849 | $47,446 | n/a | $52,709 |
| Ivy Hill Elementary School | $60,572 | $70,374 | n/a | n/a |
| John F. Kennedy School | $65,052 | $30,509 | n/a | $16,237 |
| Lafayette Street School | $39,301 | $4,121 | $44,761 | $13,241 |
| Lincoln School | $38,258 | $26,467 | n/a | $17,584 |

| Building Name | Electric Cost | Natural Gas Cost | Fuel Oil Cost | Water & Sewer Cost |
|---|---|---|---|---|
| Louise A. Spencer School | $138,209 | $90,327 | n/a | $41,138 |
| Luis Muñoz Marin School | $115,088 | $75,136 | n/a | n/a |
| Malcolm X Shabazz High School | $208,620 | $122,744 | n/a | $62,485 |
| McKinley Elementary School | $163,704 | $76,135 | n/a | $31,778 |
| Mount Vernon School | $57,030 | $77,915 | n/a | $27,736 |
| Newark Schools Stadium | $56,010 | $16,745 | n/a | $3,073 |
| Newark Vocational High School | $53,925 | $90,405 | n/a | n/a |
| NJ Regional Day School | $68,528 | n/a | n/a | $3,296 |
| Oliver Street School | $173,598 | $32,385 | n/a | $58,859 |
| Park Elementary School | $203,419 | $17,926 | n/a | $10,924 |
| Peshine Avenue School | $92,148 | $59,460 | n/a | $29,752 |
| Quitman Street School | $70,983 | $45,700 | n/a | $37,215 |
| Rafael Hernandez Elementary School | $134,124 | $2,918 | n/a | $9,749 |
| Ridge Street School | $34,708 | $5,340 | n/a | $19,313 |
| Ridge Street School Early Childhood Center | $8,657 | $12,617 | n/a | $5,961 |
| Roberto Clemente Elementary School | $35,250 | $31,915 | n/a | $7,343 |
| Salomé Ureña Elementary School | $50,091 | $42,688 | n/a | n/a |
| Science Park High School | $436,947 | $126,017 | n/a | n/a |
| Sir Isaac Newton Elementary School | $35,783 | $54,467 | n/a | $22,061 |
| South 17th Street School | $68,905 | $43,960 | n/a | $13,460 |
| South Street School | $157,481 | $40,534 | n/a | $1,347 |
| Speedway Avenue | $208,388 | $35,879 | n/a | $32,675 |
| Sussex Avenue School | $65,729 | $22,092 | n/a | $8,484 |
| Technology High School | $103,519 | $83,368 | n/a | $22,185 |
| Thirteenth Avenue School | $100,543 | $87,645 | n/a | $10,011 |
| University High School | $85,740 | $103,058 | n/a | $18,146 |
| Warehouse/ Motor Pool | $24,046 | $14,111 | n/a | $4,097 |
| Weequahic High School | $141,801 | $156,511 | n/a | $42,429 |
| West Side High School | $117,771 | $69,939 | n/a | $111,341 |
| Wilson Avenue School | $26,179 | $35,384 | n/a | $7,389 |
| Wilson Avenue School Annex | $8,944 | $5,803 | n/a | $10,920 |
| **Total** | **$6,704,244** | **$3,160,193** | **$44,761** | **$1,255,310** |

The combined EUI for electric and thermal is shown below for each school. The EUI of most schools is higher compared to the national benchmark of 48.6 for the K-12 schools.

| Building | EUI (KBtu/Sqft) |
|---|---|
| Abington Avenue School | 63 |
| American History High School | 107 |
| Ann Street School | 85 |
| Arts High School | 107 |
| Avon Avenue Elementary School | 81 |
| Bard Early College High School | 92 |
| Barringer High School | 38 |
| Belmont Runyon School | 73 |
| Benjamin Franklin School | 71 |
| Boylan Early Childhood Center | 38 |
| Bragaw Avenue School | n/a |
| Branch Brook School | 150 |
| Camden Street School | 66 |
| Central High School | 45 |
| Chancellor Avenue School | 17 |
| Cleveland Elementary School | 92 |
| Dr. E. Alma Flagg School | 75 |
| Dr. Marion A. Bolden Student Center | 68 |
| Dr. William H. Horton School | 78 |
| Early Childhood Center - Central | 44 |
| Early Childhood Center - North | 91 |
| Early Childhood Center - South | 73 |
| Early Childhood Center - West | 135 |
| East Side High School | 78 |
| East Ward Elementary School | 96 |
| Elliott Street School | 145 |
| First Avenue School | 79 |
| Fourteenth Avenue School | 54 |
| George Washington Carver School | 74 |
| Harold Wilson School | 51 |
| Harriet Tubman School | 79 |
| Hawkins Street School | 79 |
| Hawthorne Avenue School | 128 |
| Ivy Hill Elementary School | 93 |
| John F. Kennedy School | 105 |
| Lafayette Street School | 242 |
| Lincoln School | 77 |
| Louise A. Spencer School | 83 |

| Building | EUI (KBtu/Sqft) |
|---|---|
| Luis Muñoz Marin School | 67 |
| Malcolm X Shabazz High School | 72 |
| McKinley Elementary School | 96 |
| Mount Vernon School | 105 |
| Newark Schools Stadium | 140 |
| Newark Vocational High School | 77 |
| NJ Regional Day School | 96 |
| Oliver Street School | 90 |
| Park Elementary School | 72 |
| Peshine Avenue School | 76 |
| Quitman Street School | 64 |
| Rafael Hernandez Elementary School | 46 |
| Ridge Street School | 28 |
| Ridge Street School Early Childhood Center | 112 |
| Roberto Clemente Elementary School | 70 |
| Salomé Ureña Elementary School | 99 |
| Science Park High School | 111 |
| Sir Isaac Newton Elementary School | 88 |
| South 17th Street School | 88 |
| South Street School | 329 |
| Speedway Avenue | 87 |
| Sussex Avenue School | 70 |
| Technology High School | 80 |
| Thirteenth Avenue School | 71 |
| University High School | 105 |
| Warehouse/ Motor Pool | 58 |
| Weequahic High School | 107 |
| West Side High School | 88 |
| Wilson Avenue School | 61 |
| Wilson Avenue School Annex | 120 |

## Marginal Rates

The utility rates identified below were used for purposes of calculating the dollar effect of the energy savings for the schools. These rates were determined based on data from tariff data and utility data.

| Building | Utility Electric Rates | | Natural Gas | #2 Fuel Oil | Water & Sewer Cost |
|---|---|---|---|---|---|
| | $/kWh | $/kW | $/therm | $/gal | $/kgal |
| Abington Avenue School | $0.112 | $7.50 | $0.818 | n/a | $10.30 |
| American History High School | $0.087 | $7.50 | $0.694 | n/a | $9.98 |
| Ann Street School | $0.132 | $3.90 | $0.803 | n/a | $12.66 |
| Arts High School | $0.153 | $7.50 | $0.762 | n/a | $10.20 |
| Avon Avenue Elementary School | $0.121 | $3.90 | $0.709 | n/a | $9.96 |
| Bard Early College High School | $0.092 | $7.50 | $0.770 | n/a | n/a |
| Barringer High School | $0.109 | $6.48 | $0.788 | n/a | $9.88 |
| Belmont Runyon School | $0.112 | $7.50 | $0.816 | n/a | n/a |
| Benjamin Franklin School | $0.106 | $7.50 | $0.734 | n/a | $9.97 |
| Boylan Early Childhood Center | $0.119 | $3.90 | $0.750 | n/a | $10.85 |
| Bragaw Ave School | n/a | n/a | n/a | n/a | $10.00 |
| Branch Brook School | $0.139 | $3.90 | $0.813 | n/a | $10.06 |
| Camden Street School | $0.089 | $7.50 | $0.705 | n/a | $9.78 |
| Central High School | $0.069 | $7.50 | $1.011 | n/a | $10.63 |
| Chancellor Avenue School | $0.079 | $7.50 | n/a | n/a | $9.92 |
| Cleveland Elementary School | $0.113 | $3.90 | $0.774 | n/a | $9.98 |
| Dr. E. Alma Flagg School | $0.083 | $7.50 | n/a | n/a | $9.79 |
| Dr. Marion A. Bolden Student Center | $0.278 | $7.50 | $0.829 | n/a | $10.03 |
| Dr. William H. Horton School | $0.100 | $3.90 | $0.841 | n/a | $10.05 |
| Early Childhood Center - Central | $0.115 | $7.35 | $0.779 | n/a | n/a |
| Early Childhood Center - North | $0.121 | $7.50 | $0.787 | n/a | n/a |
| Early Childhood Center - South | $0.133 | $3.90 | $0.783 | n/a | $10.00 |
| Early Childhood Center - West | $0.141 | $3.90 | $0.855 | n/a | $9.77 |
| East Side High School | $0.091 | $7.50 | $0.793 | n/a | $9.97 |
| East Ward Elementary School | $0.106 | $3.90 | $0.790 | n/a | $10.32 |
| Elliott Street School | $0.124 | $7.50 | $0.813 | n/a | $9.97 |
| First Avenue School | $0.092 | $7.50 | $0.722 | n/a | $10.49 |
| Fourteenth Avenue School | $0.134 | $3.90 | $0.839 | n/a | $9.76 |
| George Washington Carver School | $0.112 | $7.50 | $0.782 | n/a | $10.11 |
| Harold Wilson School | $0.086 | $7.50 | n/a | n/a | $13.01 |
| Harriet Tubman School | $0.127 | $3.90 | $0.901 | n/a | $9.97 |
| Hawkins Street School | $0.107 | $7.50 | $0.815 | n/a | $10.06 |
| Hawthorne Avenue School | $0.116 | $3.90 | $0.780 | n/a | $9.93 |
| Ivy Hill Elementary School | $0.111 | $3.90 | $0.760 | n/a | n/a |
| John F. Kennedy School | $0.142 | $7.50 | $0.854 | n/a | $9.94 |

| Building | Utility Electric Rates | | Natural Gas | #2 Fuel Oil | Water & Sewer Cost |
|---|---|---|---|---|---|
| | $/kWh | $/kW | $/therm | $/gal | $/kgal |
| Lafayette Street School | $0.126 | $3.90 | $0.808 | $2.20 | $10.17 |
| Lincoln School | $0.103 | $3.90 | $0.800 | n/a | $10.06 |
| Louise A. Spencer School | $0.092 | $7.50 | $0.771 | n/a | $9.81 |
| Luis Muñoz Marin School | $0.096 | $7.50 | $0.790 | n/a | n/a |
| Malcolm X Shabazz High School | $0.098 | $7.50 | $0.738 | n/a | $10.14 |
| McKinley Elementary School | $0.103 | $6.78 | $0.789 | n/a | $9.83 |
| Mount Vernon School | $0.098 | $7.50 | $0.777 | n/a | $9.49 |
| Newark Schools Stadium | $0.082 | $7.46 | $0.849 | n/a | $11.18 |
| Newark Vocational High School | $0.101 | $7.50 | $0.806 | n/a | n/a |
| NJ Regional Day School | $0.093 | $7.50 | n/a | n/a | $11.16 |
| Oliver Street School | $0.116 | $7.50 | $0.813 | n/a | $9.75 |
| Park Elementary School | $0.094 | $7.49 | $0.903 | n/a | $12.17 |
| Peshine Avenue School | $0.142 | $7.50 | $0.779 | n/a | $11.10 |
| Quitman Street School | $0.092 | $7.50 | $0.810 | n/a | $9.86 |
| Rafael Hernandez Elementary School | $0.069 | $7.50 | $0.851 | n/a | $10.29 |
| Ridge Street School | $0.139 | $3.90 | $1.291 | n/a | $10.58 |
| Ridge Street School Early Childhood Center | $0.122 | $3.90 | $0.925 | n/a | $10.01 |
| Roberto Clemente Elementary School | $0.119 | $3.90 | $0.791 | n/a | $10.00 |
| Salomé Ureña Elementary School | $0.130 | $3.90 | $0.808 | n/a | n/a |
| Science Park High School | $0.087 | $7.45 | $0.776 | n/a | n/a |
| Sir Isaac Newton Elementary School | $0.105 | $3.90 | $0.782 | n/a | $9.83 |
| South 17th Street School | $0.117 | $3.90 | $0.754 | n/a | $10.02 |
| South Street School | $0.107 | $7.10 | $0.741 | n/a | $13.99 |
| Speedway Avenue | $0.100 | $7.50 | $0.715 | n/a | $10.91 |
| Sussex Avenue School | $0.098 | $7.50 | $0.855 | n/a | $10.80 |
| Technology High School | $0.096 | $7.50 | $0.777 | n/a | $10.98 |
| Thirteenth Avenue School | $0.090 | $7.50 | $0.780 | n/a | $9.97 |
| University High School | $0.101 | $7.50 | $0.793 | n/a | $9.95 |
| Warehouse/ Motor Pool | $0.097 | $3.90 | $0.919 | n/a | $14.31 |
| Weequahic High School | $0.108 | $7.50 | $0.791 | n/a | $10.24 |
| West Side High School | $0.081 | $7.50 | $0.807 | n/a | $7.86 |
| Wilson Avenue School | $0.106 | $3.90 | $0.799 | n/a | $10.57 |
| Wilson Avenue School Annex | $0.178 | $3.90 | $0.897 | n/a | $9.97 |

## Utility Breakdown by Building

The baseline utility period used for all sites is calendar year 2019 due to the significant impact of the COVID-19 global pandemic to existing building operation. The use of 2019 data allows for the building impacts to be disregarded and the data to require no adjustments based on the major operational changes. The electric and natural gas breakdown by building is attached in Appendix.

## Utility Escalation Rates

Per BPU direction, for purposes of calculating the extended value of the energy savings of this project, the following utility escalation rates have been used.

| Electric Consumption | | Electric Demand | | Natural Gas | | #2 Fuel Oil | | Water & Sewer | |
|---|---|---|---|---|---|---|---|---|---|
| Escalation Rate | Start Year of Escalation | Escalation Rate | Start Year of Escalation | Escalation Rate | Start Year of Escalation | Escalation Rate | Start Year of Escalation | Escalation Rate | Start Year of Escalation |
| 2.2% | Install Period 1 | 2.2% | Install Period 1 | 2.4% | Install Period 1 | 2.2% | Install Period 1 | 2.2% | Install Period 1 |

Note: Install period 1 represents first 12 months of construction period.

# Section 3. Financial Impact

## Energy Savings and Cost Summary

The table below provides a summary of the costs and savings associated with the measures recommended in the ESP. The savings have been calculated based on the savings methodology detailed throughout this report and included in the Appendix of this report. Costs for each measure have been estimated based on project implementation experience and industry standards.

| ID # | Energy Conservation Measure | ECM Hard Cost | Year 1 Utility Savings* | Simple Payback |
|---|---|---|---|---|
| 1 | Lighting LED and Lens Upgrades | $7,690,802 | $1,168,659 | 6.6 |
| 2 | Weather Stripping & Air Sealing | $1,676,765 | $185,269 | 9.1 |
| 3 | Pipe & Valve Insulation | $1,074,114 | $109,552 | 9.8 |
| 4 | Water Conservation | $2,463,010 | $345,877 | 7.1 |
| 5 | Building Controls Upgrades | $23,894,038 | $891,116 | 26.8 |
| 6 | Enterprise Management System | $944,300 | $0 | N/A |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of Indoor Air Quality (IAQ) Improvements- American History HS | $175,000 | $0 | N/A |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Cleveland Elementary School | $50,671 | $0 | N/A |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Dr. E. Alma Flagg School | $749,765 | $0 | N/A |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Gym H&V Refurb - Luis Muñoz Marin School | $19,400 | $596 | 32.6 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Package Unit Replacement - Luis Muñoz Marin School | $95,318 | $738 | 129.1 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Avon Avenue Elementary School | $175,786 | $2,111 | 83.3 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Harold Wilson | $749,765 | $0 | N/A |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Louise A. Spencer School | $47,600 | $859 | 55.4 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Auditorium HVAC Upgrades - University High School | $588,000 | $811 | 725.3 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Kitchen-Café – University High School | $150,071 | $0 | N/A |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Camden Street School | $90,000 | $1,482 | 60.7 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Ivy Hill Elementary School | $32,365 | $726 | 44.6 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Penthouse RTU Replacement - East Side High School | $130,259 | $0 | N/A |

| ID # | Energy Conservation Measure | ECM Hard Cost | Year 1 Utility Savings* | Simple Payback |
|---|---|---|---|---|
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Dr. William H. Horton School | $557,882 | $5,840 | 95.5 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Luis Muñoz Marin School | $69,729 | $1,135 | 61.4 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Hawthorne Avenue School | $297,812 | $2,635 | 113.0 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Bard Early College High School | $165,470 | $1,124 | 147.2 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Early Childhood Center - West | $979,059 | $9,227 | 106.1 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Mount Vernon School | $112,835 | $2,307 | 48.9 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - South 17th Street School | $668,824 | $8,308 | 80.5 |
| 9 | Chiller Replacement - Gladys Hillman-Jones Middle School | $420,129 | $5,457 | 77.0 |
| 9 | Chiller Replacement - Belmont Runyon School | $637,071 | $6,116 | 104.2 |
| 9 | Chiller Replacement - Louise A. Spencer School | $450,365 | $1,551 | 290.3 |
| 9 | Chiller Replacement - Harold Wilson | $425,071 | $3,006 | 141.4 |
| 9 | Chiller Replacement - Dr. E. Alma Flagg School - Savings Only | $0 | $3,494 | 0.0 |
| 10 | Boiler Replacement - East Side High School | $2,024,471 | $10,172 | 199.0 |
| 10 | Boiler Replacement - Lafayette Street School | $1,219,765 | $23,653 | 51.6 |
| 10 | Boiler Replacement - Salomé Ureña Elementary School | $1,222,118 | $1,537 | 795.4 |
| 10 | Boiler Replacement - Roberto Clemente Elementary School | $1,166,824 | $1,125 | 1,037.5 |
| 10 | Boiler Replacement - Benjamin Franklin School | $1,219,765 | $1,969 | 619.3 |
| 10 | Boiler Replacement - Chancellor Avenue School | $1,083,882 | $6,154 | 176.1 |
| 10 | Boiler Replacement - Harold Wilson | $667,882 | $30,727 | 21.7 |
| 10 | Boiler Replacement - Dr. E. Alma Flagg School | $676,882 | $31,143 | 21.7 |
| 10 | Boiler Replacement - Louise A. Spencer School | $1,203,882 | $6,252 | 192.6 |
| 10 | Boiler Replacement - University High School | $2,128,000 | $10,808 | 196.9 |
| 10 | Boiler Replacement - Harriet Tubman School | $565,647 | $1,448 | 390.8 |
| 10 | Boiler Replacement – McKinley Elementary School | $1,033,882 | $7,248 | 142.6 |
| 10 | Boiler Replacement - Abington Avenue - Savings Only | $0 | $827 | 0.0 |
| 10 | Boiler Replacement - Reimburse Newark Vocational High School | $1,100,000 | $13,927 | 79.0 |
| 11 | Convert Steam Boiler to Hot Water Boiler - Gladys Hillman-Jones Middle School | $986,824 | $9,110 | 108.3 |
| 12 | Boiler Burner Upgrades - Early Childhood Center - South | $130,800 | $634 | 206.5 |
| 12 | Boiler Burner Upgrades - Peshine Avenue School | $80,918 | $2,591 | 31.2 |
| 12 | Boiler Burner Upgrades - Mount Vernon School | $165,153 | $0 | N/A |
| 12 | Boiler Burner Upgrades - South 17th Street School | $156,682 | $1,829 | 85.7 |
| 13 | Decommission Boilers - Thirteenth Avenue School | $39,953 | $8,441 | 4.7 |
| 14 | Pool Upgrades - Early Childhood Center - South | $170,123 | $0 | N/A |
| 14 | Pool Upgrades - John F. Kennedy School | $153,565 | $0 | N/A |

| ID # | Energy Conservation Measure | ECM Hard Cost | Year 1 Utility Savings* | Simple Payback |
|---|---|---|---|---|
| 15 | Steam Trap Replacement | $2,949,864 | $270,992 | 10.9 |
| 16 | Variable Speed Drives on Pumps | $481,092 | $29,205 | 16.5 |
| 17 | Premium Efficiency Motors | $330,765 | $22,310 | 14.8 |
| 18 | Energy-Efficient Transformers - First Avenue School | $62,376 | $4,027 | 15.5 |
| 18 | Energy-Efficient Transformers - Gladys Hillman-Jones Middle School | $78,006 | $5,934 | 13.1 |
| 18 | Energy-Efficient Transformers - Rafael Hernandez Elementary School | $5,643 | $296 | 19.1 |
| 18 | Energy-Efficient Transformers - Belmont Runyon School | $59,606 | $4,088 | 14.6 |
| 18 | Energy-Efficient Transformers - NJ Regional Day School | $21,749 | $1,372 | 15.9 |
| 19 | Combined Heat and Power – East Side High School and Science Park High School | $566,134 | $13,118 | 43.2 |
| 20 | Aris Wind Turbine | $34,000 | $0 | N/A |
| 21 | Solar Power Purchase Agreement - Roofs through Combo PPA and ESIP | $0 | $1,950,659 | 0.0 |
| 22 | Roof Upgrades - Roofs through Combo PPA and ESIP | $7,567,649 | $11,138 | 679.4 |
| 23 | Walk-in Refrigerator/Freezer Evaporator Fan Controls | $63,000 | $8,907 | 7.1 |
| 24 | Kitchen Hood Exhaust Fan Control | $216,050 | $14,316 | 15.1 |
| 25 | Plug Load Controls | $209,208 | $34,780 | 6.0 |
| 26 | Pay for Performance Rebate Application Development | $262,500 | $0 | N/A |
| 27 | Student Engagement and Teacher Professional Development Programs - DW | $0 | $0 | N/A |
| 28 | HVAC Training Center | $0 | $0 | N/A |
| **Total** | | **$75,685,935** | **$5,298,730** | **14.3** |

*Year 1 utility savings in the above table include a 2.2% escalation on electric, water and oil utilities and 2.4% escalation on natural gas for guaranteed savings. Because utility baseline data from 2019 was used and coupled with a 30 month construction period, utility rate escalation has been applied starting at the beginning of the construction period. The construction period is anticipated to begin late in calendar year 2021.

## Operational Savings Estimates

The lighting retrofits recommended for this project will reduce the amount of lamps that need to be replaced each year due to the longer lasting lamps and new technology fixtures. The LED lighting recommended for the exterior fixtures will last much longer than the current lighting and will generate material cost savings.

A brief description of the operational savings estimated for this project is included below. Johnson Controls has worked with the school district to quantify the exact sources of savings by going through past invoices and expenses. The operational savings will not be escalated.

**Operational Savings for Financial Model**

| ECM Description | Annual Savings | Years to Carry |
|---|---|---|
| Lighting LED and Lens Upgrades | $268,498 | 5 |
| Building Controls Upgrades | $237,000 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of Indoor Air Quality (IAQ) Improvements- American History HS | $1,500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Cleveland Elementary School | $1,500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Dr. E. Alma Flagg School | $5,000 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Gym H&V Refurb - Luis Muñoz Marin School | $500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Package Unit Replacement - Luis Muñoz Marin School | $500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Avon Avenue Elementary School | $750 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Harold Wilson | $5,000 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Louise A. Spencer School | $1,500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Auditorium HVAC Upgrades - University High School | $1,500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Kitchen-Café AHU - University High School | $500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Camden Street School | $750 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Ivy Hill Elementary School | $500 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Penthouse RTU Replacement - East Side High School | $500 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Dr. William H. Horton School | $750 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Luis Muñoz Marin School | $500 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Hawthorne Avenue School | $750 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Bard Early College High School | $500 | 2 |

| ECM Description | Annual Savings | Years to Carry |
|---|---|---|
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Early Childhood Center - West | $1,000 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Mount Vernon School | $500 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - South 17th Street School | $750 | 2 |
| Chiller Replacement - Gladys Hillman-Jones Middle School | $3,800 | 2 |
| Chiller Replacement - Belmont Runyon School | $3,800 | 2 |
| Chiller Replacement - Louise A. Spencer School | $3,800 | 2 |
| Chiller Replacement - Harold Wilson | $3,500 | 2 |
| Boiler Replacement - East Side High School | $7,000 | 2 |
| Boiler Replacement - Lafayette Street School | $3,500 | 2 |
| Boiler Replacement - Salomé Ureña Elementary School | $3,500 | 2 |
| Boiler Replacement - Roberto Clemente Elementary School | $3,500 | 2 |
| Boiler Replacement - Benjamin Franklin School | $3,500 | 2 |
| Boiler Replacement - Chancellor Avenue School | $3,500 | 2 |
| Boiler Replacement - Harold Wilson | $2,000 | 2 |
| Boiler Replacement - Dr. E. Alma Flagg School | $2,000 | 2 |
| Boiler Replacement - Louise A. Spencer School | $3,500 | 2 |
| Boiler Replacement - University High School | $7,000 | 2 |
| Boiler Replacement - Harriet Tubman School | $1,500 | 2 |
| Boiler Replacement – McKinley Elementary School | $7,500 | 2 |
| Boiler Replacement - Abington Avenue - Savings Only | $2,000 | 2 |
| Convert Steam Boiler to Hot Water Boiler - Gladys Hillman-Jones Middle School | $5,000 | 2 |
| Boiler Burner Upgrades - Early Childhood Center - South | $1,000 | 2 |
| Boiler Burner Upgrades - Peshine Avenue School | $1,000 | 2 |
| Boiler Burner Upgrades - Mount Vernon School | $1,000 | 2 |
| Boiler Burner Upgrades - South 17th Street School | $1,000 | 2 |
| Steam Trap Replacement | $25,000 | 2 |
| **Total** | **$629,148** | |

# Potential Revenue Generation Estimates

## Rebates

As part of the ESP for the Newark Public Schools, several avenues for obtaining rebates and incentives have been investigated which include:

### SmartStart Incentives

New Jersey SmartStart Buildings is a statewide energy efficiency program available to qualified K-12 customers planning to construct, expand, renovate, or remodel a facility, or to replace electric or gas equipment. Incentives are available for prescriptive measures or for custom measures that are selected and incorporated into the project to help offset the added cost to purchase qualifying energy-efficient equipment.

| Incentive Type | Estimated Amount |
|---|---|
| Lighting Retrofits | $189,545 |
| Rooftop Unit Replacements | $22,538 |
| Boiler Replacements | $63,370 |
| **Total** | **$275,453** |

### Pay for Performance

| Building | Incentive #1* | Incentive #2 | Incentive #3** | Total |
|---|---|---|---|---|
| Bard Early College High School | $11,487 | $132,997 | $0 | $144,484 |
| Belmont Runyon School | $8,920 | $107,771 | $0 | $116,691 |
| Dr. E. Alma Flagg School | $5,655 | $128,839 | $0 | $134,494 |
| Early Childhood Center - Central | $2,916 | $51,805 | $0 | $54,721 |
| East Side High School | $22,676 | $165,353 | $0 | $188,029 |
| First Avenue School | $14,132 | $158,485 | $0 | $172,617 |
| Harold Wilson School | $5,501 | $77,315 | $0 | $82,816 |
| Louise A. Spencer School | $14,414 | $161,669 | $0 | $176,083 |
| Luis Muñoz Marin School | $14,351 | $152,091 | $0 | $166,442 |
| McKinley Elementary School | $11,171 | $142,649 | $0 | $153,820 |
| NJ Regional Day School | $1,629 | $39,677 | $0 | $41,306 |
| Rafael Hernandez Elementary School | $8,458 | $67,979 | $0 | $76,437 |
| Science Park High School | $20,681 | $239,178 | $0 | $259,859 |
| West Side High School | $10,913 | $107,961 | $0 | $118,874 |
| TOTAL | **$152,904** | **$1,733,771** | **$0** | **$1,886,675** |

* Incentive #1 accounts for participation in LGEA.

** Because of the uncertainty with approval of Incentive #3, the value is not included in the project financials; however, at the appropriate time, if the system meets the performance thresholds outlined in the program guidelines, Johnson Controls will apply for the incentive.

### Combined Heat and Power

Incentives are available for CHP/Cogeneration systems with heat recovery and productive use of waste heat that are located on-site. Cogeneration units that are powered by natural gas and under 500kW, as in the case of the systems recommended for Newark, are eligible for an incentive of up to $2.00/watt.

The CHP incentive is paid in three increments as outlined below:

- 30% of the incentive upon proof of equipment purchase (Incentive #1)
- 50% upon project completion and verification of installation (Incentive #2)
- Remainder 20% upon acceptance and confirmation the project is achieving the required performance thresholds based on 12 months of operating data (Incentive #3)

| Building | Estimated Incentive #1 | Estimated Incentive #2 | Estimated Incentive #3* | Estimated Total |
|---|---|---|---|---|
| Science Park High School | $21,000 | $35,000 | $0 | $56,000 |
| East Side High School | $21,000 | $35,000 | $0 | $56,000 |
| **Total** | **$42,000** | **$70,000** | **$0** | **$112,000** |

* Because of the uncertainty with approval of Incentive #3, the value is not included in the project financials; however, at the appropriate time, if the system meets the performance thresholds outlined in the program guidelines, Johnson Controls will apply for the incentive.

**Due to inability to control available incentive programs- Johnson Controls does not guarantee any rebates carried in this project.**

## Greenhouse Gas Reductions

| Avoided Emissions | Total Electric Savings (kWh) | Total Natural Savings (therm) | Total Fuel Oil Savings (Gallon) | Total Annual Avoided Emissions |
|---|---|---|---|---|
| Annual Unit Savings | 13,165,944 | 1,561,864 | 20,346 | - |
| NOx, lb | 14,614 | 14,369 | 287 | 29,270 |
| $SO_2$, lb | 12,903 | 0 | 0 | 12,903 |
| $CO_2$, lb | 18,090,007 | 18,273,809 | 365,460 | 36,729,276 |

Factors used in calculations:

- 1,374 lbs. $CO_2$ per MWh saved
- 1.11 lbs. $NO_x$ per MWh saved
- 0.98 lbs. $SO_2$ per MWh saved
- 11.7 lbs. $CO_2$ per therm saved
- 0.0092 lbs. $NO_x$ per therm saved
- 17.96 lb $CO_2$ per gallon saved
- 0.0141 lb. NOx per gallon saved

## Baseline Utility Savings

### Electric Utility Savings

| ID# | Energy Conservation Measure | Electric Consumption | | Annual Electric Demand | | Total Year 1 Electric |
|---|---|---|---|---|---|---|
| | | Dollars | kWh | Dollars | kW | Dollars |
| 1 | Lighting LED and Lens Upgrades | $926,689 | 8,176,130 | $250,915 | 31,486 | $1,177,604 |
| 2 | Weather Stripping & Air Sealing | $54,178 | 462,475 | $- | - | $ 54,178 |
| 5 | Building Controls Upgrades | $206,423 | 2,145,733 | $- | - | $206,423 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of Indoor Air Quality (IAQ) Improvements- Louise A. Spencer School | $479 | 4,802 | $140 | 17 | $619 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Ivy Hill Elementary School | $604 | 5,037 | $122 | 29 | $726 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Dr. William H. Horton School | $4,533 | 41,810 | $485 | 115 | $5,018 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Luis Muñoz Marin School | $856 | 8,223 | $279 | 35 | $1,135 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Hawthorne Avenue School | $2,354 | 18,854 | $281 | 67 | $2,635 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Bard Early College High School | $845 | 8,530 | $279 | 35 | $1,124 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Early Childhood Center - West | $6,620 | 43,590 | $1,278 | 304 | $7,898 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Mount Vernon School | $1,913 | 18,078 | $394 | 49 | $2,307 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - South 17th Street School | $6,980 | 55,388 | $532 | 127 | $7,512 |
| 9 | Chiller Replacement - Gladys Hillman-Jones Middle School | $5,457 | 34,875 | $- | - | $5,457 |
| 9 | Chiller Replacement - Belmont Runyon School | $2,815 | 23,198 | $3,301 | 408 | $6,116 |
| 9 | Chiller Replacement - Louise A. Spencer School | $639 | 6,406 | $912 | 113 | $1,551 |
| 9 | Chiller Replacement - Harold Wilson | $1,182 | 12,812 | $1,824 | 225 | $3,006 |
| 9 | Chiller Replacement - Dr. E. Alma Flagg School - Savings Only | $1,349 | 15,073 | $2,145 | 265 | $3,494 |
| 10 | Boiler Replacement - Harold Wilson | $36,793 | 398,602 | $8,042 | 994 | $44,835 |
| 10 | Boiler Replacement - Dr. E. Alma Flagg School | $38,201 | 426,772 | $8,042 | 994 | $46,243 |

| ID# | Energy Conservation Measure | Electric Consumption | | Annual Electric Demand | | Total Year 1 Electric |
|---|---|---|---|---|---|---|
| | | Dollars | kWh | Dollars | kW | Dollars |
| 16 | Variable Speed Drives on Pumps | $29,205 | 256,911 | $- | - | $29,205 |
| 17 | Premium Efficiency Motors | $22,310 | 170,471 | $- | - | $22,310 |
| 18 | Energy-Efficient Transformers - First Avenue School | $4,027 | 41,461 | $- | - | $4,027 |
| 18 | Energy-Efficient Transformers - Gladys Hillman-Jones Middle School | $5,934 | 45,818 | $- | - | $5,934 |
| 18 | Energy-Efficient Transformers - Rafael Hernandez Elementary School | $296 | 3,919 | $- | - | $296 |
| 18 | Energy-Efficient Transformers - Belmont Runyon School | $4,088 | 34,433 | $- | - | $4,088 |
| 18 | Energy-Efficient Transformers - NJ Regional Day School | $1,372 | 14,127 | $- | - | $1,372 |
| 19 | Combined Heat and Power – East Side High School and Science Park High School | $23,597 | 213,744 | $- | - | $23,597 |
| 21 | Solar Power Purchase Agreement - Roofs through Combo PPA and ESIP | $1,950,659 | - | $- | - | $1,950,659 |
| 23 | Walk-in Refrigerator/Freezer Evaporator Fan Controls | $8,907 | - | $- | - | $8,907 |
| 24 | Kitchen Hood Exhaust Fan Control | $14,316 | 120,590 | $- | - | $14,316 |
| 25 | Plug Load Controls | $34,780 | 358,083 | $- | - | $34,780 |
| | Total | $3,398,400 | 13,165,944 | $278,972 | 35,260 | $3,677,372 |

## Fossil Fuel Utility Savings

| ID# | Energy Conservation Measure | Natural Gas | | #2 Oil | | Total Year 1 Thermal Savings |
|---|---|---|---|---|---|---|
| | | Dollars | therms | Dollars | gal | Dollars |
| 1 | Lighting LED and Lens Upgrades | $(8,945) | (10,290) | $- | - | $(8,945) |
| 2 | Weather Stripping & Air Sealing | $131,091 | 285,100 | $- | - | $131,091 |
| 3 | Pipe & Valve Insulation | $109,552 | 132,608 | $- | - | $109,552 |
| 4 | Water Conservation | $18,521 | 20,938 | $- | - | $18,521 |
| 5 | Building Controls Upgrades | $684,693 | 818,298 | $- | - | $684,693 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of Indoor Air Quality (IAQ) Improvements- Gym H&V Refurb - Luis Muñoz Marin School | $596 | 745 | $- | - | $596 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Package Unit Replacement - Luis Muñoz Marin School | $738 | 923 | $- | - | $738 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Avon Avenue Elementary School | $2,111 | 2,638 | $- | - | $2,111 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Louise A. Spencer School | $241 | 285 | $- | - | $241 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Auditorium HVAC Upgrades - University High School | $811 | 938 | $- | - | $811 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Camden Street School | $1,482 | 1,852 | $- | - | $1,482 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Dr. William H. Horton School | $822 | 935 | $- | - | $822 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Early Childhood Center - West | $1,329 | 1,426 | $- | - | $1,329 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Mount Vernon School | $- | - | $- | - | $- |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - South 17th Street School | $796 | 975 | $- | - | $796 |
| 10 | Boiler Replacement - East Side High School | $10,172 | 11,810 | $- | - | $10,172 |
| 10 | Boiler Replacement - Lafayette Street School | $(21,109) | (2,403) | $44,762 | 18,853 | $23,653 |
| 10 | Boiler Replacement - Salomé Ureña Elementary School | $1,537 | 1,751 | $- | - | $1,537 |
| 10 | Boiler Replacement - Roberto Clemente Elementary School | $1,125 | 1,309 | $- | - | $1,125 |

| ID# | Energy Conservation Measure | Natural Gas | | #2 Oil | | Total Year 1 Thermal Savings |
|---|---|---|---|---|---|---|
| | | Dollars | therms | Dollars | gal | Dollars |
| 10 | Boiler Replacement - Benjamin Franklin School | $1,969 | 2,471 | $- | - | $1,969 |
| 10 | Boiler Replacement - Chancellor Avenue School | $6,154 | 6,293 | $- | - | $6,154 |
| 10 | Boiler Replacement - Harold Wilson | $(14,108) | (16,045) | $- | - | $(14,108) |
| 10 | Boiler Replacement - Dr. E. Alma Flagg School | $(15,099) | (17,186) | $- | - | $(15,099) |
| 10 | Boiler Replacement - Louise A. Spencer School | $6,252 | 7,462 | $- | - | $6,252 |
| 10 | Boiler Replacement - University High School | $10,808 | 12,540 | $- | - | $10,808 |
| 10 | Boiler Replacement - Harriet Tubman School | $1,448 | 1,481 | $- | - | $1,448 |
| 10 | Boiler Replacement – McKinley Elementary School | $7,248 | 9,060 | $- | - | $7,248 |
| 10 | Boiler Replacement - Abington Avenue - Savings Only | $827 | 930 | $- | - | $827 |
| 10 | Boiler Replacement - Reimburse Newark Vocational High School | $13,927 | 15,905 | $- | - | $13,927 |
| 11 | Convert Steam Boiler to Hot Water Boiler - Gladys Hillman-Jones Middle School | $9,110 | 9,357 | $- | - | $9,110 |
| 12 | Boiler Burner Upgrades - Early Childhood Center - South | $634 | 740 | $- | - | $634 |
| 12 | Boiler Burner Upgrades - Peshine Avenue School | $2,591 | 3,060 | $- | - | $2,591 |
| 12 | Boiler Burner Upgrades - Mount Vernon School | $- | - | $- | - | $- |
| 12 | Boiler Burner Upgrades - South 17th Street School | $1,829 | 2,230 | $- | - | $1,829 |
| 13 | Decommission Boilers - Thirteenth Avenue School | $8,441 | 10,551 | $- | - | $8,441 |
| 15 | Steam Trap Replacement | $270,992 | 241,646 | $- | - | $270,992 |
| 19 | Combined Heat and Power – East Side High School and Science Park High School | ($10,479) | (12,391) | $- | - | $(10,479) |
| 22 | Roof Upgrades - Roofs through Combo PPA and ESIP | $11,138 | 13,922 | $- | - | $11,138 |
| | **Total** | **$1,249,240** | **1,561,864** | **$44,762** | **20,346** | **$326,683** |

## Water/Sewer Utility Savings

| ID# | Energy Conservation Measure | Water and Sewer | | Total Year 1 Savings |
|---|---|---|---|---|
| | | Dollars | kgal | Dollars |
| 4 | Water Conservation | $327,356 | 29,933,798 | $327,356 |

# Business Case for Recommended Project

**JCI's ENERGY SAVINGS PLAN (ESP) for NEWARK PUBLIC SCHOOLS**
**JCI's CASH FLOW ANALYSIS FORM**
**NEWARK BOARD OF EDUCATION - ENERGY SAVINGS IMPROVEMENT PROGRAM**

ESCO NAME: **Johnson Controls**

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, 2.2% electric, oil and water & sewer per year**; and

1. Term of Agreement: 20 **years (240 Months)**
2. Construction Period [(2)] (months): 30 **months**
3. Cash Flow Analysis Format:

**Project Cost [(1)] : $96,416,313**
**Cost of Issuance : $1,750,000**
**Financed Amount : $98,166,313**

Interest Rate to Be Used for Proposal Purposes: 2.25%

| Year | Annual Energy Savings | Annual Solar PPA Savings | Annual Operational Savings | Energy Rebates/ Incentives | Total Annual Savings | Annual Project Costs | Board Costs | Annual Service Costs [(3)] | Net Cash Flow to Client | Cumulative Cash Flow |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| Installlation | $133,368 | | | | $133,368 | | | | | |
| Installlation | $1,936,387 | | | | $1,936,387 | | | | | |
| Installlation | $2,471,616 | | | | $2,471,616 | | | | | |
| 1 | $3,348,071 | $1,950,659 | $629,148 | $424,678 | $6,352,556 | $10,653,149 | $10,869,927 | $216,778 | $24,000 | $24,000 |
| 2 | $3,424,200 | $2,033,271 | $629,148 | $1,849,449 | $7,936,068 | $7,695,290 | $7,912,068 | $216,778 | $24,000 | $48,000 |
| 3 | $3,502,064 | $2,070,790 | $268,498 | $0 | $5,841,353 | $5,600,574 | $5,817,353 | $216,778 | $24,000 | $72,000 |
| 4 | $3,581,701 | $2,108,785 | $268,498 | $0 | $5,958,985 | $5,934,985 | $5,934,985 | | $24,000 | $96,000 |
| 5 | $3,663,152 | $2,147,262 | $268,498 | $0 | $6,078,913 | $6,054,913 | $6,054,913 | | $24,000 | $120,000 |
| 6 | $3,746,460 | $2,186,229 | | | $5,932,689 | $5,908,689 | $5,908,689 | | $24,000 | $144,000 |
| 7 | $3,831,665 | $2,225,693 | | | $6,057,358 | $6,033,358 | $6,033,358 | | $24,000 | $168,000 |
| 8 | $3,918,811 | $2,265,662 | | | $6,184,473 | $6,160,473 | $6,160,473 | | $24,000 | $192,000 |
| 9 | $4,007,943 | $2,306,143 | | | $6,314,086 | $6,290,086 | $6,290,086 | | $24,000 | $216,000 |
| 10 | $4,099,106 | $2,347,145 | | | $6,446,250 | $6,422,250 | $6,422,250 | | $24,000 | $240,000 |
| 11 | $4,192,346 | $2,388,674 | | | $6,581,020 | $6,557,020 | $6,557,020 | | $24,000 | $264,000 |
| 12 | $4,287,711 | $2,430,740 | | | $6,718,451 | $6,694,451 | $6,694,451 | | $24,000 | $288,000 |
| 13 | $4,385,249 | $2,473,350 | | | $6,858,600 | $6,834,600 | $6,834,600 | | $24,000 | $312,000 |
| 14 | $4,485,010 | $2,516,513 | | | $7,001,523 | $6,977,523 | $6,977,523 | | $24,000 | $336,000 |
| 15 | $4,587,045 | $2,560,237 | | | $7,147,282 | $7,123,282 | $7,123,282 | | $24,000 | $360,000 |
| 16 | $4,691,405 | | | | $4,691,405 | $4,667,405 | $4,667,405 | | $24,000 | $384,000 |
| 17 | $4,798,143 | | | | $4,798,143 | $4,774,143 | $4,774,143 | | $24,000 | $408,000 |
| 18 | $4,907,315 | | | | $4,907,315 | $4,883,315 | $4,883,315 | | $24,000 | $432,000 |
| 19 | $5,018,975 | | | | $5,018,975 | $4,994,975 | $4,994,975 | | $24,000 | $456,000 |
| 20 | $5,133,181 | | | | $5,133,181 | $5,053,866 | $5,053,866 | | $79,315 | $535,315 |
| **Totals** | $88,150,924 | $34,011,154 | $2,063,792 | $2,274,127 | $126,499,997 | $125,314,347 | $125,964,682 | $650,335 | $535,315 | |

**NOTES:**

**(1) Includes: Hard costs and project service fees defined in ESCO's PROPOSED "FORM V"**

**(2) No payments are made by Board during the construction period**

**(3) This figure should equal the value indicated on the ESCOs PROPOSED "FORM V". DO NOT include in the Financed Project Costs.**

# Section 4. Energy Conservation Measures

- ECM 1: Lighting – Interior and Exterior Fixture Retrofit and Lens Replacement Program
- ECM 2: Weather Stripping & Air Sealing
- ECM 3: Pipe & Valve Insulation
- ECM 4: Water Conservation
- ECM 5: Building Controls Upgrades
- ECM 6: Enterprise Management System
- ECM 7: Install / Replace Air-Handling Units and Package Units with Addition of Indoor Air Quality Improvements
- ECM 8: Install / Replace Rooftop Units with Addition of Indoor Air Quality Improvements
- ECM 9: Chiller Replacements
- ECM 10: Boiler Replacement
- ECM 11: Replace Steam Boilers with Hot Water Boilers and Eliminate Steam-to-Hot Water Heat Exchanger
- ECM 12: Boiler Burner Upgrades
- ECM 13: Decommission Boilers
- ECM 14: Pool Upgrades
- ECM 15. Steam Trap Replacement
- ECM 16: Variable Speed Drives on Pumps
- ECM 17: Premium Efficiency Motors
- ECM 18: Energy-Efficient Transformers
- ECM 19: Combined Heat and Power
- ECM 20: Aris Wind Turbine
- ECM 21: Solar PV- Power Purchase Agreement
- ECM 22: Roof Upgrades
- ECM 23: Walk-In Refrigerator/Freezer Evaporator Fan Controls
- ECM 24: Kitchen Hood Controls
- ECM 25: Plug Load Controls
- ECM 26: Pay for Performance (P4P) Rebate
- ECM 27: Student Engagement and Teacher Professional Development Program
- ECM 28: HVAC Training Center

| ECM No. | Energy Conservation Measure | District Wide | East/ Central Region | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | American History High School | Ann Street School | Central High School | Cleveland Elementary School | Early Childhood Center - Central | East Side High School | East Ward Elementary School | Hawkins Street School | Lafayette Street School | Newark Vocational High School | Oliver Street School | Quitman Street School | Science Park High School | Sir Isaac Newton Elementary School | Sussex Avenue School | Wilson Avenue School | Wilson ECC (Alyea St) | New South Street |
| 1 | Lighting LED and Lens Upgrades via Direct Install | | ✓ | | | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | | |
| 1 | Lighting LED and Lens Upgrades | | | | ✓ | | ✓ | ✓ | | | | | ✓ | | ✓ | | | | ✓ | |
| 2 | Weather Stripping & Air Sealing | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 3 | Pipe & Valve Insulation | | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 4 | Water Conservation | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 5 | Building Controls Upgrades | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 6 | Enterprise Management System | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 7 | Install / Replace Air-Handling Units and Package Units | | ✓ | | | ✓ | | | | | | | | | | | | | | |
| 8 | Install / Replace Rooftop Units | | | | | | | ✓ | | | | | | | | | | | | |
| 9 | Chiller Replacement | | | | | | | | | | | | | | | | | | | |
| 10 | Boiler Replacement | | | | | | | ✓ | | | ✓ | | | | | | | | | |
| 11 | Convert Steam Boiler to Hot Water System | | | | | | | | | | | | | | | | | | | |
| 12 | Boiler Burner Upgrades | | | | | | | | | | | | | | | | | | | |
| 13 | Decommission Boiler and Install New Kettles | | | | | | | | | | | | | | | | | | | |
| 14 | Pool Upgrades | | | | | | | | | | | | | | | | | | | |
| 15 | Steam Trap Replacement | | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | |
| 16 | Variable Speed Drives on Pumps | | ✓ | | | | | ✓ | | | | | | | | | | | | |
| 17 | Premium Efficiency Motors | | ✓ | | | | | ✓ | | | | | | | | | | | | |
| 18 | Energy Efficient Transformers | | | | | | | | | | | | | | | | | | | |
| 19 | Combined Heat and Power - 35 kW CHP | | | | | | | ✓ | | | | | | | ✓ | | | | | |
| 20 | Aris Wind Turbine | | | | | | | | | | | | | | | | | | | |
| 21 | Solar Power Purchase Agreement - Roofs through Combo PPA and ESIP | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| 22 | Roof Upgrades - Roofs through Combo PPA and ESIP | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| 23 | Walk-in Refrigerator/Freezer Evaporator Fan Controls | | ✓ | | ✓ | | ✓ | ✓ | | | | | | | ✓ | | | | | |
| 24 | Kitchen Hood Exhaust Fan Control | | ✓ | | ✓ | | ✓ | ✓ | | | | | | | ✓ | | | | | |
| 25 | Plug Load Controls | | ✓ | ✓ | | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 26 | Pay for Performance Rebate Application Development | | | | | | ✓ | ✓ | | | | | | | ✓ | | | | | |
| 27 | Student Engagement and Teacher Professional Development Programs - DW | | | | | | | | | | | | | | | | | | | |
| 28 | HVAC Training Center - DW | TBD | | | | | | | | | | | | | | | | | | |
| | Total Energy Conservation Measures | | 15 | 7 | 8 | 11 | 11 | 18 | 9 | 9 | 10 | 8 | 9 | 9 | 13 | 10 | 10 | 10 | 8 | 4 |

| ECM No. | Energy Conservation Measure | North Region | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dr. E. Alma Flagg School | Dr. William H. Horton School | First Avenue School | Ridge Street ECC | Salomé Ureña Elementary School | Newark Schools Stadium | Gladys Hillman Jones School | Elliott Street School | Park Elementary School | Rafael Hernandez Elementary School | Ridge Street School | Roberto Clemente Elementary School | Abington Avenue School | Benjamin Franklin School | Branch Brook School | Dr. Marion A. Bolden Student Center | McKinley Elementary School | Luis Muñoz Marin School |
| 1 | Lighting LED and Lens Upgrades via Direct Install | | ✓ | | | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | | | | |
| 1 | Lighting LED and Lens Upgrades | ✓ | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ |
| 2 | Weather Stripping & Air Sealing | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 3 | Pipe & Valve Insulation | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 4 | Water Conservation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 5 | Building Controls Upgrades | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 6 | Enterprise Management System | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 7 | Install / Replace Air-Handling Units and Package Units | ✓ | | | | | | | | | | | | | | | | | ✓ |
| 8 | Install / Replace Rooftop Units | | ✓ | | | | | | | | | | | | | | | | ✓ |
| 9 | Chiller Replacement | | | | | | | ✓ | | | | | | | | | | | |
| 10 | Boiler Replacement | ✓ | | | | ✓ | | | | | | | ✓ | | ✓ | | | ✓ | |
| 11 | Convert Steam Boiler to Hot Water System | | | | | | | ✓ | | | | | | | | | | | |
| 12 | Boiler Burner Upgrades | | | | | | | | | | | | | | | | | | |
| 13 | Decommission Boiler and Install New Kettles | | | | | | | | | | | | | | | | | | |
| 14 | Pool Upgrades | | | | | | | | | | | | | | | | | | |
| 15 | Steam Trap Replacement | | | | ✓ | ✓ | | | | | | ✓ | | ✓ | ✓ | | | | ✓ |
| 16 | Variable Speed Drives on Pumps | | | | | | | ✓ | | | | | | | | | | | |
| 17 | Premium Efficiency Motors | ✓ | | | | | | ✓ | | | ✓ | | | | | | | | |
| 18 | Energy Efficient Transformers | | | ✓ | | | | ✓ | | | ✓ | | | | | | | | |
| 19 | Combined Heat and Power - 35 kW CHP | | | | | | | | | | | | | | | | | | |
| 20 | Aris Wind Turbine | | | | | | ✓ | | | | | | | | | | | | |
| 21 | Solar Power Purchase Agreement - Roofs through Combo PPA and ESIP | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 22 | Roof Upgrades - Roofs through Combo PPA and ESIP | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 23 | Walk-in Refrigerator/Freezer Evaporator Fan Controls | | | | | | | ✓ | | | | | | | | | | | |
| 24 | Kitchen Hood Exhaust Fan Control | | | | | | | ✓ | | | | | | | | | | | |
| 25 | Plug Load Controls | ✓ | ✓ | ✓ | | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| 26 | Pay for Performance Rebate Application Development | ✓ | | ✓ | | | | | | | ✓ | | | | | | | ✓ | ✓ |
| 27 | Student Engagement and Teacher Professional Development Programs - DW | | | | | | | | | | | | | | | | | | |
| 28 | HVAC Training Center - DW | | | | | | | | | | | | | | | | | | |
| | Total Energy Conservation Measures | 13 | 10 | 11 | 7 | 11 | 5 | 11 | 9 | 7 | 11 | 10 | 10 | 10 | 11 | 7 | 8 | 11 | 13 |

| ECM No. | Energy Conservation Measure | South Region | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Avon Avenue Elementary School | Belmont Runyon School | Bragaw Ave | Chancellor Avenue School | Early Childhood Center - South | Harold Wilson | Hawthorne Avenue School | Louise A. Spencer School | NJ Regional Day School | Peshine Avenue School | University High School |
| 1 | Lighting LED and Lens Upgrades via Direct Install | ✓ | | | ✓ | | | ✓ | | | ✓ | ✓ |
| 1 | Lighting LED and Lens Upgrades | | ✓ | | | ✓ | ✓ | | ✓ | ✓ | | |
| 2 | Weather Stripping & Air Sealing | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 3 | Pipe & Valve Insulation | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| 4 | Water Conservation | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 5 | Building Controls Upgrades | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 6 | Enterprise Management System | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 7 | Install / Replace Air-Handling Units and Package Units | ✓ | | | | | ✓ | | ✓ | | | ✓ |
| 8 | Install / Replace Rooftop Units | | | | | | | ✓ | | | | |
| 9 | Chiller Replacement | | ✓ | | | | ✓ | | ✓ | | | |
| 10 | Boiler Replacement | | | | ✓ | | ✓ | | ✓ | | | ✓ |
| 11 | Convert Steam Boiler to Hot Water System | | | | | | | | | | | |
| 12 | Boiler Burner Upgrades | | | | | ✓ | | | | | ✓ | |
| 13 | Decommission Boiler and Install New Kettles | | | | | | | | | | | |
| 14 | Pool Upgrades | | | | | ✓ | | | | | | |
| 15 | Steam Trap Replacement | ✓ | ✓ | | ✓ | ✓ | | ✓ | | | ✓ | ✓ |
| 16 | Variable Speed Drives on Pumps | | ✓ | | | | ✓ | | ✓ | | | |
| 17 | Premium Efficiency Motors | | ✓ | | | ✓ | ✓ | | | | | ✓ |
| 18 | Energy Efficient Transformers | | ✓ | | | | | | | ✓ | | |
| 19 | Combined Heat and Power - 35 kW CHP | | | | | | | | | | | |
| 20 | Aris Wind Turbine | | | | | | | | | | | |
| 21 | Solar Power Purchase Agreement - Roofs through Combo PPA and ESIP | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 22 | Roof Upgrades - Roofs through Combo PPA and ESIP | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 23 | Walk-in Refrigerator/Freezer Evaporator Fan Controls | | | | | | | | | | | ✓ |
| 24 | Kitchen Hood Exhaust Fan Control | | | | | | | | | | | ✓ |
| 25 | Plug Load Controls | ✓ | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ |
| 26 | Pay for Performance Rebate Application Development | | ✓ | | | | ✓ | | ✓ | ✓ | | |
| 27 | Student Engagement and Teacher Professional Development Programs - DW | | | | ✓ | | | | | | | |
| 28 | HVAC Training Center - DW | | | | | | | | | | | |
| | Total Energy Conservation Measures | 11 | 14 | 1 | 12 | 13 | 14 | 11 | 14 | 9 | 11 | 15 |

| ECM No. | Energy Conservation Measure | West Region | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Bard Early College High School | Camden Street School | Early Childhood Center - West | Fourteenth Avenue School | Harriet Tubman School | Ivy Hill Elementary School | John F. Kennedy School | Lincoln School | Mount Vernon School | South 17th Street School | Speedway Avenue | Thirteenth Avenue School | West Side High School |
| 1 | Lighting LED and Lens Upgrades via Direct Install | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | |
| 1 | Lighting LED and Lens Upgrades | ✓ | | | | | | | | ✓ | | ✓ | | ✓ |
| 2 | Weather Stripping & Air Sealing | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 3 | Pipe & Valve Insulation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 4 | Water Conservation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 5 | Building Controls Upgrades | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 6 | Enterprise Management System | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 7 | Install / Replace Air-Handling Units and Package Units | | ✓ | | | | | | | | | | | |
| 8 | Install / Replace Rooftop Units | ✓ | | ✓ | | | ✓ | | | ✓ | ✓ | | | |
| 9 | Chiller Replacement | | | | | | | | | | | | | |
| 10 | Boiler Replacement | | | | | ✓ | | | | | | | | |
| 11 | Convert Steam Boiler to Hot Water System | | | | | | | | | | | | | |
| 12 | Boiler Burner Upgrades | | | | | | | | | ✓ | ✓ | | | |
| 13 | Decommission Boiler and Install New Kettles | | | | | | | | | | | | ✓ | |
| 14 | Pool Upgrades | | | | | | | ✓ | | | | | | |
| 15 | Steam Trap Replacement | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | | |
| 16 | Variable Speed Drives on Pumps | ✓ | ✓ | | | | | ✓ | | | | | | ✓ |
| 17 | Premium Efficiency Motors | ✓ | | | | | | ✓ | | | | ✓ | ✓ | ✓ |
| 18 | Energy Efficient Transformers | | | | | | | | | | | | | |
| 19 | Combined Heat and Power - 35 kW CHP | | | | | | | | | | | | | |
| 20 | Aris Wind Turbine | | | | | | | | | | | | | |
| 21 | Solar Power Purchase Agreement - Roofs through Combo PPA and ESIP | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 22 | Roof Upgrades - Roofs through Combo PPA and ESIP | | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 23 | Walk-in Refrigerator/Freezer Evaporator Fan Controls | ✓ | | | | | | ✓ | | | | | | ✓ |
| 24 | Kitchen Hood Exhaust Fan Control | ✓ | | | | | | ✓ | | | | | | ✓ |
| 25 | Plug Load Controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 26 | Pay for Performance Rebate Application Development | ✓ | | | | | | | | | | | | ✓ |
| 27 | Student Engagement and Teacher Professional Development Programs - DW | | | | | | | | | | | | | |
| 28 | HVAC Training Center - DW | | | | | | | | | | | | | |
| | Total Energy Conservation Measures | 13 | 10 | 11 | 9 | 11 | 11 | 14 | 9 | 12 | 11 | 10 | 11 | 14 |

# ECM 1: Lighting – Interior and Exterior Fixture Retrofit and Lens Replacement Program

## ECM Summary

Lighting energy efficiency upgrades and occupancy sensors provide a substantial energy benefit and quality of light improvement. State-of-the-art LED lighting technology is now cost-effective, efficient and recommended for all light fixtures in the school district. LED technology can also allow efficient dimming which drives additional savings and extends the life of the LED investment.

School districts realize significant utility savings, reduced maintenance costs, and improved overall lighting systems performance, visual comfort and acuity. In addition to saving energy and reducing costs, the lighting upgrades will:

- Improve lighting quality through designs that meet or exceed current Illumination Engineering Society (IES) recommendations while addressing specific illumination requirements for task/area functions. The scope will provide a quality of light superior to what is currently installed.
- Be economically viable and meet the school district's financial requirements.
- Improve lighting inventory standardization for long-term maintenance improvements.
- Be environmentally sustainable via reduced greenhouse gas emissions and eliminate hazardous materials such as mercury in linear fluorescent and compact fluorescent lamps.

In an effort to reduce electricity consumption, we are proposing to retrofit the existing lighting system with newer energy-efficient technology. The lighting retrofit design incorporates the replacement of lamps and ballasts as well as the replacement of light fixtures when the fixture is in poor condition.

The scope will provide a quality of light superior to what is currently installed.

LED lighting systems exhibit the following characteristics:

- Extremely long-life – up to 50,000+ hours.
- Highly efficient with very low wattage consumption.
- Solid state lighting technology ensures that the fixtures are highly durable.

## Existing System

**Interior Lighting**

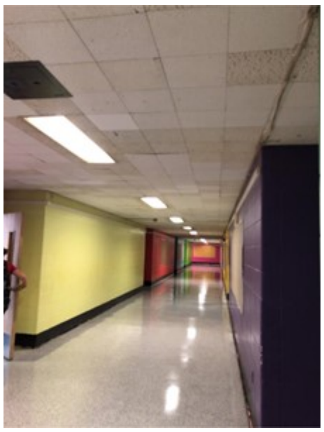
Johnson Controls has performed a preliminary survey of existing lighting systems at all the buildings within the scope of this ESIP. Existing lighting is primarily T8 fluorescent consisting of standard 4' lamps and normal ballast factor standard electronic ballasts. Some locations are good candidates for fixture modification to reduce the number of lamps while still maintaining proper light levels.

The classrooms, locker rooms, computer labs, and other spaces are equipped with fixtures that can be retrofit to more efficient LED applications. All exit signs within the building should be retrofitted with new LED fixtures where applicable.

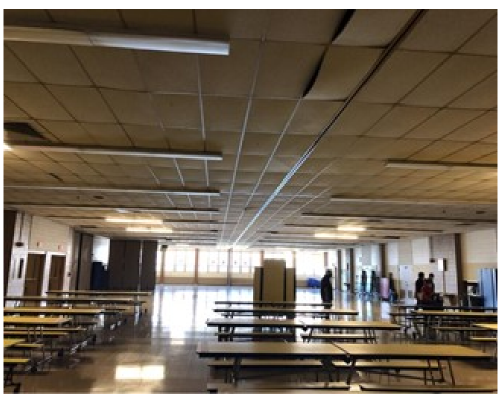
**Exterior Lighting**

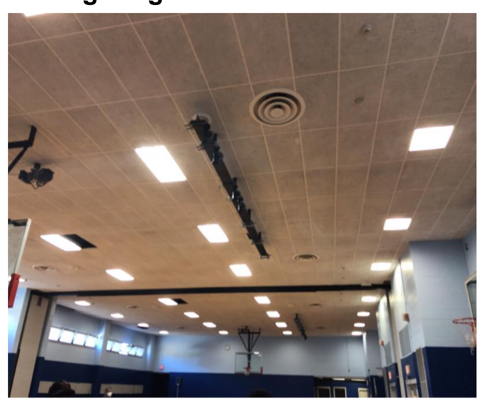
Johnson Controls has performed a preliminary survey of existing exterior lighting systems at the buildings within the scope of this ESIP. The exterior lighting is primarily wall packs, flood lights, shoebox, canopy and pole-mounted fixtures currently using outdated high wattage fixtures. Existing fixtures will be upgraded to low watt LED fixtures with advanced specular properties that deliver quality light, while also limiting light pollution.

**Existing Lighting in Classrooms and Gathering Areas**

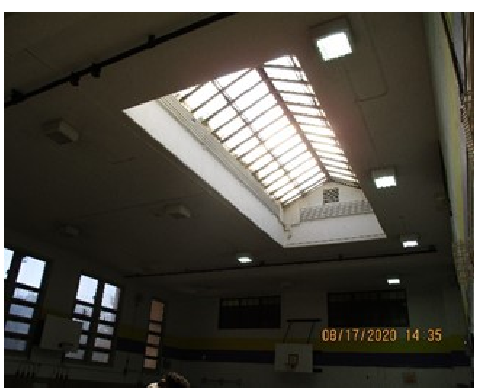


**Corridor and Classroom Lighting**





**Cafeteria and Gymnasium Lighting**




**Gymnasium with Skylight and Media Room**

## Proposed System

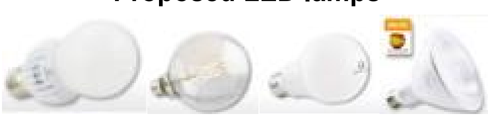
Lighting upgrades were developed using a combination of NJ's Office of Clean Energy Direct Install (DI) program and directly by Johnson Controls through the ESIP. The DI Partner for the project – Willdan – had their own team of auditors survey the buildings and create the scope, cost and savings according to the DI program rules. Rest assured, both the DI and the ESIP surveys identified opportunities for energy savings through the installation of new high-efficiency LED lighting by re-lamping the existing fixtures. A total of 29 schools are eligible through the DI program with a buy-down of approximately $1.4 million dollars for just the lighting scope of work. The goal is that all the buildings – those going through DI and the non-DI buildings – will have the same look and aesthetics at the completion of the project. The detailed scope of the lighting work can be found in the line-by-lines located in the Appendix for both the DI and non-DI buildings.

**Interior Lighting**

The primary upgrade and energy savings strategies for the interior of the buildings consist of the following categories.

- Older technology T8 lamps and U-Tube T8 lamps will be eliminated and new LED technology will be installed in its place using line-voltage tubes.
- Incandescent and compact fluorescent lamps (short life and less efficient) will be replaced with new long-life and highly efficient LED lamps.
- Existing gymnasium fixtures will be replaced with new LED high bay fixtures
- A budget for lens replacements has been included. The lens replacement program will be used to identify broken, yellowed and/or missing lenses throughout the schools included in the scope of this ESIP and replace those lenses with new. It is anticipated to be accomplished through a combination of off-the-shelf and custom replacements and will is included for both the DI buildings and non-DI buildings.

**Proposed LED lamps**



**Proposed Exterior Fixtures**

**Proposed LED High Bays**

**Proposed Troffers & LED Kits**

**Proposed ULB – TLED (direct wire)**

Exterior Lighting

Johnson Controls has identified opportunities for energy savings through the installation of new high-efficiency lighting. Johnson Controls proposes to replace these fixtures with new LED fixtures that will produce a crisper whiter light which will enhance pedestrian visibility and safety. In addition, photocell sensors will be added to most of these fixtures to turn off lights automatically during day-lit periods.

**Proposed Exterior Fixtures**


All lighting work will be installed in a thoughtful manner with careful consideration of any occupant belongings and surrounding equipment. Tarps will be used to cover all exposed desks, computers, office equipment, etc. Cleanup will take place at the end of each shift with all vacuuming, dusting and trash removal being completed before leaving the premises. Johnson Controls and Willdan each performed detailed surveys during the investment grade audit and developed a lighting line-by-line for each location. In general, the following scope of work will be applicable to the lighting retrofit:

- Safely disconnect the existing lighting fixture from live circuit.
- Removal of existing T8 and older lamps.
- Install new LED line-voltage tubes.
- Replace lenses and fixture coverings as needed.
- Retrofit metal halide fixtures with high output LED screw-in lamps.
- Replace incandescent lamps with new LED screw-in lamps.
- Replace exterior high intensity discharge fixtures and select compact fluorescent fixtures with new LED exterior fixtures.
- Reconnect all the wiring.
- Test for operation.
- Cleanup work area.
- Properly dispose of removed material.
- Provide training to staff on operation of new lighting system.

## Facilities Recommended for This Measure

- Several Schools (Refer to ECM Matrix) – Excludes schools that were part of the previous ESIP phases

## Energy Savings Methodology

Energy savings calculations are based upon hours of operation for each area surveyed. These hours are determined through a combination of information obtained from the personnel during the survey as well as commonly accepted industry standards. Ballast wattages presented within the energy savings analysis are based upon the manufacturers' reported technical data.

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

| | |
|---|---|
| Existing kW | = Existing wattage/1,000 per fixture |
| Cost per kWh | = Average $/kWh |
| Cost of Existing Lighting | = Existing kW x Cost per kWh x Existing Hours of Operation |
| Proposed kW | = Proposed wattage/1,000 watts per fixture |
| Cost per kWh | = Average $/kWh |
| Cost of Proposed Lighting | = Proposed kW x Cost per kWh x Proposed Hours of Operation |
| Energy Savings $ | = Cost of Existing Lighting – Cost of Proposed Lighting |

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | As part of the measure design and approval process, specific product selection will be provided for your review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period. The new lamps themselves carry a 10-year manufacturer's warranty.

## Changes in Infrastructure

No architectural or structural changes to the facility are anticipated with the implementation of this measure.

## Customer Support and Coordination with Utilities

Coordination of the electrical tie-in will be required. All interruptions will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | No facility resource use is required; job site storage may be required. |
| Waste Production | This measure will produce waste by products. The ballasts must be accounted for and removed in accordance with local and state codes. |
| Environmental Regulations | No environmental impact is expected. |

# ECM 2: Weather Stripping & Air Sealing

## ECM Summary

Energy is lost from various leakages throughout the buildings due to infiltration. The heat losses and heat gains occur due to gaps and openings that allow the building's conditioned (heated or cooled) air to mix with the outdoor ambient air. This measure will seal these leaks, resulting in energy savings and improved comfort in the areas and occupied spaces that are subjected to outdoor air infiltration.

Existing as well as new buildings typically have numerous air-leak paths through the envelope in such locations as gaps at transitions between wall, floor and roof levels; structural penetrations through the wall system; and at transitions in wall system types.

**Air Leakage**

There are pathways for air leakage throughout every building. Priority is placed on holes near the top and bottom of the building envelope to alleviate energy loss impact of stack effect. Improved weatherization reduces air leakage in buildings. Air leakage is the uncontrolled migration of air through the building envelope caused by pressure differences due to the wind, chimney (or stack) effect, and mechanical systems. It has been shown to represent the single largest source of heat loss or gain through the building envelope of nearly all types of buildings.

Beyond the potential for energy savings, uncontrolled air leakage can affect the thermal comfort of occupants, air quality through ingress of contaminants, the imbalance of mechanical systems, and the structural integrity of the building envelope through moisture migration. Control of air leakage involves the sealing of gaps, cracks, and holes, using appropriate materials and systems, to create a continuous plane of air-tightness to encompass the building envelope. This includes door weather stripping, roof-wall sealing and added insulation to reduce energy usage and improve comfort.

**The three Major Building Pressure Effects**

All buildings "leak" air. Fresh air is required for all public buildings; it ensures a "healthier" condition inside of the building. Air leakage needs to be controlled; if not, barometric pressures are placed on the building which causes discomfort and higher energy costs. Three of the most crucial effects of barometric pressures are the following:

- Wind Effect
- Mechanical Effect
- Stack Effect

**Wind Effect**

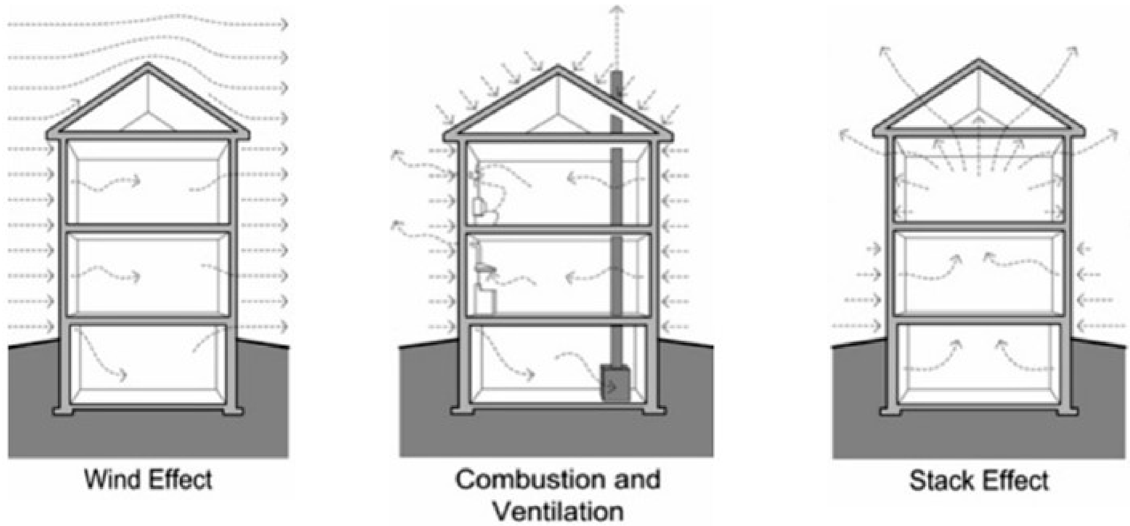
From everyday experience, it is known that wind creates pressure – the stronger the wind, the greater the pressure. When a wind blows around a building it creates an inward pressure on the up-wind side. A very simplified form of wind effect is shown in the photo below. In practice, there is also a complicated wind pressure pattern across the building's ceiling.

**Mechanical Venting**

If a building has a mechanical venting system, then the flue effect is important. The venting can create negative pressure causing a vacuum on the building. This phenomenon sucks air out of the rest of the building and reduces its pressure. Cold air is pulled into the building through every crack and opening.

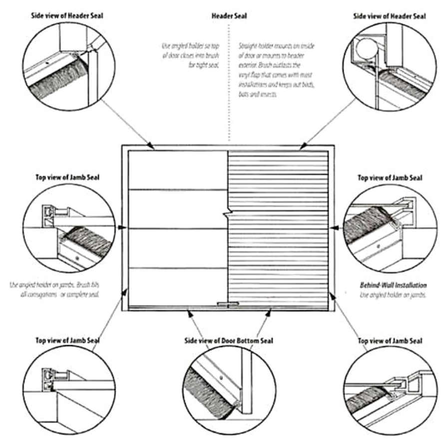
**Stack Effect in Two or More Story Buildings**

In winter, the air inside the building is warmer than the air outside, and therefore has a lower density. This density difference between the inside and outside air, creates a pressure difference across the building envelope. The pattern of this pressure difference is shown in the right drawing, where the arrows show the direction and relative size of the pressure effect. This pattern is present in all heated buildings and is known as the stack effect.




**Weather Stripping**

Door and window openings are the most obvious areas to address when sealing the building. They must seal while still allowing access. In most instances the sealing is permanent, but in these two areas there is friction from the constant opening and closing. Therefore, it is important to seal these areas with a durable product that is flexible while still strong enough to withstand abuse, wear, and tear.



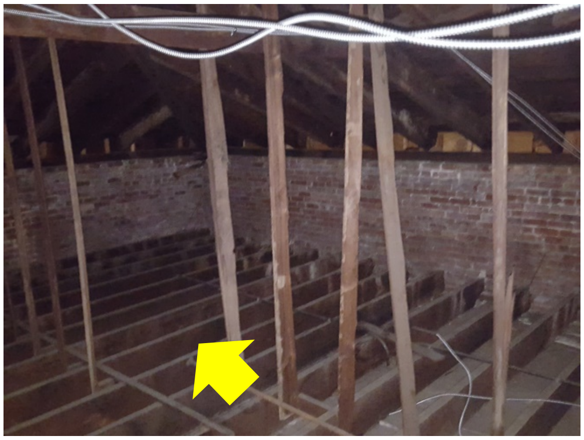

Garage door weather stripping can be even more critical as the "gap" around the door can be much larger. Also, if the current door is not insulated, there are opportunities to increase the insulation value without having to replace the entire door and mechanism.

## Existing System

Infiltration/exfiltration is the rate of uncontrolled air exchange that occurs through unintentional building openings. Throughout the buildings, many leaks were found that would allow heat to be lost during the winter and heat gained during the summer. These openings range from gaps around doors, exhaust fans and various other gaps allowing air to pass from a region of higher pressure to that of lower pressure. Outside wind conditions also provide increased pressure gradients across the leakage surfaces, which allow for correspondingly increased leakage rates. Temperature gradients also create the source to sink flow, therefore the greater the difference between the outdoor air and the indoor air temperature, the greater the rate of infiltration.

Attic Air Barrier Retrofit – failing ceilings above the drop ceiling expose the building to large amounts of air leakage. (Avon Academy).

Attic Bypass Air Sealing & Insulation –no insulation at the attic flat for controlling heat loss or heat gain (Benjamin Franklin School).



Attic Bypass Air Sealing & Insulation – there is no insulation at the attic flat. (Uplift/Newton School).

AC Unit Weatherization – the semi-permanently installed window AC creates a large gap between the window sashes where weather stripping at the meeting rail no longer makes contact (Lincoln Elementary School).

AC Unit Weatherization – the semi-permanently installed window AC creates a large gap (Abington Ave School)

AC Unit Weatherization – the semi-permanently installed window AC creates a large gap old foam materials has deteriorated.

Door Weather Stripping – large gaps highlighted by daylights indicate air leakage pathways that need to be addressed in the building (Broadway/Luis Munoz Marin School).

Door Weather Stripping – trim needs to be sealed and the door properly weather stripped in order to solve air leakage problems at the door assembly (Wilson ECC).

Door Weather Stripping – there are no door sweeps installed resulting in an obvious area of air leakage at the doors (Central High School).

Caulking – unsealed snap trim reveal window framing components and dirt buildup at air leakage pathways around the window.

Caulking – unsealed snap trim with only air permeable fiberglass within the window cavity results in air leakage pathways around the window (South 17th Street School)

Buck Frame Air Sealing – above drop ceilings the window buck frame is often left untreated due to being out of sight. These areas of construction need be sealed to prevent air leakage just as the window trim and intersections are meant to be sealed below drop ceilings (Rafael Hernandez School).


Roof-Wall Intersection Air Sealing – the exterior flashing and finishes at the roof-wall intersection are not constructed to stop air leakage (Belmont Runyon School).

Roof-Wall Intersection Air Sealing – the concrete wall needs to be continuous to the roof-deck in order to create a full air barrier in the building. (ECC Central).

Overhang Air Sealing - the overhang extends beyond the conditioned space. Gaps in the exterior finishes of recessed lights and at perimeter of outdoor ceiling surface are direct pathways for infiltration/ exfiltration (John F. Kennedy School).

Overhang Air Sealing – the plane of the exterior wall does not extend beyond the drop ceiling. Dirt buildup in fiberglass indicates air leakage as fiberglass "filters" debris as air moves through the building envelope (Bard Early College School).

Window Restoration/Interior Storm Installation - the large stained glass single pane window assembly is a major weakness in the thermal envelope of the building.

Window Restoration/Interior Storm Installation Glaziers or other specialized professions should be brought in to repair/replace glass as needed prior to interior storm window installation.

## Proposed System

The purpose of the visual evaluation is to identify potential design flaws, construction installation errors, inferior or improper material usage (if any), inspect the systems conditions, how they interact with one another and test for deterioration that affects efficiency. As part of evaluating a structure, Johnson Controls includes interviewing occupants for historical data. How the systems, occupants, and structure react when conditions are constantly changing and what idiosyncrasies exist are key factors in determining where and what to look for when diagnosing the concerns.

Johnson Controls has identified areas where building upgrades will increase the efficiency of the existing equipment, create a more comfortable interior condition and impact on the sizing of any new equipment intended to be installed as part of the new building usage plan. In addition, the retrofits will help reduce and can even eliminate some of the existing deterioration that is presently occurring.

**Building Envelope Improvement**

**Air-Conditioning Unit Weatherization** – air-conditioning units installed in double hung and sliding windows throughout the school district are allowing air to infiltrate and exfiltrate buildings. Where window air-conditioning units are installed, the meeting rail of the movable sashes no longer touch resulting in a large air leakage pathway.

**Attic Bypass Sealing** – interior walls, plumbing, electrical, and HVAC penetrations that are not properly sealed in an attic allow conditioned air to escape into the vented attic space. Since warm air rises, sealing the attic from the conditioned space is crucial to maintaining an efficient building. Air movement through fibrous insulation reduces the effectiveness of the existing insulation. Attic hatches need to be insulated to prevent thermal heat loss and weather stripped to prevent air leakage.

**Attic Flat Insulation** – attic insulation is crucial for controlling conductive heat loss in a building. After air gaps are sealed and convective air loss is reduced the biggest remaining form of heat loss becomes conduction. Under-insulated surfaces result in excessive energy loss due to the lack of a properly insulated thermal barrier.

**Buck Frame Air Sealing** – the buck frame is the rough opening in the structural framing of the building left open for windows or doors to later be installed. This opening is sometimes filled with foam insulation sealants and finished with a variety of casing materials; often the buck frame is not sealed properly with fiberglass or not sealed at all leaving buck frames very susceptible to air leakage. This condition is especially prominent above drop ceilings where finishing air barrier materials such as window casing and caulk are not continued due to builders assuming they were aesthetic finishes only; this misunderstanding allows unnecessary air infiltration and exfiltration at unfinished buck frames.

**Caulking** – there are gaps between the door frames and the door jambs. These gaps allow direct infiltration/exfiltration; clear daylight is showing at select joints which is a clear indicator of air leakage.

**Door Weather Stripping** – deteriorated weather stripping materials, ineffective weather stripping installation and daylight showing at the perimeter of door systems create direct pathways for unwanted infiltration/ exfiltration at the buildings.

**Overhang Air Sealing** – overhangs are roofs, floor systems or areas above entryways that extend beyond the plane of the exterior wall system. These areas of construction are often misunderstood by builders and the cavity that extends beyond the plane of the exterior wall system is often incorrectly "connected" to the interior heated spaces of the building. Overhangs that are not properly sealed at the plane of the surface that should separate the conditioned space from the outdoors throughout the buildings lead to excessive air leakage and heat loss at these vulnerable areas in the building envelope.

**Overhead Door Weather Stripping/Roll-up Door Weather Stripping** – remove existing weather stripping and replace with new commercial grade weather stripping to create a full air seal around the door. With low grade, none, or deteriorating materials in place, overhead and roll-up doors are a major source of air leakage.

**Roof-Wall Intersection Air Sealing** – the roof-wall intersection is regularly an area that allows unwanted air leakage through the building shell. The roof-wall intersection is the largest area of unwanted air losses throughout the buildings. Exterior flashing and finish details at this area are not constructed to stop air leakage (exterior flashings are for water control, not air control); unsealed exterior flashing details combine with interior gaps in the framing between the roof and wall assembly to allow infiltration/ exfiltration.

**Wall Air Sealing/Insulation** – a wall assembly that does not have an effective air barrier in place allows unnecessary air leakage losses. Areas of poorly insulated and sealed wall assemblies create bypasses for air leakage and heat loss that force the heating and cooling systems to work harder than necessary.

**Window Weatherization** – the compression seal windows are allowing air to infiltrate the building at the perimeter of each window system. The deteriorated weather stripping that was in place has left a metal-on-metal closure intersection that is very leaky. Properly installed weather stripping is required here to ensure unnecessary window drafts no longer affect occupant comfort levels. Double hung windows do not have proper weather stripping installed resulting in drafty windows that have a direct negative affect on building occupant comfort.

**Capital Improvement**

**Attic Air Barrier Retrofit** – failing ceilings found on the top floors of select buildings result in large bypasses in the thermal envelope of the building. Fiberglass is being laid directly on drop ceilings resulting in an air-permeable insulation layer that has a severely degraded R-value due to air leakage simply bypassing insulation before insulation has a chance to be effective.

**Window Restoration/ Interior Storm Window Installation** – single pane stained glass windows at the front of the Arts High School building are a weak point in the thermal envelope of the building. The combination of a metal frame, single pane glass, and broken/missing panes are resulting in large amounts of conductive and convective heat loss that force heating and cooling systems to work harder than necessary.

## Facilities Recommended for This Measure

- Several Schools (Refer to ECM Matrix) – Excludes schools that were part of previous ESIP phases

## Scope of Work

See the Appendix for a summary of work by building.

## Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Energy Savings $ = ((Existing Airflow – Proposed Airflow) x 1.08 (OA Avg. Temp – Indoor Avg. Temp) / Heating or Cooling Efficiency) x (fuel cost)

Note: ASHRAE Chapter 26.21 Infiltration formula 2001 Fundamentals, pages 26.21 and 26.22

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | As part of the measure design and approval process, specific product selection will be provided for your review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Changes in Infrastructure

No architectural or structural changes to the facility are anticipated with the implementation of this measure.

## Customer Support and Coordination with Utilities

The service to the specific locations may require interruption to allow for the repair. Coordination with site personnel will be required to minimize interruption. All interruptions (if necessary) will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result from the reduction of energy loss from infiltration resulting in lower fuel consumption. The equipment uses no other resources. |
| Waste Production | This measure produces no waste by products. |
| Environmental Regulations | MSDS documentation will be provided as required. |

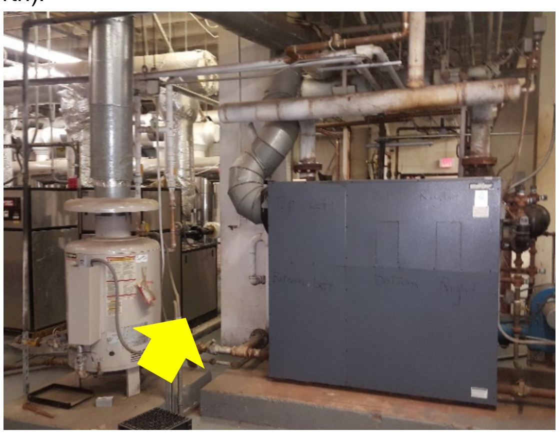
# ECM 3: Pipe & Valve Insulation

## Existing Conditions

Un-insulated valves and piping have significant heat losses due to the exposure of the steel or copper piping to the surrounding air. During the site inspections, valves and fittings were observed without insulation or the existing insulation was damaged in a portion of the areas throughout the buildings. Adding the proper amount of insulation will not only conserve energy but will also improve safety by reducing the chance for burns on hot piping or slipping due to condensate on a pipe.

Un-insulated steam pipes (Branch Brook School/ ECC North).

Un-insulated steam and condensate pipes (University High School).



Un-insulated pipes in the heating system and domestic hot water system (13th Avenue/ Dr. MLK Jr.).

Un-insulated condensate pipes, steam traps and strainers (Ivy Hill Elementary School).

Un-insulated pipes in the domestic hot water system

Un-insulated pipes in the domestic hot water system (Ivy Hill Elementary School).

Suction diffusers, pumps and valves in the heating hot water system are not insulated (13th Avenue/ Dr. MLK Jr).

Pumps and valves in the heating hot water system are not insulated (McKinley School).

## Facilities Recommended for This Measure

- Several Schools (Refer to ECM Matrix) – Excludes schools that were part of previous ESIP phases

## Scope of Work

See the Appendix for the summary of work by building.

Pipe & Tank Insulation

Installation Specifications:

- Install pipe insulation to meet the insulation requirements of the fluid temperature in the pipe.
- Use/install pipe wrap covering/ jacket to protect the insulation material as required in the work area.

Materials:

- Materials will vary by the application and workspace; materials include fiberglass, mineral wool, foam glass, Styrofoam, urethane and closed cell rubber.

Valve & Fitting Insulation

Installation Specifications:

- Install on-site, custom fabricated insulation blankets to wrap the un-insulated or poorly insulated components.

Materials:

- EverGreen Cut 'n Wrap Insulation Kits –removable and reusable insulation fitting covers with fiberglass insulation and industrial-grade coated fabric jacket.

## Energy Savings Methodology

**Mechanical Insulation Savings Calculations**

This section describes our methodology for calculating energy savings. We use standard heat transfer methods to compute heat loss from bare and insulated mechanical systems (piping, valves, fittings, tanks, and ductwork). The difference in heat loss is the energy savings, as follows:

Energy Savings = [ Existing Heat Loss] – [ Insulated Heat Loss ]

**Methodology**

We use standard heat transfer methods to compute radiation, convection, and conduction heat loss from (or gain to, for cold systems) bare and insulated systems. Key parameters that affect the heat transfer rate include: temperature of fluid (e.g. steam, hot water, chilled water, etc.); surface temperature of the component (e.g. pipe, fitting, tank, ductwork); temperature of environment; emissivity of surface; average wind speed where applicable; percentage of existing component covered with insulation; and condition of existing insulation, where applicable.

**Energy Use**

Existing and proposed energy use are computed as follows:

Pipes & Fittings

Heat Loss (Btu/h) = (Heat Loss / lin.ft. bare pipe)x (lin.ft. of pipe) x [ 1 – (%insulated) ] +

(Heat Loss / lin.ft. insulated pipe) x (lin.ft. of pipe) x (%insulated)

Fuel Loss (MMBtu/yr) = (Heat Loss Btu/h) x (heating hrs/year) / (efficiency)

Electric Loss (kWh/yr) = (Heat Loss Btu/h) x (cooling hrs/year) / (12,000 Btu/ton-hr) x (cooling kW/ton)

Tanks, Plates, & Ductwork

Existing and proposed heat loss for tanks, plates, and ductwork are calculated as follows:

Heat Loss (Btu/h) = (Heat Loss / sq.ft.)x (sq.ft. of component) x (qty) x [ 1 – (%insulated) ] +

(Heat Loss / sq.ft. insulated) x (qty) x(sq.ft. of component) x (%insulated)

Fuel Loss (MMBtu/yr) = (Heat Loss Btu/h) x (heating hrs/year) x (efficiency)

Energy Savings

Energy savings are the difference between existing and proposed heat loss:

Fuel Savings (MMBtu/yr) = (Existing Fuel Loss) – (Proposed Fuel Loss)

Cost Savings ($/yr) = (Fuel Savings MMBtu/yr) x (Fuel Rate $/MMBtu)

## Maintenance Requirements

Follow manufacturers' recommendations for preventative maintenance.

## Benefits

- Thermal energy savings
- Capital improvements of HVAC systems

# ECM 4: Water Conservation

## Existing Conditions

During the preliminary visit to the schools, several areas where a water conservation project could be undertaken were identified to save water as well as upgrade some existing plumbing fixtures.

**Water Faucet in Dr. Alma Flagg School**

Existing water closets and urinal use older non-chloramine resistant diaphragm valves. These diaphragms and components deteriorate over time due to the flexing of the rubber and chloramines in the water treatment process.

- The older water closet diaphragms have partially degraded diaphragms creating an average 20%-40% additional flush volume per flush depending on the location.
- The fixtures should be retrofit to low flow using newer chloramine resistant synthetic diaphragm valves and respective low flow china where required.
- Many 1.6 gpf bowls have been retrofit with higher volume flush valves.

## Benefits

- Reduction in water usage.
- Reduction in domestic heating fuel consumption.
- Reduced maintenance requirements or costs.

## Facilities Recommended for This Measure

- Several Schools (Refer to ECM Matrix) – Excludes schools that were part of the previous ESIP phases

## Scope of Work

See the Appendix for the summary of work by building.

**Water Conservation Measures for Restrooms:**

**Flush Valve Water Closets**: Most commercial facilities use flush valve water closets. Flush valves are designed to release precise volumes of water when activated. High-efficiency flush valve and china combinations can enable a facility to greatly reduce its water consumption by reducing flush valve flow rates and the amount of water required for evacuation. Johnson Controls proposes to replace or repair floor mount flush valves of 1.28 gpf.

In each bathroom with more than one flush valve in a row, the last flush valve shall be fitted with a Sentinel flush valve sensor to automatically flush once every 24 hours regardless of regular use and building occupancy in order to prevent sewer debris build up.

<u>Tank Style Water Closets</u>: Existing Tank Type toilet range from 3.5 gpf to 1.6 gpf model. These models should be change to HET design models.

- HET Tank Type – 1.0 gpf Tank Type Toilet
- HET ADA compliant Tank Type – 1.0 gpf Tank Type Toilet
- HET Child Size Tank Type – 1.0 gpf Tank Type Toilet

<u>Flush Valve Water Closets</u>: Existing water closets consist of both 3.5 gpf design and 1.6 gpf models. These models use older rubber diaphragm valve models. Flush valves are designed to release precise volumes of water when activated. High-efficiency flush valve and china combinations can enable a facility to greatly reduce its water consumption by reducing flush valve flow rates and the amount of water required for evacuation.

<u>Water Closet China</u>

- HET Wall Mount TS Toilet (1.28 gpf) or equal
- HET Wall Mount RS Toilet (1.28 gpf) or equal
- HET Floor Mount Toilet (1.28 gpf) or equal
- HET Floor Mount ADA Toilet (1.28 gpf) or equal
- HET Floor Mount Child Size Toilet (1.28 gpf) or equal
- All sensors to be reused as listed in the audit

<u>Water Valve / Diaphragms</u>

- HET or equal – 1.28 gpf Valve
- HET or equal – 1.28 gpf Valve Kit
- All sensors to be reused as listed in the audit

**Urinals**: High-efficiency flush valve and china combinations for urinals can enable a facility to greatly reduce its water consumption by reducing flush valve flow rates and the amount of water required for evacuation. Johnson Controls proposes to install 0.125 gpf high-efficiency urinal system (bowl and manual valve).

<u>1.5 gpf and 1.0 gpf Wall Mount Urinals</u>: High-efficiency flush valve and china combinations for urinals can enable a facility to greatly reduce its water consumption by reducing flush valve flow rates and the amount of water required for evacuation.

<u>Urinal Valve / Diaphragms</u>

- 1/2 gpf Valve

**<u>Bathroom Faucet Aerators</u>:** Most faucets use aerators to restrict the volume of water at the mouth of a faucet and to generate a more comfortable flow. High-efficiency aerators can greatly reduce flow rates from faucets and create a comfortable flow for handwashing and cleaning. Restricting faucet flow rates enables a facility to conserve water and reduce energy usage associated with heating water.

- Neoperl or equal 0.5 gpm Vandal Proof Aerator
- Neoperl or equal 1.5 gpm Vandal Proof Aerator
- Single Handle Basin Cock Faucets or equal
- 4" Center Set Faucets

Showerhead Replacement: High-efficiency pressure compensating showerheads can greatly reduce shower flow rates and create a comfortable flow. Restricting shower flow rates enables a facility to conserve water and reduce energy usage associated with heating water.

- Niagara or equal 1.5 gpm ultra low flow showerhead
- Niagara or equal 1.5 gpm water saver handheld shower head
- In Line Shower flow restrictors

**Water Conservation Measures for Kitchens**

Johnson Controls proposes to retrofit existing high flow kitchen and dish sprayers with water efficient 0.6 gpm pressure compensating sprayers. Existing high flow prep sink faucets will be fitted with new 1.5 gpm kitchen sink aerators and install foot pedal flow controls. Foot pedal flow controls prevent unattended flow of water from a faucet during food preparation.

Kitchen Dishwashing Sprayer: Existing high flow kitchen and dish sprayers will be retrofit with water efficient 0.6 gpm pressure compensating sprayers.

- Low Consumption 0.6 gpm kitchen pre-rinse sprayer

Kitchen Prep Sink: Existing high flow prep sink faucets will be retrofit with new 1.5 gpm kitchen sink aerators and foot pedal flow controls. Foot pedal flow controls prevent unattended flow of water from a faucet during food preparation.

- 1.5 gpm Aerators and foot flow control device

Kitchen Faucet Aerators: Existing high flow kitchen hand washing faucets will be retrofit with water efficient 1.5 gpm vandal proof aerators.

- Vandal Proof Aerator 1.5 gpm

## Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Total Water Savings (kgal) = kgal Used Existing Device – kgal Used Proposed Device

Hot Water Savings (kgal) = kgal Hot Water Existing Device – kgal Hot Water Proposed Device

Energy Savings (therms) = (8.33lbs/gallon x Hot Water Savings in Gallons x 1Btu/lb/degree F x Temperature Rise Water)/100,000 Btu/therm/ Boiler Efficiency/Heat Transfer Efficiency

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | As part of the measure design and approval process, specific product selection will be provided for your review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Customer Support and Coordination with Utilities

The service to the specific locations may require interruption to allow for the repair. Coordination with site personnel will be required to minimize interruption. All interruptions (if necessary) will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result from the reduction of energy use from reduced water usage, resulting in lower fuel consumption. The equipment uses no other resources. |
| Waste Production | This measure produces no waste by products. |
| Environmental Regulations | MSDS documentation will be provided as required. |

# ECM 5: Building Controls Upgrades

## ECM Summary

The school district currently uses older pneumatic control and direct digital controls (DDC) controls to run the buildings' HVAC systems. This ECM includes various measures to control unit run time and space temperature setpoints. Providing new DDC to the HVAC equipment will reduce the energy consumption of the entire building as well as ease the burden on the maintenance personnel.

## Existing System

The buildings surveyed had a variety of controls systems from the latest DDC to pneumatic controls with some BAS scheduling. Facilities with DDC systems had electronically controlled field devices; however, front-end computers with which to access, monitor and control the system were not readily available in most buildings. The operators have limited scheduling, monitoring and override capabilities with the older systems.

Older pneumatic controls systems often have issues because they are maintenance-intensive. Building personnel must ensure the pressurized air stays clean and dry, the pneumatic air compressors are functional, and the controls and gauges are calibrated regularly. This interferes with the ability to ensure that control strategies are being implemented correctly.

As a whole, it helps the system realize its full potential by implementing enhanced-programming strategies to ensure that all potential ECMs are being used. The constant change in technology is reason to periodically revisit any existing building controls systems to take full advantage of their inherent energy conservation capabilities.

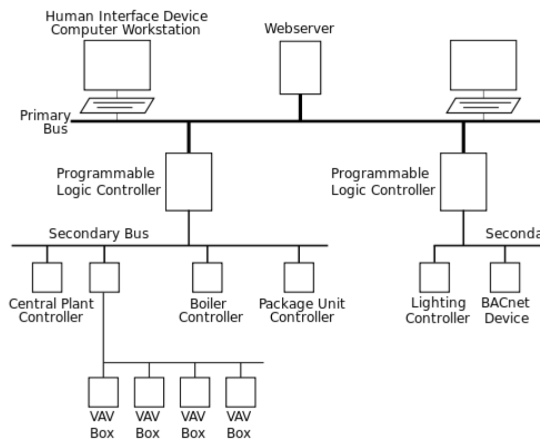
These energy conservation opportunities include modifications to the existing control infrastructure while providing capabilities/settings to optimize performance and enable additional energy savings to be captured.

## Proposed System

Johnson Controls proposes an upgrade to an **open protocol system architecture** full DDC system to enable the school district's facilities to have superior scheduling, monitoring and controls capabilities. An upgraded DDC system will be provided to integrate the mechanical systems to a single front-end and availability to access the system from almost anywhere a network connection can be had.

The buildings included in the scope of this ESIP phase will be upgraded to the latest controls technology, moving away from the legacy systems. This enables a consistent mechanical system mapping to the front-end, allowing the facility management team to schedule, monitor and control from a single dashboard with remote capabilities. Graphics will be provided and included in the BAS along with mechanical equipment to be controlled by the system.

As part of an effort to realize the existing system and the proposed upgrades to the fullest potential, Johnson Controls proposes to review the existing BAS Sequence of Operations and its proper operation. Johnson Controls will work with the school district to define operating schedules for each space and piece of equipment. In addition, multiple sensor points will be checked for proper function and that the BAS is reading the correct value at the computer workstation.




Outside of the DDC work, mainly in hallways and stairwells and other steam terminal equipment that will not be retrofit with new digital control valves and actuators, Johnson Controls proposes to replace the existing manual control valves with thermostatic control valves. Replacement will reduce energy use and improve control of the steam heating distribution system.

Danfoss is one such manufacturer and the pre-settable steam valve assemblies incorporate easy setting adjustments with clearly engraved setting markers scaled from 1 thru 7 and N. Each number setting corresponds to a preset temperature that controls the steam flow to the radiator or unit ventilator by maintaining setpoint.

The following are some of the strategies that will be implemented using a DDC system:

**Unoccupied Temperature Space Temperature Setbacks**

With the installation of new control valves paired with new, networkable thermostats, space temperatures can be better controlled. During unoccupied times, these zone temperatures can be setback so that spaces are not heated or cooled unnecessarily. For example, if the heating space setpoint is 72°F, during unoccupied times, this can be changed to 60°F. A warm-up scheduled can be included so that the spaces are at the occupied temperature setting for the next morning.

**Occupancy Schedules**

As HVAC equipment is updated with more sensors and new valves, better run time control can be obtained. By setting equipment schedules to match closely with occupancy patterns, equipment can be shut down or put in standby mode during unoccupied times. This will not only reduce energy consumption, but also extend the life of equipment by reducing the amount of run hours.

In general, the scope of work will include the following items. The final details will be included on the final engineered drawings and specifications that will be used for bidding and procurement purposes. A complete scope of work by building is included in the Appendix.

- Retrofit existing HVAC mechanical control system with new BACnet controls.
- Demo existing digital control panels and end devices and replace with new DDC controls including new panel, conduit and wire.
- Existing pneumatic controls shall be abandon in place.
- Installation shall be conduit in all expose or open areas and plenum rated open cabling in concealed accessible areas.
- Mounting of new control panels and 120 VAC power by installing contractor.
- Duct smoke detectors shall be reused and reconnected.
- Dampers actuators installed and wired by installing contractor
- Include fire/acoustical caulking of own work.
- Include Network “Cat 6” data drops to new network panels.

## Benefits

- Fuel energy savings
- Improved occupant comfort
- Capital improvement of BAS

## Facilities Recommended for This Measure

- Several Schools (Refer to ECM Matrix). Excludes schools that were part of the previous ESIP phases.

## Energy Savings Methodology

Savings are generated by incorporating temperature setbacks during unoccupied times with improved occupancy scheduling. The building modeling uses ASHRAE's bin method. This method begins with recording the average temperature for every hour of the year, then tallying those values by temperature range.

The model is used to determine the gains and the overall heat transfer coefficient. This is based upon a combination of the following variables.

- Building Weight (Density)
- Heat Gains (UadT*EFLH)
- Mechanical Ventilation (1.08*cfm*dT*EFLH)

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | As part of the ECM design and approval process, specific product selection will be provided for your review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Maintenance Requirements

Follow manufacturers' recommendations for preventative maintenance. It is recommended that the facilities operate on a service schedule to keep the BAS in proper working order.

## Changes in Infrastructure

New controls will be installed at the locations that will allow operators to efficiently operate the building. No architectural or structural changes to the facility are anticipated with the implementation of this measure.

## Customer Support and Coordination with Utilities

No utility interruptions are expected. All interruptions (if necessary) will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result from reduced equipment operation and energy consumption. The equipment uses no other resources. |
| Waste Production | This measure will not produce waste by products. |
| Environmental Regulations | No environmental impact is expected. |

# ECM 6: Enterprise Management System

## ECM Summary

Johnson Controls proposes to install an enterprise management system containing a comprehensive, analytical and optimization tool that proactively analyzes building energy and equipment data to track energy usage, identify issues, faults, and opportunities for improved performance and operational savings. Powerful analytics root out energy and equipment-related problems 24x7. These analytics run in the background and find energy and equipment anomalies. Actionable information is provided to the customer through the fault detection and diagnostic (FDD) feature. The enterprise management solution is broken out into modules which deliver tailored outcomes based on specific need.

## Existing System

The Newark Public Schools are not currently equipped with the tools to track energy and operational parameters at a building level and generate reports. Along with typical BAS information, leveraging the BAS trends can open up a world of “big data” and provide a digital transformation into the 21st century.

## Proposed System

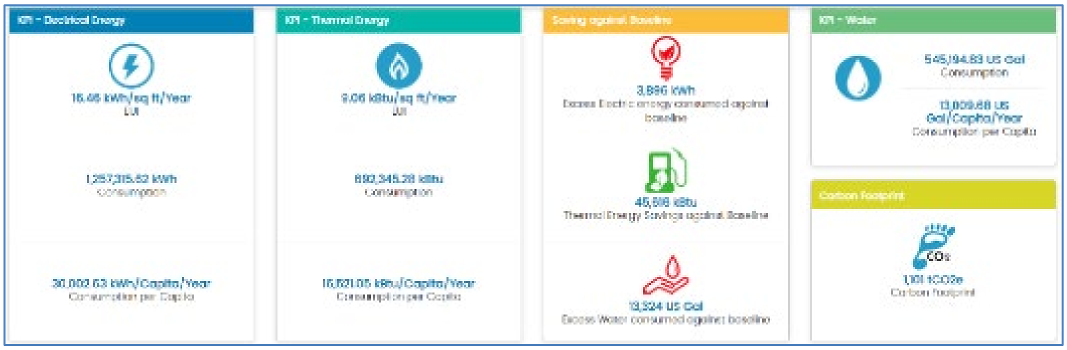
An enterprise management system, helps facility managers oversee their energy and equipment trends across their facilities. This solution offers the Newark Public Schools a full range of options to choose from. Outlined below, Johnson Controls is prepared to assist the Newark Public Schools in optimizing day-to-day activities by providing three core features: real-time energy management, FDD, and advisory services. All of these features will be made available through a web-based application that can be accessed through any smart device. Utilizing engineering expertise with easy-to-implement FDD strategies has repeatedly proven to generate significant savings. This unique approach allows clients to leverage optimization tactics that “close the loop” and pinpoints inefficiencies hiding in everyday operations. All data will be sourced from the network server or over BACNet/IP.

**Energy Management**

High Level Benefits

- Easy to understand summary reports can be generated from the dashboard data using the built-in automated reporting tool.
- Time series energy demand and consumption can be aggregated and displayed using baselines with various out-of-the-box dashboards. Custom dashboards can also be configured to a user’s needs.
- Manual imports of historical and project energy data is possible through standard Excel templates.
- Used alone, or coupled with the asset performance add-on, it provides a system that allows easy enterprise performance comparisons and life cycle management, providing detailed visibility into site operations.
- The energy management section has the ability to use information from the existing building management system to monitor consumption of various commodities mapped for that space. Johnson Controls plans to tie into the pulse outputs provided by utility meters, where available, in order to collect building energy data. The data will be centralized on the network server.
    - Energy KPI’s depict energy consumption details for electricity, thermal, water etc., such as EUI, consumption, and per capita consumption.
    - KPI Cards help users to briefly monitor the spaces, with the ability to visualize the cards at Portfolio, Location, and Building levels.

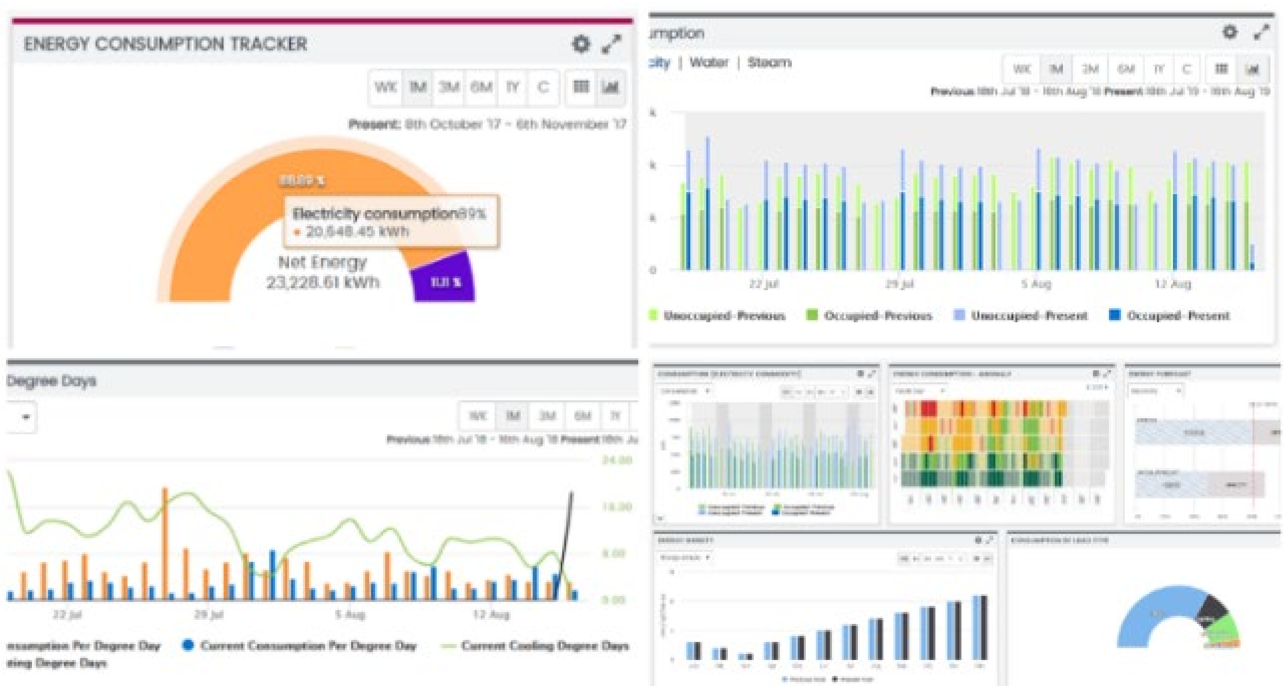
- Energy FDDs provides for energy monitoring unexpectedly high energy use, high unoccupied loads and non-working day consumption.



The details below provide an overview of major features supported by application.

Energy Management software automatically collects, analyzes, and displays information for all configured physical meters and virtual meters located in a facilities operation. The information for energy demand and consumption can be aggregated and displayed using various out-of-the-box dashboards.

- Energy Density Dashboards
- Energy Summary of Commodities
- Energy Tracker with Baseline
- Energy Forecast
- Custom Dashboards; dashboards can be configured to display data for space or meters
- Heat Map; can be used for easy detection of "hot spots"
- Energy Fault Detection
- Energy Summary Reports with Auto Scheduling
- Consumption and Demand Comparisons
- Data Cleansing and Normalization
- User Defined Baseline

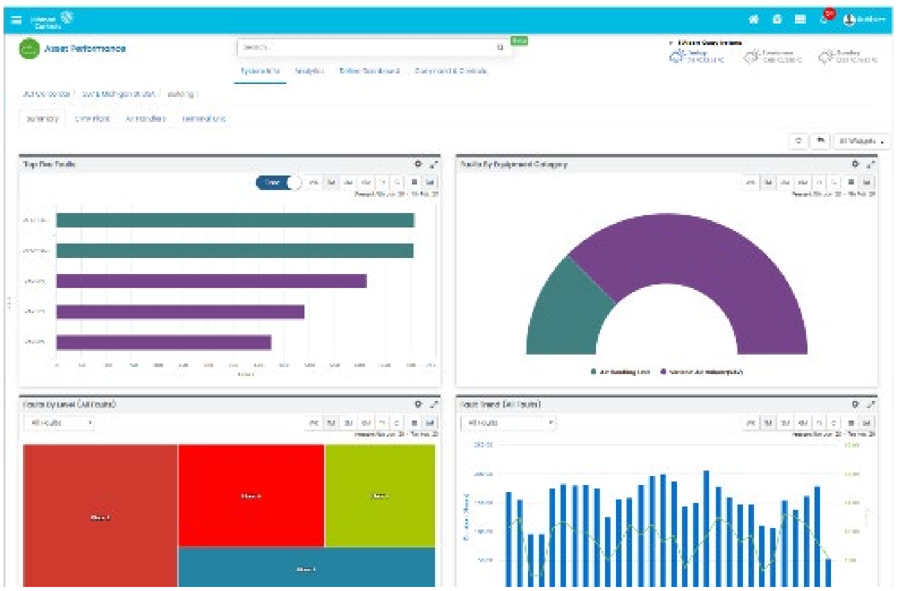


Custom dashboards can also be configured to a user's needs. Easy to understand summary reports can be generated from the dashboard data using the built-in automated reporting tool. Used alone, or coupled with Equipment Management software add-on, it provides a system that allows easy enterprise performance comparisons and life cycle management providing detailed visibility into site operations.

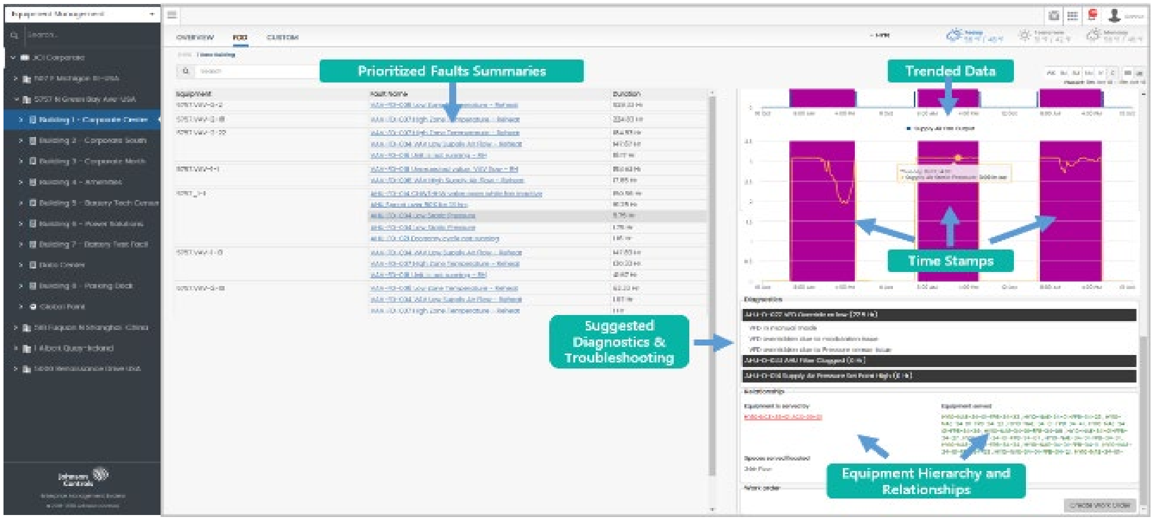
The performance of the EPM models are automatically evaluated periodically, and if it is determined necessary the model is automatically re-trained and re-adjusted (hyper-parameter tuning) using newly collected sensor data to reflect changes in the building (occupant behavior change, equipment change/degradation, building usage change etc.)

**Asset Performance (includes Maintenance Management)**

The Equipment Management software add-on of enterprise management system provides the connectivity to monitor, troubleshoot and maintain configured equipment points located in the building management system. Rule driven fault detection, notification and diagnostics are displayed in a time series format with total duration of existence allowing equipment managers to easily pinpoint and fix equipment problems. All data is displayed in easy to read dashboards and provide for developing custom equipment KPIs.




- Equipment FDD
- Equipment Analysis and Dashboards
- Waterside (Chiller, Boiler, Pumps, etc.) KPIs
- Custom Equipment Rule Editor
- Standard Rule Library (HVAC, Energy, Lighting, etc.)
- Custom Equipment KPIs
- Fault Notification
- FDD Driven Work Orders
- Rule Driven Diagnostics
- Equipment-based FDD Visualization
- Airside (AHU, RT, VAV, Fan Coil, Fans, etc.) KPIs
- Equipment Thermal Heat Map




**Fault Detection and Diagnostics (FDD)**

Equipment FDD gathers data from sensors and equipment, then applies complex algorithms to uncover potential problems, alerting staff to an impending issue, and identifying the issue's likely root cause. Easy to understand visuals are displayed to help technicians quickly zone in on a preventative solution, dramatically reducing baseline energy consumption, capital costs, and equipment reliability and longevity. The central management platform FDD engine is preloaded with a standard global rule library so customers can begin with a solid foundation. The visual displays help guide the user to identify a preventative solution by clearly earmarking the following:

- Location - Space affected by Fault
- Equipment Tag – Naming convention are adopted from the BAS or adapted for preference
- Simple fault summary statements
- Assigned priority and duration of fault occurrence
- Pertinent trended information that triggered the fault
- Highlight Occurrence of the fault
- Diagnostics – Second tier of analysis scans for root cause and suggests specific solutions
- Equipment Hierarchy - Equipment relationships - serving and served by

High Level Benefits

- Rule driven fault detection, notification, and diagnostics, are displayed in a time series format with total duration of existence, allowing equipment managers to easily pinpoint and fix equipment problems
- Faults can be categorized by: Space, equipment category, type, top five faults, fault trends and details by levels (floor, wing or meter)

Fault Dashboards – Fault Dashboards help the user to quickly and easily identify what spaces are affected by faults.

Fault Notification – A Bell Icon, which is an indicator of a Fault Notification, is in the upper right corner of the screen and notifies the user of all the latest faults.

Fault Backdated Reprocessing – The user can request for backdated faults.

Custom Equipment Rules Editor – The custom equipment rules editor function allows the user to create new rules, define other equations, as well as the threshold limits for each rule to detect as a breach from the normal condition applicable to their facilities operation. The rule editor does not require any software coding experience in a click based graphical view.

Fault Reports – Report supports user-configurable schedules for delivering the reports to the Inbox through email.

Fault Monetization – Shows the energy impact of inefficient equipment and energy waste to help users prioritize actions and drive utility savings.

Targeted ECM –Enterprise management can identify six specific categories of ECM to provide continuous commissioning and energy savings. Using parent-child meter/ equipment space relationships, powerful analytics root out energy and equipment-related problems listed below 24x7 to prioritize energy and equipment anomalies.

| ECM Category | Specific Measures |
|---|---|
| Scheduling Equipment Loads | Improve scheduling for HVAC and refrigeration |
| | Improve scheduling for lighting |
| | Improve scheduling for plug loads |
| Economizer/outside air loads | Improve economizer operation/use |
| | Reduce overventilation |
| Control Problems | Reduce simultaneous heating and cooling |
| | Tune control loops to avoid hunting |
| | Optimize equipment staging |
| | Zone rebalancing |
| Controls setpoint changes | Adjustment of heating/cooling and occupied/unoccupied temp setpoints |
| | Reduction of terminal unit minimum airflow setpoint |
| | Duct static pressure setpoint change |
| | Hydronic differential pressure setpoint change |
| | Preheat temperature setpoint change |
| Controls reset schedule addition or modification | Supply air temperature reset |
| | Duct static pressure reset |
| | Chilled water supply temperature reset |
| | Hot water supply temperature reset or hot water plant lockout |
| | Condenser water supply temperature reset |
| Equipment improvements/load reduction | Add or optimize variable frequency drives (VFDs) |
| | Pump discharge throttled or over pumping and low delta |

## Asset Maintenance (Ticketing System)

The asset maintenance software is a direct link to enterprise manager's FDDs and provides specific the ability to generate work orders, service reports and maintenance KPIs. Users can use the information to update and track work orders, check Service Report status, and allocate resources to closing tickets, and measure performance of maintenance teams by tracking specific KPIs like time to respond, asset related work orders etc. The system revolutionary analytics uses main rule, diagnostic rules, work orders and service reports to assist in scheduling and performing predictive maintenance.

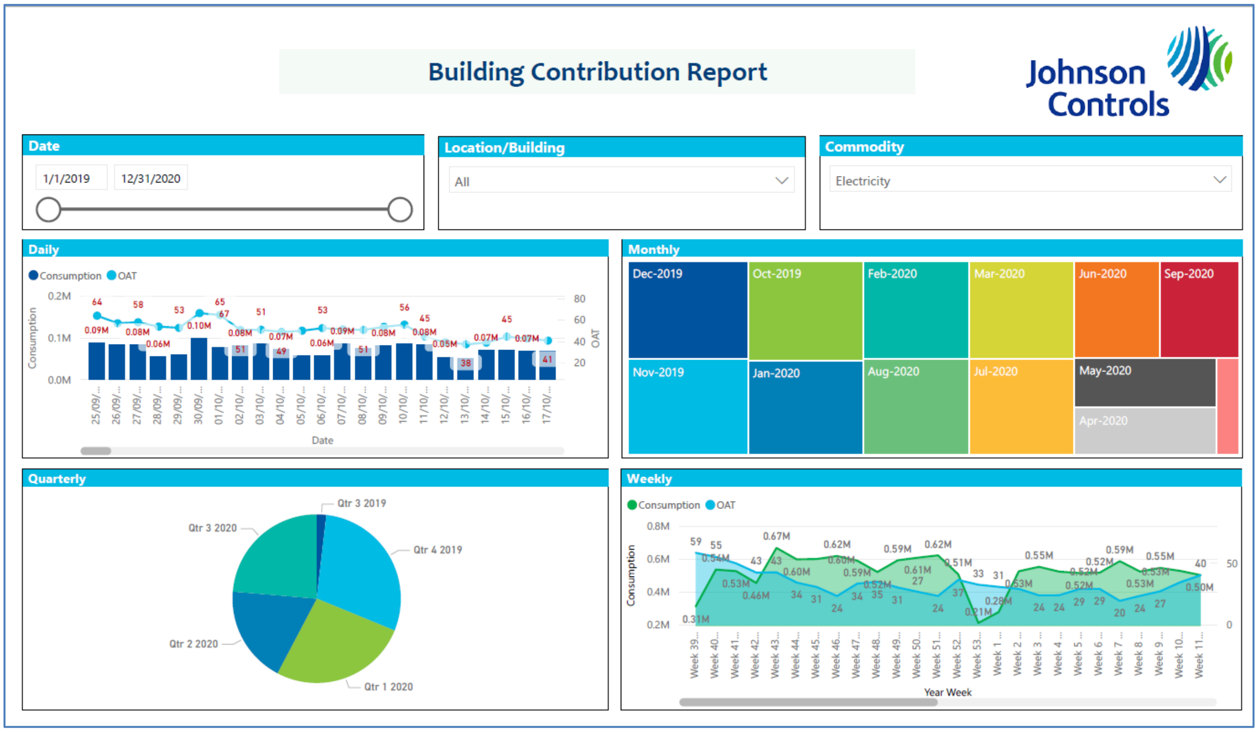
## Report Builder

Power BI application or equivalent should be embedded into enterprise management platform providing the most powerful report creation capability for the world of smart buildings. Power BI is a collection of software services that work together to turn unrelated sources of buildings information into interactive insights. Power BI dashboards provide a 360-degree view for business users with their most important metrics in one place, updated in real-time, and available on all of their devices. Every report that is built should view and edit modes which are configurable, roles and rights section. With Power BI, facility managers can build energy related reports such as:

- Energy consumption breakdown by services and type of space
- Energy usage profile analytic (for different services/space type) based on Real-time data
- Analytic report comparing people occupancy with ACMV consumption usage
- Analytic report comparing people occupancy with lighting consumption usage
- Analytic report comparing people occupancy with receptacle load consumption usage
- Energy summary of buildings
- Building energy contribution
- Degree days-based energy consumption
- Portfolio overall demand and other important visualizations

Correlation of consumption with respect to running hours makes identification of wastages and other silos very easy with visualizations on Power BI.

Users have the liberty to define visuals, filters, shapes, text boxes, drill-through, and visualizations. Power BI is a powerful SaaS application that can be accessed itself without having to worry about underlying infrastructure. Click on the video link below to know how Power BI helps in enabling to visualize and analyze data with efficiency.




## Facilities Recommended for This Measure

- Facilities included as part of ECM 5: Building Controls Upgrades are included in this ECM, as well

## Equipment Information

| | |
|---|---|
| Equipment Identification | Product cut sheets and specifications for generally used product can be included if requested by the customer. As part of the measure design and approval process, specific product selection will be provided for your review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

# ECM 7: Install / Replace Air-Handling Units and Package Units with Addition of Indoor Air Quality Improvements

## ECM Summary

Some air-handling units that are installed in the buildings are in poor condition and require replacement. This measure proposes to replace the older, existing split/condensing units with units that will have increased efficiency and reliability.

## Existing System

Various air-handling units, split units and packaged units have surpassed their useful service life and have very poor cooling energy efficiencies (7.0 to 8.0 EER). The high-efficiency units of today have cooling efficiency of 12 to 14 EER with digital controls, air side economizers and high-efficiency fan motors.


**American History High School**

**Thirteenth Ave School**

## Proposed System

The heating and cooling efficiencies of the existing air-handling units, packaged units and split units could be vastly improved by replacing them with high-efficiency heating and cooling units that feature digital controls, air side economizers and high-efficiency fan motors.

During the design phase, different approaches and technologies will be evaluated to improve the indoor air quality. Some examples are listed below:

- Increasing Ventilation Rates: Increasing the amount of clean outdoor air and increasing the amount of filtered recirculated air decreases pathogen exposure probability by diluting and removing aerosols.
- Improving Filtration: Adding filters, including high efficiency particulate air (HEPA) filters and filters with the highest minimum efficiency reporting value (MERV) rating can trap more particles and increase your building's clean air percentage.
- Disinfecting Air with UV-C Lighting: Ultraviolet germicidal irradiation (UVGI) is a disinfection method that uses UV-C light to inactivate viral and bacterial microorganisms in the air so they are unable to replicate. UVGI can be used to disinfect air passing through air-handling units and by circulating room air through UV-C troffers in the ceiling.

Johnson Controls

- Room Control: Temperature, room pressurization, and relative humidity also aid in destabilizing airborne viral transmission by reducing cross contamination and creating protective environments for occupants.

Air-handling units included will be outside air balanced prior to installation to determine the actual outside air ventilation rates. The air-handling units will be balanced again after installation to verify the new ventilation rates.

## Scope of Work

The following table provides a list of the type and quantity of units being replaced in each building included in the scope:

| Building | Type | Quantity | Description/Location |
|---|---|---|---|
| Alma Flagg | Air-Handling Unit | 4 | 2nd Floor Mech Room |
| American History High School | Heating Ventilating Unit | 1 | Gymnasium |
| | Heating Ventilating Unit | 1 | Cafeteria |
| Avon Elementary School | Heating Ventilating Unit | 1 | All Purpose Room |
| | Heating Ventilating Unit | 1 | Stage/Auditorium |
| Camden Street Elementary School | Heating Ventilating Unit | 3 | Gym, Café, Kitchen |
| Cleveland Elementary School | Heating Ventilating Unit | 1 | Gymnasium |
| Harold Wilson | Air-Handling Unit | 4 | 2nd Floor Mech Room |
| Louise Spencer | Heating Ventilating Unit | 1 | Cafeteria |
| Luis Muñoz Marin | Packaged Unit | 1 | Child's Study Area |
| | Heating Ventilating Unit | 1 | Gymnasium |
| University High School | Air-Handling Unit | 2 | Kitchen/Cafeteria |

In general, the scope of work will include the following items. The final details will be included on the final engineered drawings and specifications that will be used for bidding and procurement purposes.

<u>Demolition and Removal Work</u>

- Disconnect, remove and properly dispose of existing unit
- Disconnect existing electrical disconnect
- Disconnect existing BAS connections (as required)
- Properly disconnect and isolate smoke alarms and other life safety devices connected to the unit
- Remove existing unit and dispose of properly
- Safely disconnect equipment from existing ducting and cold/hot water piping
- Temporarily seal or cap all disconnected utilities

<u>New Installation Work</u>

- Furnish, install, and commission new unit to match existing sizing
- Reconnect equipment to existing electrical power wiring, reusing equipment starter. Provide labor, conduit, fittings, gauges, insulation, etc.
- Reconnect equipment to new/existing BAS control system
- Installation to be performed in accordance with mechanical, electrical, fire, local, state and national installation and operational codes

- Reconnect equipment to existing ducting, installing transition ductwork as required
- Reconnect equipment to existing distribution piping
- Provide new unit factory start-up and commissioning

## Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

| | |
|---|---|
| | Air-Conditioning Savings |
| Existing kW | = Existing wattage of AC unit x Qty of Units |
| Cost per kWh | = $/kWh |
| Cost of Existing Air-conditioning | = Existing kW x Cost per kWh x Effective Full-load Hours |
| Cost of Proposed Air-conditioning | = Proposed kW x Cost per kWh x Effective Full-load Hours |
| Energy Savings $ | = Existing AC Costs – Proposed AC Costs |
| | Heating Savings |
| Existing Heating Efficiency | = Existing Heat Production/ Existing Fuel Input |
| Proposed Heating Efficiency | = Proposed Heat Production/ Proposed Fuel Input |
| Energy Savings $ | = (Heating Production / Existing Heating Efficiency – Heating Production / Proposed Efficiency) x Cost per therm |

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Few quality and cost-effective manufacturers are available. The customer and Johnson Controls will determine final selections. |
| Equipment Identification | Product cut sheets and specifications for generally used product can be included if requested by the customer. As part of the measure design and approval process, specific product selection will be provided for your review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Changes in Infrastructure

New equipment will be installed as described. No architectural or structural changes to the facility are anticipated with the implementation of this measure.

## Customer Support and Coordination with Utilities

There may be short-term interruptions to equipment operation, while the new units are installed. Installation will be scheduled during a time which provides for the lowest reasonable facility impact. Impact to the occupants will be kept at a minimum. All interruptions (if necessary) will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result from reducing electrical usage through improved EER ratings of the new equipment under similar operating conditions. The equipment uses no other resources. |
| Waste Production | This measure will produce waste by products. Old units will be demolished, removed and disposed of according to all guidelines by contractor. |
| Environmental Regulations | All work must be performed in accordance with EPA guidelines with regards to refrigerant reclaiming. |

# ECM 8: Install / Replace Rooftop Units with Addition of Indoor Air Quality Improvements

## ECM Summary

There are numerous packaged rooftop units that heat and cool the schools. These rooftop units have surpassed their useful service life and have very poor cooling energy efficiencies (8.5 to 9.0 EER). The high-efficiency units of today have cooling efficiency of 12 to 14 EER with digital controls, air side economizers and high-efficiency fan motors.

The heating and cooling efficiencies of these rooftop units could be vastly improved by replacing them with high-efficiency heating and cooling units that feature digital controls, air side economizers and high-efficiency fan motors.

There are also numerous, smaller split systems throughout the school district that would be replaced with high-efficiency units with EERs between 14 and 18.

## Existing Systems

**Luis Muñoz Marin School**

**Hawthorne Avenue School**

**Mount Vernon School**

## Proposed System

The heating and cooling efficiencies of the existing roof top units could be vastly improved by replacing them with high-efficiency heating and cooling units that feature digital controls, air side economizers and high-efficiency fan motors.

During the design phase, different approaches and technologies will be evaluated to improve the indoor air quality. Some examples are listed below:

- Increasing Ventilation Rates: Increasing the amount of clean outdoor air and increasing the amount of filtered recirculated air decreases pathogen exposure probability by diluting and removing aerosols.
- Improving Filtration: Adding filters, including HEPA filters and filters with the highest minimum efficiency reporting value (MERV) rating can trap more particles and increase your building's clean air percentage.
- Disinfecting Air with UV-C Lighting: Ultraviolet germicidal irradiation (UVGI) is a disinfection method that uses UV-C light to inactivate viral and bacterial microorganisms in the air so they are unable to replicate. UVGI can be used to disinfect air passing through air-handling units and by circulating room air through UV-C troffers in the ceiling.
- Room Control: Temperature, room pressurization, and relative humidity also aid in destabilizing airborne viral transmission by reducing cross contamination and creating protective environments for occupants.

## Scope of Work

The following table provides a list of the type and quantity of units being replaced in each building included in the scope:

| Building | RTU | Multizone Unit | Split System | Description |
|---|---|---|---|---|
| Bard Early College High School | 1 | -- | -- | Teachers and Conference rooms |
| | -- | -- | 5 | Kindergarten rooms |
| Dr. William Horton School | -- | 2 | -- | Academy Section |
| Early Childhood Center – West | -- | 3 | -- | Newer Addition |
| East Side High School | 1 | -- | -- | Penthouse |
| Hawthorne School | 2 | -- | -- | Cafeteria & Gym |
| Luis Muñoz Marin School | 1 | -- | -- | Auditorium |
| Mount Vernon School | 1 | -- | -- | Gym & Basement Classrooms |
| South 17th School | -- | 2 | -- | Newer Addition |
| Ivy Hill Elementary School | -- | -- | 1 | Library |

In general, the scope of work will include the following items. The final details will be included on the final engineered drawings and specifications that will be used for bidding and procurement purposes.

- Provide roof protection around the units and work path across the roof
- Provide the proper roof edge protection for the work area
- Inspect the roof for any roof leaks
- Safe off existing rooftop units from the electrical power, control sources
- Disconnect the power feeders, control wiring and the hot water supply / return connections

- Reclaim the refrigerant from the existing units and dispose of properly
- Furnish and install the required crane to lift the existing rooftops off the roof and new packaged units and to the roof
- Furnish and install the required storage, trucking of the new units to the site and old units from the site for disposal
- Lift the old units off the roof and set the new units over a weekend (single day operation)
- Connect the existing power wiring to the new units (check phasing)
- Provide factory installed smoke detector (connection to fire system by others)
- Provide and install controls connections for each unit
- Provide factory start-up assistance of the installing trades (electrical, mechanical) 2 days per unit
- Provide air balancing of the new units
- Provide factory start-up of the units on weekend hours
- Provide start-up and balance reports within 5 days of start-up
- Clean off the work areas

## Savings Methodology

Energy savings result from the improved efficiency on the units.

kW Savings = Measured kW **x** ((1/std. Eff.) - (1/New Eff.))

Annual kWh Savings = Demand savings **x** Hrs. Operating per Year

## Benefits

- Electric savings generated through an increased efficiency
- Lower utility expenditures
- Reduced operations and maintenance cost, new unit will be under warranty
- Improved system reliability
- Improved comfort

# ECM 9: Chiller Replacements

## Existing Conditions

The chillers in the listed schools are less efficient than the new generation of high-efficiency chillers.

**Gladys Hillman-Jones Middle School**

**Belmont Runyon School**

## Scope of Work

Johnson Controls proposes replacing the existing nominal efficiency air-cooled chillers with new high-efficiency units. Installing air-cooled chillers eliminates the need to provide for and maintain cooling towers. The proposed chiller improves part-load performance and uses environmentally friendly R-134A refrigerant. Replacing the old chillers will avoid future chiller repair and replacement expenditures. The latest generation of chillers also have VFD compressors, improved DDC and operating sequences to improve efficiency, reliability and turndown capacity.

The following table provides a list of the type and quantity of units being replaced in each building included in the scope:

| School | Chillers | Type | Tonnage | Install Location |
|---|---|---|---|---|
| Gladys Hillman-Jones School | 2 | Air-Cooled Chillers | 125 | Parking Lot |
| Belmont Runyon | 2 | Air-Cooled Chillers | 171 | Roof |
| Louise A Spencer | 1 | Air-Cooled Chiller | 100 | Mechanical Room and Roof |
| Harold Wilson School | 2 | Air-Cooled Chillers | 100 | Outside of Mechanical Room |

Savings are being carried within the ESIP cash flow for the chiller replacement at Alma Flagg. However, the work is being done outside of the ESIP and will not be done by Johnson Controls.

In general, the scope of work will include the following items. The final details will be included on the final engineered drawings and specifications that will be used for bidding and procurement purposes.

- Safe off the chilled water supply and return isolation valves.
- Drain the chilled water system to modify the chilled water piping system as required.
- Disconnect, remove and properly dispose of the existing chiller.
- Disconnect electrical and controls connections and reserve for reuse as required and demolish connections no longer required.
- Demolish the all the existing cooling tower and associated water piping and pumps and discard from the site as required for any air-cooled chiller conversion.

- Strip back the required pipe insulation to allow for the removal of the required chilled water piping to allow for the chilled water piping removal as required.
- Reclaim and properly dispose of refrigerant and oil per local codes.
- Provide and install chillers.
- Provide and install new concrete equipment pads as required.
- Modify and reconnect new chiller to existing chilled water piping.
- Insulate all new and disturbed chilled water pipe, valves and fittings. Paint new piping to match existing.
- Reconnect chiller to existing electrical system.
- Reconnect equipment to BAS.
- Equipment start-up by factory authorized representative.
- Install meters as required for M&V of the energy savings.

## Savings Methodology

Savings were calculated using a bin-calc Excel-based workbook.

## Benefits

- Improved part-load performance
- Use of a more environmentally friendly refrigerant
- Reduced chiller repair and replacement expenditures
- Reduced utility cost

# ECM 10: Boiler Replacement

## ECM Summary

This ECM replaces boilers that operate at lower than acceptable efficiencies and are at the end of their life. The new boilers will help the school district achieve future energy savings and lower the amount of maintenance cost during the contract period. This ECM was applied to boiler systems based on operation condition and thermal efficiencies.

## Existing System

There are three different types of boiler systems considered under this measure

- Replace existing boiler with hot water condensing boilers
- Replace existing steam boilers with new, high-efficiency steam boilers
- Replace electric boilers with natural gas hot water condensing boilers

Replacing these inefficient boilers with new energy-efficient equipment and state-of-the-art controls would result in significant energy and maintenance cost savings along with improved performance.


**Lafayette School**

**Harriet Tubman School**

## Proposed System Upgrades

**Steam to Steam Boiler Replacement**

This measure will replace the existing steam boilers at several schools with new steam boilers. The replacement of existing boilers with new high-efficiency units will provide efficiency gains from the reduction in radiant and convective heat losses. In many instances, the locations of the boilers provide difficult access into and out of the boiler room. The old boilers will be taken apart in pieces while the new boilers will be field-erected in place using a boiler from Easco.

**Install Hot Water Condensing Boilers**

This measure will install new hot water boilers in place of the aging, lower efficiency units currently in use at McKinley School. Introducing higher efficiency, modulating gas boilers will provide the same amount of heat to the building at a lesser cost to the school district. The boilers will have a better controllability with hot water temperature reset based on outside air. In addition, substantial operations and maintenance savings will be realized as the equipment will be brand new and will come with a full warranty. This will increase reliability of the heating system and allow school maintenance personnel to divert its resources to other, more needing areas of maintenance demand in the school district.

**Electric to Natural Gas Conversion and Install Condensing Boilers**

Natural gas is a more efficiency source of energy than electricity to produce heating hot water. Johnson Controls proposes to replace the existing inefficient electric boiler system at Dr. E. Alma Flagg School and Harold Wilson School with high-efficiency natural gas fired hot water boilers. It is the Newark Public Schools' responsibility to work with the local utility to ensure gas is brought to the building in order to be able to install natural gas-fired boilers. An alternate exists at Harold Wilson School to use a heat pump chiller in lieu of a natural gas boiler. Final selection at Harold Wilson will be made during the Design Phase of the project.

## Scope of Work

The following table provides a list of the type and quantity of units being replaced in each building included in the scope:

| School | Existing Quantity | Existing Type | Proposed Type | Heating Input (MBtu/h) |
|---|---|---|---|---|
| Alma Flagg | 1 | Electric Hot Water | Gas Fired Hot Water | 2,000 |
| Ben Franklin | 2 | Gas Fired Steam | Gas Fired Steam | 8,400 |
| Chancellor Ave | 2 | Gas Fired Steam | Gas Fired Steam | 5,250 |
| East Side High | 2 | Gas Fired Steam | Gas Fired Steam | 14,700 |
| Harold Wilson | 1 | Electric Hot Water | Gas Fired Hot Water | 2,000 |
| Harriet Tubman | 1 | Gas Fired Steam | Gas Fired Steam | 4,200 |
| Lafayette Street | 2 | Oil-Fired Steam | Gas Fired Steam | 8,400 |
| Louise Spencer | 2 | Gas Fired Steam | Gas Fired Steam | 14,700 |
| McKinley | 2 | Gas Fired Hot Water | Gas Fired Hot Water | 8,400 |
| Roberto Clemente | 2 | Gas Fired Steam | Gas Fired Steam | 7,350 |
| Salomé Ureña | 2 | Gas Fired Steam | Gas Fired Steam | 7,350 |
| University High | 3 | Gas Fired Steam | Gas Fired Steam | 16,800 |

Savings are being carried within the ESIP cash flow for the boiler replacements at Abington Avenue and Newark Vocational. However, work at both locations is being done outside of the ESIP and will not be done by Johnson Controls.

In general, the scope of work will include the following items. The final details will be included on the final engineered drawings and specifications that will be used for bidding and procurement purposes.

<u>Demolition, removal and disposal:</u>

- Existing boiler(s)
- Boiler breeching as required
- Hot water pumps if required

<u>Furnish and install the following:</u>

- New boilers with new burner(s)
- Modify Flue(s) as required for new boiler(s)
- All piping, valves, and fittings to connect new boiler(s) to existing heating distribution system
- All natural gas piping required for a complete operational system
- Insulate heating system piping with fiberglass and PVC fittings

- Electrical power and control wiring to new boiler(s)
- Leak check piping
- Coordinate with new DDC controls
- Provide factory start-up and warrantee

## Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Existing Heating Efficiency = Existing Heat Production / Existing Fuel Input

Proposed Heating Efficiency = Proposed Heat Production / Proposed Fuel Input

Energy Savings $ = Heating Production (Proposed Efficiency – Existing Efficiency)

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | As part of the measure design and approval process, specific product selection will be provided for the customer's review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Customer Support and Coordination with Utilities

Minor support will be required for the interruption of utilities for brief tie-in periods. All interruptions will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result from greater plant efficiency, and reduced maintenance costs. |
| Waste Production | This measure will produce waste by products. Existing boilers will be removed and demolished according to proper guidelines by contractor. |
| Environmental Regulations | Environmental impact is expected; all regulations will be adhered to in accordance with federal and local code requirements. |

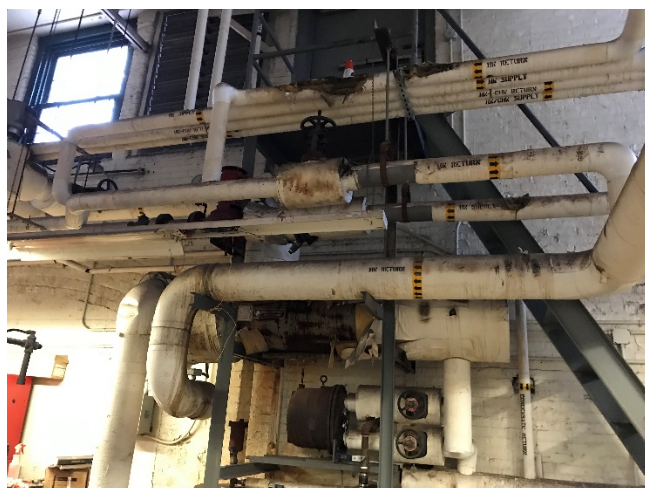
# ECM 11: Replace Steam Boilers with Hot Water Boilers and Eliminate Steam-to-Hot Water Heat Exchanger

## ECM Summary

Steam-heated buildings use more energy than buildings with hot-water-distribution systems. This is because with steam heat, the boiler must heat the water to the point at which it becomes steam, which takes much more energy than heating water just enough for a hot water system. In addition, steam-heated buildings often have the problem of uneven heating, which is a big cause of energy waste in buildings because the maintenance staff has to overheat some spaces to provide adequate heat to others. Therefore, converting a steam distribution system to hot water can save energy as well as reduce problems with maintenance and uneven heating of rooms and other areas.

## Existing System

The boilers at Gladys Hillman-Jones (aka Newark School of Global Studies) are considered as candidates for the steam-to-hot water system conversion based on our evaluation of the building. The boilers are used to make steam which goes through the heat exchanger to produce hot water which is then distributed throughout the building. Steam is not used anywhere else besides in the heat exchanger. Therefore, it will be a more efficient process to create hot water directly from the boilers instead of going through the secondary process of sending steam through a heat exchanger.

**Gladys Hillman-Jones School**

## Proposed System Upgrades

Johnson Controls proposes replace the steam boilers with hot water boilers and eliminate the steam-to-hot-water heat exchangers. New modulating condensing gas boilers are available that minimally operate at 88% efficiency, and can operate as high as 96% depending on return water temperatures. New dedicated boiler venting would also need to be installed either through the roof or sidewall. Asbestos abatement will be performed prior to any work, as necessary.

**Eliminate Steam to HW Heat Exchangers**

Johnson Controls proposes to replace the existing natural gas fired steam boilers at Gladys Hillman-Jones by eliminating the steam-to-hot water heat exchanger and installing natural gas fired high-efficiency condensing boilers to provide for the hot water service of the building.

## Scope of Work

The following table provides a list of the type and quantity of units being replaced in each building included in the scope:

| School | Quantity | Existing Type | Proposed Type | Heating input (MBtu/h) |
|---|---|---|---|---|
| Gladys Hillman-Jones | 2 | Gas Fired Steam | Gas Fired Hot Water | 5,250 |

In general, the scope of work will include the following items. The final details will be included on the final engineered drawings and specifications that will be used for bidding and procurement purposes.

Demolition, removal and disposal:

- Existing boiler(s)
- Boiler breeching as required
- Steam-to-hot water heat exchanger

Furnish and install the following:

- New boilers with new burner(s)
- Modify Flue(s) as required for new boiler(s)
- All piping, valves, and fittings to connect new boiler(s) to existing heating distribution system
- All natural gas piping required for a complete operational system
- Insulate heating system piping with fiberglass and PVC fittings
- Electrical power and control wiring to new boiler(s)
- Leak check piping
- Coordinate with new DDC controls
- Provide factory start-up and warrantee

## Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Existing Heating Efficiency = Existing Heat Production / Existing Fuel Input

Proposed Heating Efficiency = Proposed Heat Production / Proposed Fuel Input

Energy Savings $ = Heating Production (Proposed Efficiency – Existing Efficiency)

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | As part of the measure design and approval process, specific product selection will be provided for the customer's review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result from greater plant efficiency, and reduced maintenance costs. |
| Waste Production | This measure will produce waste by products. Existing boilers will be removed and demolished according to proper guidelines by contractor. |
| Environmental Regulations | Environmental impact is expected; all regulations will be adhered to in accordance with federal and local code requirements. |

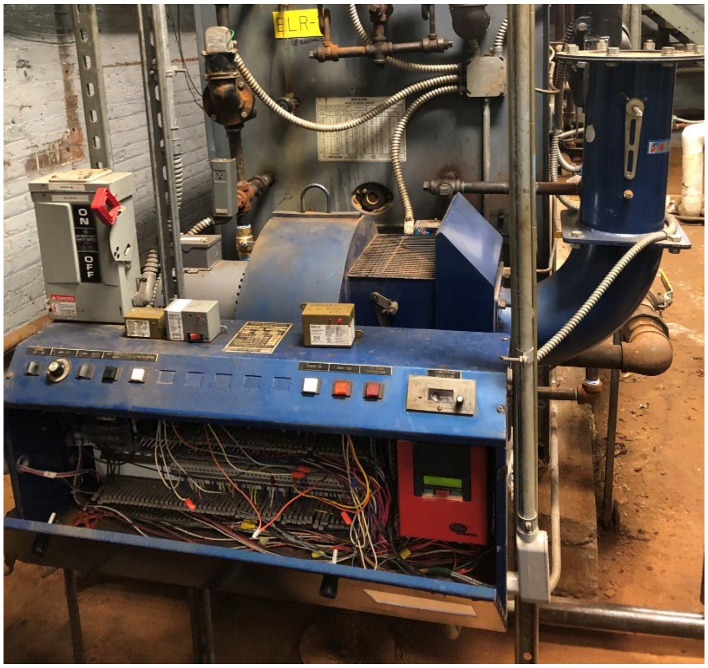
# ECM 12: Boiler Burner Upgrades

## ECM Summary

During the course of the investment grade audit, boilers were looked at for possible replacement. Where replacing the entire boiler was not necessary, replacing the burners were looked as an alternative solution. The burners that operate at lower than acceptable efficiencies and are at the end of their life should be replaced. The new burners will help the school district achieve future energy savings and lower the amount of maintenance cost during the contract period.

## Existing System

**Early Childhood Center – South**




**Peshine Avenue School**

## Scope of Work

The following table provides a list of the type and quantity of units being replaced in each building included in the scope:

| School | Quantity | Heating input (MBtu/h) |
|---|---|---|
| Early Childhood South | 2 | 6,277,000 |
| Mt. Vernon School | 2 | 6,495,000 |
| Peshine Ave School | 2 | 5,230,000 |
| South 17th Street school | 2 | 5,124,000 |

In general, the scope of work will include the following items. The final details will be included on the final engineered drawings and specifications that will be used for bidding and procurement purposes.

- Remove existing unit(s) and dispose of properly.
- Install new burner(s).
- Assemble and install burner units in compliance with manufacturer’s installation instructions. All work must be done in a neat and workman like manner.

- Start-up and testing will be performed and commissioning report will be provided.
- Burners will be equipped with lead lag control performed by the new DDC control system.
- Re-install controllers on new burners, as applicable.

## Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Existing Heating Efficiency = Existing Heat Production/ Existing Fuel Input

Proposed Heating Efficiency= Proposed Heat Production/ Proposed Fuel Input

Energy Savings $ = Heating Production (Proposed Efficiency – Existing Efficiency)

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | As part of the FIM design and approval process, specific product selection will be provided for your review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Changes in Infrastructure

New burners will be installed. For most of the burner replacements, no architectural or structural changes to the facility are anticipated with the implementation of this measure.

## Customer Support and Coordination with Utilities

Minor support will be required for the interruption of utilities for brief tie-in periods. Continuity of service must be maintained for the customer. All interruptions will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result from greater plant efficiency, and reduced maintenance costs. |
| Waste Production | This measure will produce waste by products. Existing burners will be removed and demolished according to proper guidelines by contractor. |
| Environmental Regulations | Environmental impact is expected; all regulations will be adhered to in accordance with federal and local code requirements. |

# ECM 13: Decommission Steam Boiler & Replace Kettles

## ECM Summary

The heating source for the steam kettles in the kitchen of 13th Avenue School is provided be a Weil-McLain steam boiler located in the boiler room. The steam produced by the boiler is used only for two (2) 20 gallon steam kettles located in the kitchen. This measure proposes the boiler will be removed and kettles replaced with units that are locally heated via natural gas direct firing.

**Thirteenth Avenue School**

## Scope of Work

**Mechanical:**

- Safe off the existing boiler from the natural gas service.
- Disconnect and remove the steam supply main and condensate return, isolate the piping connection from the boiler.
- Disconnect and remove the existing breeching from the boiler over to the chimney and discard.
- Demolish the existing heating boiler and remove from the building and discard (customer option to retain if desired).
- Remove existing steam kettles and cut back existing steam piping (customer option to retain kettles if desired)
- Install new gas service from existing kitchen source branch to allow for new kettle gas connection per manufacturer specifications
- Furnish and install new direct fired kettles in kitchen per manufacturer specification
- Start-up and test the new kettles

**Electrical:**

- Safe off the boilers from the electrical power circuits, lockout-tag out.
- Provide 115V to new kettles per manufacturer specifications

## Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Existing Heating Efficiency = Existing Heat Production / Existing Fuel Input

Proposed Heating Efficiency = Proposed Heat Production / Proposed Fuel Input

Energy Savings $ = Heating Production (Proposed Efficiency – Existing Efficiency)

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | As part of the measure design and approval process, specific product selection will be provided for the customer's review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Environmental Issues

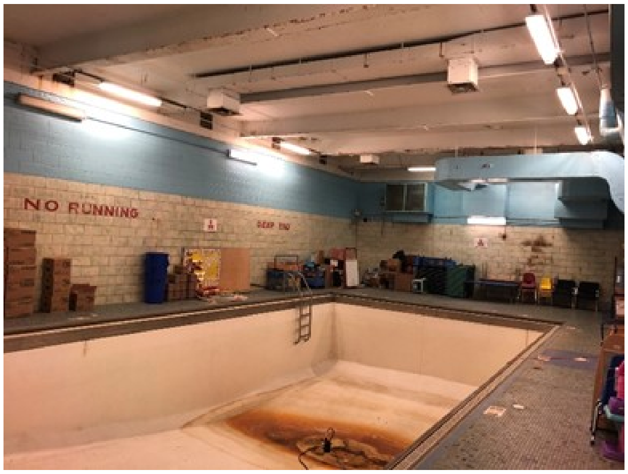
| | |
|---|---|
| Resource Use | Energy savings will result from greater point source efficiency, and reduced boiler system maintenance costs. |
| Waste Production | This measure will produce waste by products. Existing boilers will be removed and demolished according to proper guidelines by contractor. |
| Environmental Regulations | Environmental impact is expected; all regulations will be adhered to in accordance with federal and local code requirements. |

# ECM 14: Pool Upgrades

## Existing Conditions

The pool heater at Early Childhood Center-South is not functioning along with the heating and ventilating (H&V) unit serving the pool area and locker room. Although the pool itself is in need of some rehab, the pool heater keeps the water temperature at a consistent level while the H&V unit provides heating and supplies outside air to the spaces. This ECM does not address any modification/repairs to the pool itself.

At John F. Kennedy School, the PoolPak unit is in poor working condition. This unit helps to dehumidify the pool area and provides some air condition to keep the environment from getting overly humid and uncomfortable for those using the pool.




**Early Childhood Center - South**

## Scope of Work

In general, the scope of work will include the following items. The final details will be included on the final engineered drawings and specifications that will be used for bidding and procurement purposes.

**Early Childhood Center – South**

- Provide and install a natural gas fired pool heater rated to heat 24,000 gallons of indoor pool water
- Pour a new concrete equipment pad suitable for the new pool heater footprint
- Set the new pool heater onto the new pad
- Provide and install the required pipe, valves, and fittings to connect the new heater to the pool water circulation system
- Provide and install the required new double wall exhaust pipe and fittings to connect the new heater to the existing chimney
- Provide factory start-up and test the pool heater
- Refurbish the H&V unit serving the pool and locker room areas by:
    - Cleaning the entire unit including the heating coils
    - Repair or replace interior insulation
    - Perform maintenance on the damper sections and repair/replace damper operators, as needed

- Replace the bearings and belts on the blower, as needed
- Replace air filters and repair or replace the door gaskets
- Provide and install new high-efficiency blower motor and sheaves
- Test, adjust and balance the H&V unit

**John F. Kennedy School**

- Cap off the existing duct system serving the actual pool area. Duct work for the locker rooms to remain operational
- Provide and install roof-mounted PoolPak, dehumidification/air-conditioning unit
- Fabricate and install the required new supply duct work across the pool area wall with the required supply air diffusers
- Furnish and install the factory provided controls
- Provide and install new thermostats for the locker room areas
- Install new zone dampers and related controls to operate the dampers
- Provide factory start-up of the PoolPak unit

## Facilities Recommended for This Measure

- Early Childhood Center – South
- John F. Kennedy School

## Savings Methodology

There are no savings associated with this ECM.

## Benefits

- Reduced operations and maintenance cost, new unit will be under warranty.
- Improved system reliability.

# ECM 15. Steam Trap Replacement

## ECM Summary

The three important functions of steam traps are as follows:

- To discharge condensate as soon as it is formed
- Not to allow steam to escape
- To be capable of discharging air and other incondensable gases

Steam traps can be split into three major types:

1. **Mechanical traps.** They have a float that rises and falls in relation to condensate level and this usually has a mechanical linkage attached that opens and closes the valve. Mechanical traps operate in direct relationship to condensate levels present in the body of the steam trap. **Inverted bucket** and **float traps** are examples of mechanical traps.
2. **Temperature traps.** They have a valve that is driven on / off the seat by either expansion / contraction caused by temperature change. They differ from mechanical traps in that their design requires them to hold back some condensate waiting for it to cool sufficiently to allow the valve to open. In most circumstances this is not desirable as condensate needs to be removed as soon as it is formed. Thermostatic traps and bimetallic traps are examples of temperature operated traps.
3. **Thermodynamic (TD) traps.** Thermodynamic traps work on the difference in dynamic response to velocity change in flow of compressible and incompressible fluids. As steam enters, static pressure above the disk forces the disk against the valve seat. The static pressure over a large area overcomes the high inlet pressure of the steam. As the steam starts to condense, the pressure against the disk lessens and the trap cycles. This essentially makes a TD trap a “time cycle” device: it will open even if there is only steam present, this can cause premature wear. If non-condensable gas is trapped on top of the disc, it can cause the trap to be locked shut.

A significant amount of energy is lost during a failed open steam trap scenario. Johnson Controls proposes to replace the steam traps which will reduce heat losses significantly.

This ECM will consist of two parts:

- **Inspection** – The first process involves providing a complete steam trap survey (and report) conducted by a trained and qualified steam trap survey technician. Typically, steam traps are checked by measuring the temperature difference between the inlet and outlet of the trap. In addition, sound measuring instruments are used to listen to the flow in the trap to verify proper operation. The technician conducting the survey will inspect the installation and application of the steam trap. In many cases the incorrect type or rating of steam trap is installed or the incorrect steam trap is used in a particular application. During the survey all condensate systems including pumping systems should be inspected for proper operation.
- **Steam Trap Survey Report Analysis** – The second process involves studying the steam trap report, verifying deficiencies, selecting the proper steam trap for the application and replacing the defective steam traps.

## Existing System

The steam operated facilities consist of steam and condensate main piping, steam and condensate distribution piping, strainers, steam control valves terminal equipment (steam coils, heaters, etc.), condensate pumps and steam traps. The function of the steam trap is to vent air and drain condensate formed in the steam distribution systems and prevent live steam from exiting when condensate is discharged.

The condensate is trapped and removed via various styles of steam traps (float and thermostatic, inverted bucket and thermodynamic types), each having a specific function and range of applications. These traps require constant maintenance to assure proper operation.

**Steam Trap Characteristics**

| Type of Trap | Maintenance Characteristics |
|---|---|
| Float Type Mechanical Traps | Float operated valve located under water level prevents steam escape. Does not vent air and gas, but usually has thermostatic vent. |
| Inverted Bucket Mechanical Trap | Resistant to water hammer and steam leaks. Prone to freezing, vents only a limited amount of air. |
| Bimetallic Thermostatic Trap | Not vulnerable to water hammer. |
| Thermodynamic Disk Trap | Will dump live steam if cool air surrounds trap. May need insulation for proper operation. |

## Proposed System

Johnson Controls proposes to replace steam traps located at multiple steam heating system buildings included in the scope of the project.

Thermostatic steam traps will be replaced with new Barnes and Jones cage units and covers.

Float and thermostatic steam traps will include complete replacement with new steam traps manufactured by Barnes & Jones Inc. All existing strainers, isolation valves, check valves, and fittings in good repair will be reused.

## Facilities Recommended for this Measure

- 32 Schools Included (Refer to ECM table). Excludes schools that were part of previous ESIP phases.

## Scope of Work

- Furnish and install necessary steam traps of proper sizes and type based on function of equipment
- Check operation of the new steam traps
- Provide training on maintenance of steam traps and recommended steam trap maintenance schedule

## Benefits

- Steam savings
- Operational savings through new equipment and preventative maintenance plan

# ECM 16: Variable Speed Drives on Pumps

## ECM Summary

This measure proposes to install variable speed drive controls on the pumps within the school district. This control will allow for a more efficient operation of the pumps and reduce electric consumption.

## Existing System

Johnson Controls identified that many pumps do not have any type of modulation controls on them.

## Proposed System

This ECM will install a variable speed drive on the electric motor associated with the pumps. In some cases, this will also include a new inverter duty motor (if not already rated as such) along with the drive for optimal efficiency. Motor replacements are outlined and described in ECM 17.

Varying the speed of a motor to match the actual load improves control and reduces electrical motor power (kW), which may result in both comfort improvement and electrical energy savings. The speed of the motor changes by varying voltage and frequency to the motor. As the system's load changes, so does the required motor-driven output.

A control program and variable speed drive will modulate the speed of the motor and match the output to the load. By reducing the speed of an electric motor, the energy required by the motor is reduced. The actual power required is proportional to the cube of the speed. For example, if a motor's speed is reduced to 80%, the motor's energy consumption decreases by approximately 50%.

## Scope of Work

In general, the scope of work will include the following items. The final details will be included on the final engineered drawings and specifications that will be used for bidding and procurement purposes.

| School | Motor HP | Description | Quantity |
|---|---|---|---|
| American History High School | 7.5 | HW Pump | 2 |
| East Side High School | 7.5 | HW Pump | 3 |
| Gladys Hillman-Jones Middle School | 20 | Dual Temp Pumps | 2 |
| Belmont Runyon School | 20 | HW Pump | 2 |
| | 20 | CHW Pump | 3 |
| Harold Wilson School | 5 | HW Pump | 2 |
| | 7.5 | CHW Pump | 3 |
| Louise A. Spencer School | 30 | HW Pump | 1 |
| | 7.5 | CHW Pump | 2 |
| Bard Early College High School | 30 | HW Pump | 2 |
| Camden Street School | 10 | HW Pump | 2 |
| John F. Kennedy School | 5 | HW Pump | 2 |
| | 10 | CHW Pump | 2 |
| West Side High School | 7.5 | HW Pump | 2 |

- Furnish and install new variable speed drives
- Provide electrical power wiring from the main electrical panel to each new unit mounted variable speed drive

- Reuse existing electrical wiring where possible. Note variable speed drives may be located remotely in electrical or mechanical room
- Modify electrical power wiring distribution panel as needed
- Extend communication bus to/from each variable speed drive to/from existing energy management system as applicable
- Perform any required programming and graphics modifications

## Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

kWh savings  kWh reduced = [(Fan kW) x (Reduced Flow/Orig. Flow)^2] x EFLH

Where EFLH = Effective Full-load Hours

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | Product cut sheets and specifications for generally used product will be included in the comprehensive audit. As part of the measure design and approval process, specific product selection will be provided for your review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Changes in Infrastructure

No architectural or structural changes to the facility are anticipated with the implementation of this measure.

## Customer Support and Coordination with Utilities

Coordination of the electrical lock out and tag out will be required. All interruptions (if necessary) will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result from reducing electrical usage by load following. The equipment uses no other resources. |
| Waste Production | This measure may produce waste by products. Old motors will be removed and disposed of according to all guidelines by the contractor. |
| Environmental Regulations | No environmental impact is expected. |

# ECM 17: Premium Efficiency Motors

## ECM Summary

Energy savings can be obtained by replacing the standard efficiency motors that are installed throughout the school district with premium efficiency motors. Johnson Controls has identified motors in the school district as candidates for replacement with premium efficiency equivalents.

## Existing System

Johnson Controls has identified heating hot water pump motors, chilled water pump motors, and air-handling units as good candidates for replacement of motors to premium efficiency units.

## Proposed System

The improved efficiency of the NEMA Premium® efficient motors is primarily due to better designs with use of better materials to reduce losses. The electricity used to power a motor represents 95% of its total lifetime operating cost. Because many motors operate continuously, even small increases in efficiency can yield substantial energy and dollar savings.

## Scope of Work

In general, the scope of work will include the following items. The final details will be included on the final engineered drawings and specifications that will be used for bidding and procurement purposes.

| School | HW Pumps | CHW Pumps | AHU | ERUs |
|---|---|---|---|---|
| American History High School | (2) 7.5 HP | - | - | - |
| East Side High School | (3) 7.5 HP | - | - | - |
| Dr. E. Alma Flagg School | - | - | (2) 5HP | - |
| Gladys Hillman-Jones Middle School | - | - | (3) 10 HP | - |
| Rafael Hernandez Elementary School | - | - | (2) 15 HP<br>(1) 20 HP | - |
| Belmont Runyon School | (2) 1.5 HP | - | (6) 1 HP | - |
| Early Childhood Center - South | - | - | - | - |
| Harold Wilson School | - | (3) 7.5 HP | - | - |
| University High School | - | - | (4) 5 HP | - |
| Bard Early College High School | (2) 30 HP | - | - | - |
| John F. Kennedy School | (2) 5 HP | - | - | - |
| Speedway Avenue | - | - | - | (4) 5 HP |
| Thirteenth Avenue School | - | - | (5) 5 HP | - |
| West Side High School | (2) 20 HP | - | (6) 1 HP | - |

This ECM replaces existing inefficient electric motors with NEMA Premium® efficiency motors. The electric motors driving the pumps and fans are candidates for replacing with premium efficiency motors. These standard efficiency motors run considerable amount of time over a year.

In general, the scope of work will include the following items. The final details will be included on the final engineered drawings and specifications that will be used for bidding and procurement purposes.

- Furnish and install new premium efficiency motors
- Installation shall include leveling alignment and reinstallation of a serviceable belt guard
- Reconnect motor to existing electrical power wiring, reusing motor starter
- Perform start-up, testing, verification of motor rotation and other testing per manufacturer specifications

## Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Motor kW Savings = Measured kW x ((1/std. Eff.) - (1/New Eff.))

Annual kWh Savings = Motor kW Savings x Hrs. Operating per Year

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | Product cut sheets and specifications for generally used product will be included in the comprehensive audit. As part of the measure design and approval process, specific product selection will be provided for your review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Changes in Infrastructure

New motors will be installed in place of the old motors. No architectural or structural changes to the facility are anticipated with the implementation of this measure.

## Customer Support and Coordination with Utilities

There may be short-term interruptions to equipment operation, while the new motor is installed. Installation will be scheduled during a time which provides for the lowest reasonable facility impact. Impact to the occupants will be kept at a minimum. All interruptions will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result from reducing electrical usage by operating higher efficiency motors for the same horsepower output. The equipment uses no other resources. |
| Waste Production | This measure will produce waste by products. Old motors shall be disposed of in accordance with all federal, state and local codes. |
| Environmental Regulations | No environmental impact is expected. |

# ECM 18: Energy-Efficient Transformers

## ECM Summary

Replacing existing transformers with energy-efficient types will provide reduced electricity waste; optimized, quiet and efficient electrical power; improved efficiency for a lower operating cost over life of the transformer; and new equipment with a 25-year pro-rated warranty.

## Existing System

During the site audit, several transformers throughout the school district were identified that were in need of replacement. These transformers were noticeably hot, which is an indication of energy waste. More efficient transformers will reduce the amount of electricity lost through the distribution system thus making the entire electrical system more efficient.

Transformers are typically purchased as part of a total electrical distribution package, installed, and forgotten for 40-50 years. The majority of these transformers are operating at a small fraction of their nameplate capacity, resulting in very low efficiency, and are often producing large amounts of excess heat, resulting in energy losses, and higher electric costs. According to the Department of Energy, half of all existing transformers are approaching a mean time to failure of 32 years. Replacing these units prior to a sudden end of life, results in lower risk of facility down time.

## Proposed System

Transformers such as the E-Saver-C3 transformer by Powersmith is the ideal transformer for institutional and commercial environments where energy efficiency is a priority. Optimized for lowest life cycle cost, these types of transformers reduce waste by as much as 74%.

**Typical Powersmith E-Saver high-efficiency transformer**

For example, Powersmiths E-Saver-C3 is a three-phase common-core, ventilated, dry type isolation transformer, built in an ISO 9001 and ISO14001 environment to NEMA ST-20 and other applicable ANSI and IEEE standards. Primary and secondary terminals and voltage taps are readily accessible by removing the front cover plate; 10kV BIL. The E-Saver-C3 has 220°C class insulation, is rated for 60 Hz, and comes in a NEMA 1 ventilated indoor enclosure. It exceeds the efficiency requirements of a Department of Energy candidate Standard Level 3 (CSL 3). The E-Saver-C3L comes in two models optimized for light loading: copper-wound k-7 listed, and aluminum-wound k-4 listed. Both have a 130°C temperature rise. The E-Saver-C3H is optimized for heavy loading, is copper-wound, has a UL listed k-13 rating, and a 105°C temperature rise. The C3H model has an 80°C option with k-20 rating.

## Scope of Work

| School | Location | kVA |
|---|---|---|
| First Avenue School | 103 Elec | 112.5 |
| | 114 Elec | 150 |
| | 219 Elec | 150 |
| | Stage | 112.5 |
| | Stage | (2) @ 15 each |
| Gladys Hillman-Jones | 103 | (2) @ 30 each |
| | Main Elec | 45 |
| | Boiler Rm | 30 |
| | Main Office (201A) | (2) @ 30 each |
| | Main Office (201A) | 45 |
| | 323 | 75 |
| | 323 | 45 |
| | 416 | 75 |
| | 419 | 45 |
| Rafael Hernandez Elementary School | Main Elec | 30 |
| Belmont Runyon School | B206 Elec | (2) @ 45 each |
| | 2nd Flr Air Hndlr Rm | 45 |
| | B160 Elec | 75 |
| | B160 Elec | 45 |
| | Elec Rm By S117 | 30 |
| | B141 Elec | 45 |
| | B141 Elec | 30 |
| NJ Regional Day School | Main Elec | 75 |
| | Main Elec | 112.5 |

In general, the scope of work will include the following items. The final details will be included on the final engineered drawings and specifications that will be used for bidding and procurement purposes.

- Use existing supports for ceiling mounted transformers, if applicable.
- Accept delivery of transformers.
- Rigging of transformers from staging area to transformer location, pads where needed.
- Disconnect and remove existing transformer.
- Install new high-efficiency transformer of same size, using existing feeds and grounds.

## Savings Methodology

Below is the general approach to calculate savings for this measure.

| | |
|---|---|
| Cost per kWh | = Average Site $/kWh |
| Cost of Existing Loss | = kWh x (1-Efficiency of Transformer Existing) |
| Proposed Loss | = kWh x (1-Efficiency of Transformer Proposed) |
| Energy Savings $ | = (Existing kWh – Proposed kWh) x kWh Rate |

## Benefits

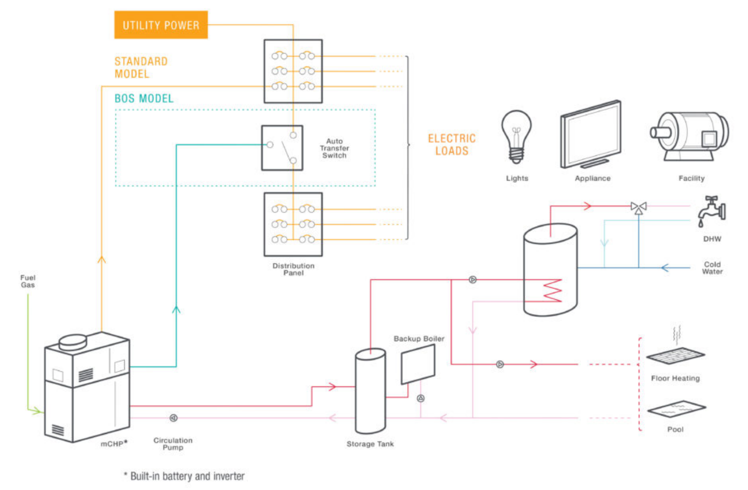
- Electrical energy savings
- Reduction in maintenance costs

# ECM 19: Combined Heat and Power

## ECM Summary

This ECM proposes the installation of two (2) CHP units which will consume natural gas to produce electricity and use excess heat for the hot water heating systems. Based upon the current cost of natural gas and rates for electricity experienced in this territory, this measure is an excellent opportunity to mitigate market supply risks and produce free heat for the heating systems.

Installation of a CHP system within an ESIP project allows project funding and business case analyses to be carried out up to 20 years.




## Existing System

Based on analysis of utility data, the locations chosen for this measure are Science Park High School and East Side High School. The waste heat produced by the CHP at Science Park will be used to heat the pool water and then supplement the heating system with the remaining waste heat. The unit at East Side High will be used to supplement the building heating system. In both locations, the electricity produced by the CHP will be distributed through the main switch gear and consumed within the building.

## Proposed System

Each system will include:

- One (1) 35 kW low emissions cogeneration module.
- One (1) pump and valve module station complete with circulating pump and thermostatic mixing valve to be located in the boiler room.
- Load modules for interfacing with the boiler plant, building space heating and other thermal loads encompassing pumps, heat exchangers, control values, and sensors for system monitoring and remote operation.
- Hydronic piping distribution from cogeneration unit to interface with building thermal loads.
- Natural gas piping from the existing service location to the cogeneration unit.
- Engine exhaust piping including silencer.
- One (1) electrical system including all necessary wiring, conduit, and fuse disconnect or circuit breaker with adequate fault duty using the standard electrical interface and a utility grade relay for interconnection and parallel operation with utility. The electrical interconnection points will be in the boiler room, including conduit, wiring, and related electrical devices.
- MCC panel with all control circuit protection, circuit protection for all pumps and other electric devices, variable speed drives, and devices for data communication for live monitoring and operating control of the entire system. BAS package for CHP plant control panel.
- Glycol based modulating heat dissipation system located on outdoor pad next to boiler room to keep system operational during varying periods with limited or no thermal load.

- Piping insulation and all required insignia to identify flow direction, valves and system components.
- Other appurtenances to make the system operational.
- Provide all rigging and shipping.
- Proper ventilation for the cogeneration system and required ductwork from the unit's exhaust to outside.
- System start-up with factory authorized technicians.

**Proposed Specifications of unit**

| YANMAR 35 kW CHP System Specifications | | | | CP35D1 | | | |
|---|---|---|---|---|---|---|---|
| Model | | | | CP35D1-TNUG | CP35D1Z-TNUG | CP35D1-TNUW | CP35D1Z-TNUW |
| Configuration | | | - | Standard | Standard with Blackout Start | Radiator-Free | Radiator-Free with Blackout Start |
| Power Output | Rated output | | kW | 35 | 35 | 35 | 35 |
| | Voltage, Frequency | | V, Hz | 208, 60 | 208, 60 | 208, 60 | 208, 60 |
| | Phase and Wire | | - | 3 phase, 3 wire | 3 phase, 3 wire *3 | 3 phase, 3 wire | 3 phase, 3 wire *3 |
| | Modulation | | | 0.5 to 35 kW with optional CT/Transducer kit *1 | | | |
| Fuel | Gas Type | | - | Natural gas | Natural gas | Natural gas | Natural gas |
| | Pressure | Standard | in WC (kPa) | 9.0 (2.25) | 9.0 (2.25) | 9.0 (2.25) | 9.0 (2.25) |
| | | Working Range | in WC (kPa) | 8.0-10.0 (2.0-2.5) | 8.0-10.0 (2.0-2.5) | 8.0-10.0 (2.0-2.5) | 8.0-10.0 (2.0-2.5) |
| | Consumption (LHV) | | BTU (kW) | 367,487 (107.7) | 367,487 (107.7) | 367,487 (107.7) | 367,487 (107.7) |
| | | | THERMS/HR | 3.67 | 3.67 | 3.67 | 3.67 |
| | Consumption (HHV)*2 | | BTU (kW) | 407,114 (119.3) | 407,114 (119.3) | 407,114 (119.3) | 407,114 (119.3) |
| | | | THERMS/HR | 4.07 | 4.07 | 4.07 | 4.07 |
| | Conusmption (Input kW/kWe) | | kW | 3.08 | 3.08 | 3.08 | 3.08 |
| Heat Output (Heat Recovery) | Rated recovered heat | | BTU/HR (kW) | 204,040 (59.8) | 204,040 (59.8) | 204,040 (59.8) | 204,040 (59.8) |
| | Rated Temp. | INLET | °F (°C) | 167 (75) | 167 (75) | 167 (75) | 167 (75) |
| | | OUTLET | °F (°C) | 176 (80) MAX 190.4 (88) | 176 (80) MAX 190.4 (88) | 176 (80) MAX 190.4 (88) | 176 (80) MAX 190.4 (88) |
| | Rated Hot water Flow | | GPM (L/min) | 46.5 (176) | 46.5 (176) | 46.5 (176) | 46.5 (176) |
| Input Power Supply | Voltage, Frequency | | V, Hz | 208, 60 | 208, 60 | 208, 60 | 208, 60 |
| | Staring Current | | A | 46 | 46 | 46 | 46 |
| | Rated power consumption | Radiator fan stop | kW | 0.72 | 0.75 | NA | NA |
| | | Radiator fan run | kW | 0.97 | 1.00 | NA | NA |
| Gross Efficiency | Overall efficiency (LHV) | | % | 88.0 | 88.0 | 88.0 | 88.0 |
| | Generating efficiency (LHV) | | % | 32.5 | 32.5 | 32.5 | 32.5 |
| | Exhausst heat recovery rate (LHV) | | % | 55.5 | 55.5 | 55.5 | 55.5 |
| Operation Noise | Radiator fan stop | | dB(A) | 62 | 62 | NA | NA |
| | Radiator fan run | | | 64 | 64 | NA | NA |
| Dimensions | Width | | in (mm) | 78.7 (2000) | 78.7 (2000) | 78.7 (2000) | 78.7 (2000) |
| | Depth | | in (mm) | 31.5 (800) | 31.5 (800) | 31.5 (800) | 31.5 (800) |
| | Height | | in (mm) | 78.2 (1987) | 78.2 (1987) | 78.2 (1987) | 78.2 (1987) |
| | Weight | | lbs (kg) | 3,064 (1390) | 3,284 (1430) | 3,064 (1390) | 3,284 (1430) |
| Maintenance interval | | | hr | 7500 | 7500 | 7500 | 7500 |
| Standard Warranty | | | - | 2 Years; 15,000 Hours* | 2 Years; 15,000 Hours* | 2 Years; 15,000 Hours* | 2 Years; 15,000 Hours* |
| YES Product Protection | | | - | 10 Years; 30,000 Hours* | 10 Years; 30,000 Hours* | 10 Years; 30,000 Hours* | 10 Years; 30,000 Hours* |
| | | | - | 10 years; 60,000 Hours* | 10 years; 60,000 Hours* | 10 years; 60,000 Hours* | 10 years; 60,000 Hours* |
| Emissions & Certifications | | | | EPA Certified<br>UL2200 Certified<br>CSAC22.2 No 14 Certified<br>CSAC22.2 No 100 Certified<br>UL1741/IEEE1547 Certified | | | |

*1 The minimum modulation amount is dependent on the CT and Transducer specifications
*2 Natural gas calculations for fuel consumption are based on converting LHV to HHV: LHV=983 BTU/scf,HHV= 1,089 BTU/scf
*3 Transformer necessary for 120V AC power requirements.
* Whichever comes first

## Incentives

The New Jersey Clean Energy Program offers incentives for several types of CHP and fuel cell systems. For systems of both large and small generating capacity, a variety of equipment and installation requirements exist for determining eligibility. Johnson Controls will review the incentive requirements to determine suitability and will complete the applications necessary to receive as many incentives as possible. All incentives will be paid directly to the school district to be used as the school district deems necessary.

## Facilities Recommended for This Measure

- Science Park High School
- East Side High School

## Energy Savings Methodology

Savings for cogeneration will be estimated using a custom spreadsheet using the following methodology:

Energy: kW/module x module(s) x net after "parasitic loads" x annual run hours

= net kWh output x $/kWh avg. displaced energy

Demand: kW/module x module(s) available x net after "parasitic loads"

When Heat Used to Displace Boiler Gas Use:

$$\frac{\left(\frac{Th}{hr\ module}\right) x}{boiler\ efficiency}\ x\ modules\ x\ \$/\text{Th boiler gas rate}$$

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | Product cut sheets and specifications for generally used product will be included in the comprehensive audit. As part of the measure design and approval process, specific product selection will be provided for your review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Changes in Infrastructure

The most significant physical changes due to the proposed measure will be the installation of the new cogeneration engine and the associated electrical switchgear, gas piping, exhaust piping, etc. In addition, new heat exchanger piping, exterior remote radiator, plate and frame heat exchangers and associated controls will also be installed. This system may be connected into the upgraded BAS and will include an array of various safety and feedback alarms.

## Customer Support and Coordination with Utilities

The new cogeneration plant will require interconnection with the existing utility supply and other facility switchgear. In addition, the plant will be required to meet all of utility interconnection requirements as stated in the guidelines. All interruptions will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result in producing useful electricity through the combustion of lower cost co-gen rate natural gas and the recovery of heat from the engine. |
| Waste Production | This measure will produce waste by products including oxides of nitrogen, carbon dioxide and carbon monoxide. |
| Environmental Regulations | Air emission qualifications if required will be filed with the EPA. |

# ECM 20: Aris Wind Turbine

## ECM Summary

Newark Schools Stadium was surveyed for the application of this measure. Although these are stand-alone systems and not tied into the building electrical system, they are capable of producing light in areas around the Stadium through the use of batteries charged by the small wind turbine and solar panel.

## Scope of Work

Johnson Controls proposes to install two (2) Aris Remote Power Units (RPU) that will include a 300-Watt wind turbine for electrical generation, a 250-watt polycrystalline solar panel, one (1) LED light each and a 24V battery storage system. The physical location and system variation must be agreed upon with the school district.

- 80 Watt LED Hybrid Streetlight (RPU) with single lamp arm
- Newark School District banner print and tailfin
- Installation, foundation, cleanup and haul away

By installing a RPU system, you will receive the following benefits.

- LED lighting and enhanced security
- Use free energy from the wind and sun
- Provide a valuable teaching program to instill environmental awareness and responsibility

## Energy Savings Methodology

There are no savings associated with this ECM.

## Changes in Infrastructure

Concrete foundations will be poured and new equipment will be installed.

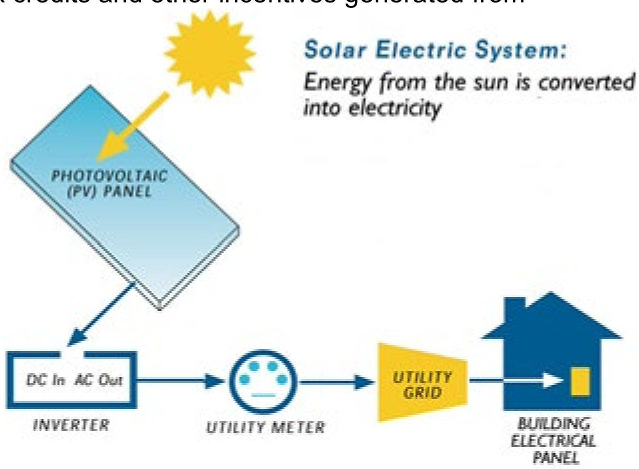
# ECM 21: Solar PV- Power Purchase Agreement

## ECM Summary

Electricity generated from solar PV panels will reduce the quantity of power purchased from the local utility. The generation of an excess power from the solar system can be transferred back to the gird via net-metering. Many factors affect the size of the solar PV installation, including on-site consumption load, suitable roof space or open space.

Solar electrical energy is generated when the sun's energy strikes the solar PV panel. A series of PV panels are combined in a PV array. Electrical energy, in Direct Current (DC), is sent from the array to an inverter, which converts the electricity to Alternating Current (AC) power. The AC electrical output from the inverter is integrated into the building's electrical system.

A solar PPA is a financial agreement where a developer (3rd party PPA provider) arranges for the design, permitting, financing and installation of a solar energy system. The developer sells the power generated to the school district at a fixed rate that is typically lower than the baseline utility rate. This lower electricity price serves to offset the school district's purchase of electricity from the grid while the developer receives the income from these sales of electricity as well as any tax credits and other incentives generated from the system. The developer remains responsible for the operations and maintenance of the system for the duration of the agreement. Typically at the end of the PPA contract term, a customer may be able to extend the PPA, have the developer remove the system or choose to buy the solar energy system from the developer.




All the sites were evaluated for the potential to install rooftop, carport, and/or ground mount PV solar panels for power generation. The amount of roof area, parking space, and land available determines how large of a solar array can be installed on any given location.

This ECM will reduce the cost of electrical power resulting in good financial benefits for the school district.

## Scope of Work

Johnson Controls recommends that the Newark Public Schools enter into a PPA to leverage the investor tax incentives and lucrative Transition Renewable Energy Credits (TRECs) by installing an aggregate of a 17 MW system across the school district based on information collected from the selected provider's bid proposal. Final design, layout and sizing will take place following execution of the PPA contract.

In addition, a portion of the roof upgrades needed to support the new panels will be borne by the PPA and paid for over the term of the PPA agreement through a small increase in the PPA rate ($0.009/kWh for every $2.5M of roofing upgrades). The PPA is estimated to include up to $5M worth of roof upgrades. Refer to ECM 22 for a detailed description of the roof upgrade work.

By installing a PV system, the school district will receive the following benefits:

- $34 million in savings over the next 15 years as per ESIP statute, by lowering the cost of purchased electricity.
- Use free energy from the sun to reduce the effect of utility rate increases.
- Protect the environment by using clean, renewable energy in the schools.
- Provide a valuable teaching program to instill environmental awareness and responsibility.


650 kW Solar PV Layout of Louise A Spencer Elementary School


350 kW Solar PV Layout of Harold Wilson School

## Facilities Recommended for This Measure

- Several Schools (Refer to ECM Matrix). Excludes schools that were part of the previous ESIP phases.

## Savings Methodology

Energy savings results from the difference between the baseline utility electric rate and PPA.

## Maintenance Requirements

Maintenance is to be included as part of the PPA agreement and provided by the PPA provider as outlined in the terms and conditions of the PPA agreement.

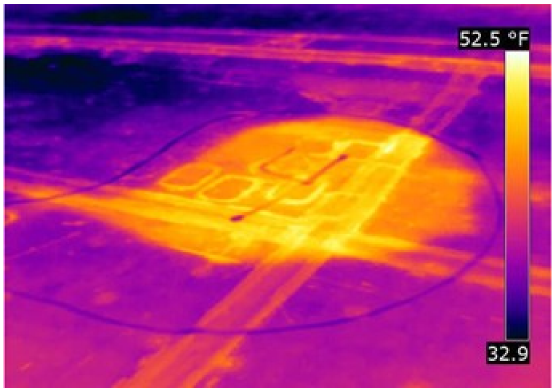
## Benefits

- Energy cost savings
- Reduced carbon footprint
- Resiliency

# ECM 22: Roof Upgrades

The roof of a building can cause a significant amount of energy waste throughout the year. A lack of insulation between the roof structure and the conditioned space can result in excess heat gain as a result of the sun beating on the roof throughout the year and conduction during the summer as well as heat loss during the winter months. Another issue that may arise with roofs is leaking through cracks and weather damage. Upgrading the roof with a new high-efficiency roofing system will reduce the energy consumption through increased insulation values as well as repair any leaks or holes in the structure. Occupant comfort will be improved due to a reduction in heating load from the roof and maintenance will be easier because many existing problems with the structure will be repaired.

In preparation of the installation of the solar PV systems, existing roofs will be upgraded with a polyurethane foam coating and silicone sealant. An infrared roof moisture survey will be conducted to identify deficient and/or wet roof sections and repairing as necessary.



**Infrared Roof Moisture Survey Results and Silicone Sealent Application**

## Scope of Work

There are various types of roofs found at the schools throughout the school district. The actual scope will depend on the type of roof and the condition it is in. Below describes the procedure specific to each type of roofing system:

Membrane Roofs (EPDM, TPO, PVC)

- Power wash
- Prime with wash primer (EPDM Only)
- Make visible repairs (fastening, cutting and sealing of delaminated roof)
- Spray apply polyurethane foam @ all penetrations, curbs and wall flashings and coat with 30 mils of silicone
- Spray or roll ½ gallon/square of Silcoxy H3 over seams
- Spray 3G/Sq on field of roof

Smooth Built of Roofs (Including Modified Bitumen Roofs)

- Perform an infrared survey
- Make visible repairs (fastening, cutting and sealing of delaminated roof)
- Spray apply polyurethane foam @ all penetrations, curbs and wall flashings and coat with 30 mils of silicone
- Prime existing roof surface with Everprep bleed blocker primer @ 1G/Sq

- Spray or roll ½ gallon/square of Silcoxy H3 over seams
- Spray apply 3G/Sq of Silcoxy H3 silicone on the roof field

Foam/Silicone Roofs

- Perform an infrared survey
- Make visible repairs (fastening, cutting and sealing of delaminated roof)
- Scarify low foam areas to create positive water flow to drains
- Power wash
- Spray apply 3g/sq of Silcoxy h3 silicone on the field and granulate

BUR With Gravel

- Perform an infrared survey
- Make visible repairs (fastening, cutting and sealing of delaminated roof)
- AquaVac loose stone off the roof surface
- Spray apply 1.5" over entire field of the roof
- Spray apply 3g/Sq of Silcoxy H3 over the roof field and granulate

## Facilities Recommended for this Measure

- All buildings included in the ECM matrix for this measure are considered for roof upgrades. The scope will be executed either by the PPA provider or through the ESIP. Roof upgrades to be carried by the ESIP will be determined and finalized after a PPA contract is executed.

## Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Existing Cooling Cost = Existing kWh Usage x $/kWh

Existing Heating Cost = Existing Therms x $/Therm

Proposed Cooling Cost = New kWh Usage x $/kWh

Proposed Heating Cost = New Heating Therms x $/Therm

Energy Savings $ = Existing System Cost – Proposed System Cost

## Maintenance Requirements

There will be no additional maintenance responsibilities that the school district staff is not already performing in order to keep the buildings in working order. The condition of the new roof will need to be monitored.

## Benefits

- Electrical energy savings
- Fuel energy savings
- Capital improvement to building structure and roof system
- Occupant comfort improvement due to reduced thermal loading from roof and sealing gaps in building structure
- Operational savings based on repairing any roof leaks or issues

## Warranty

The upgraded roofs will be warranted for a period of fifteen (15) years.

# ECM 23: Walk-In Refrigerator/Freezer Evaporator Fan Controls

## ECM Summary

The walk-in refrigerators and walk-in freezers are controlled by a dry bulb temperature and as a result run continuously throughout the year. Installing cooler control systems was assessed. The system will monitor both dry and wet bulb temperature within the walk-in boxes and allow evaporators and compressors to modulate up and down based on enthalpy setpoints rather than by dry bulb temperature alone. Savings is a result of reduced run time of evaporator fans, compressors and door heaters.

## Proposed System

Johnson Controls proposes to replace the existing evaporator fan motors with energy-efficient electronic commutated motors. In addition, a controller will be installed at each unit to slow these fans when full speed operation is unnecessary. The controller does this simply and economically by taking advantage of a basic principle of motor operation: the lower the voltage applied to a motor, the less rotational force it produces. The controller unit senses when refrigerant has ceased flowing through the evaporator coil and cuts the voltage to the motor by almost two-thirds (usually from 110-115 volts down to 20 volts). The net effect is that the controller, by cutting the voltage going to the motor, also cuts the motor's speed – typically from about 1,600 to 400 RPM. The lower speed is considered the bare minimum required to provide defrosting and prevent air in the cooler from stratifying into layers of higher and lower temperature.

## Scope of Work

- Furnish and install evaporator fan controller systems in appropriate locations.
- Replace fan motor with electronic commutated motors where appropriate.
- Install all supplemental equipment for the successful operation of evaporator fan controllers, such as temperature and ice sensors.
- Installation and wiring must comply with local and all applicable codes.
- Provide start-up, warranty, and training for maintenance personnel.

## Facilities Recommended for This Measure

- 10 Schools Included (Refer to ECM table)

## Savings Methodology

Savings are calculated using the following methodology:

Evaporator Fan Cycling Savings = (Fan Off Hours * fan kW) + (Reduced Cooling Load from kWh Cycle Savings) + (Reduced Compressor Run Time Savings)

Evaporator Fan ECM Motor Savings = (Run Hours of Evaporator Fans * (PSC Motor kW – ECM Motor kW))

Door Heater Cycling Savings = Current Door Heater Hours to Maintain 5°F Above Dew point * New Power Level Percent to Maintain 5°F Above Dew point)

Demand Savings = Heater kW * % Maximum Power to Maintain 5°F Above Dew point

## Maintenance Requirements

- Periodically the equipment should be checked to ensure proper operation.

## Benefits

- Electrical energy savings

## Warranty

All installed equipment and workmanship will be under warranty for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Changes in Infrastructure

No architectural or structural changes to the facility are anticipated with the implementation of this measure.

There may be short-term interruptions of access to coolers and freezers during retrofit installations. All interruptions will be coordinated and scheduled with the staff at least 24 hours in advance.

## Environmental Impact

This ECM will have a positive environmental impact through resource conservation and pollution prevention as follows:

- Reduction in electricity consumption
- Reduction in air pollution (e.g. greenhouse gases, SOx, NOx, CO2, PM, Mercury, etc.)

Johnson Controls and its subcontractors will minimize waste production during the implementation of this ECM.

## Environmental Issues

| | |
|---|---|
| Waste Production | This measure will not produce waste by products. |
| Environmental Regulations | Environmental impact is expected; all regulations will be adhered to in accordance with federal and local code requirements. |

# ECM 24: Kitchen Hood Controls

## Existing Conditions

Kitchen hoods are usually operated from the time the first kitchen employee enters the kitchen to the time the last kitchen employee leaves the kitchen. The kitchens have constant flow exhaust hoods that are operated manually by the kitchen staff. The overall strategy for improving the performance of the kitchen hood systems is to install a hood control system that determines kitchen hood fan speed based on the cooking load under the hood.

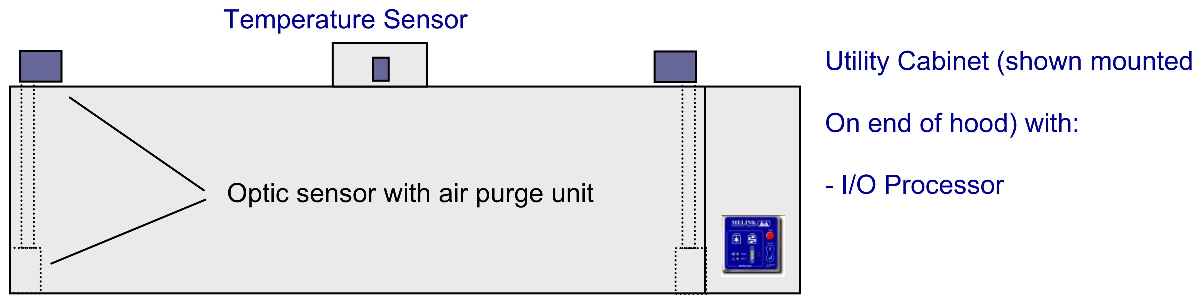
## Proposed System

Johnson Controls will provide kitchen hood control systems in the schools with the kitchen service. This measure will reduce annual energy costs and reduced maintenance. In addition, time of day scheduling, manual timer controls are added to reduce the operation time of the exhaust fans where cost-effective.

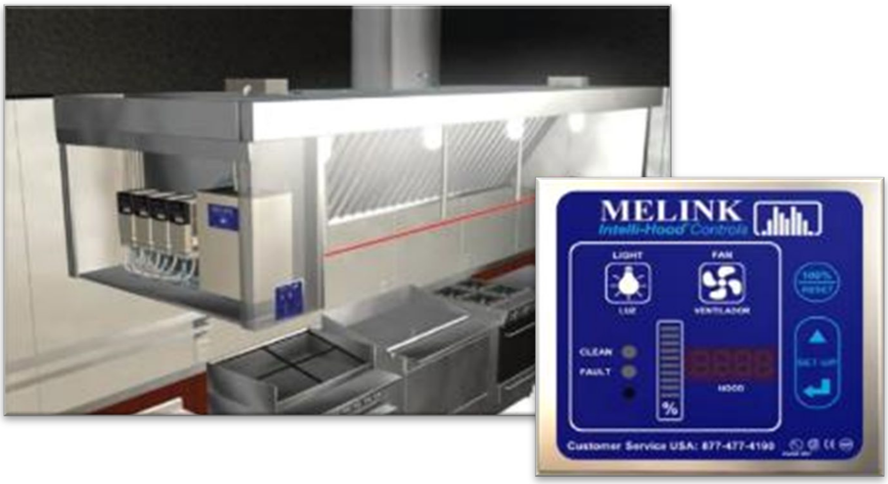
The kitchen hood system will automatically control the speed of the exhaust and make-up fans above to ensure optimal hood performance. The system includes the following components:

- I/O Processor - Sends signals to the VFDs for up to four independent exhaust fans and one makeup air unit (multiple VFDs can be controlled with each signal).
- Keypad - Controls lights and fans for up to four hoods (one keypad per I/O Processor).
- Temperature Sensors - Monitors exhaust air temperature at duct (one sensor per exhaust duct).
- Optic Sensors - Monitors smoke load inside hood (one sensor set per Type 1 hood).
- Variable Frequency Drive(s) - Varies fan speed (one VFD per fan).
- Cables - Links I/O Processor to keypad, sensors, and VFDs.

The I/O processor shall be mounted above the hood closest to the keypad and the keypad shall be mounted next to the existing hood switch. The temperature sensors shall be mounted in each exhaust collar while the optic sensors shall be mounted inside the ends of each Type 1 hood with air purge units (APU) mounted on top. The VFDs shall replace the existing magnetic starters for each fan.




**Kitchen Hood Controls Diagram**




## Scope of Work

- Mount and wire the I/O processor above the hood closest to the keypad, with 115/1 or 230/1 VAC input from the hood light circuit.
- Mount the keypad next to the existing hood switch.
- Mount a temperature sensor in each hood exhaust duct.
- Mount an optic sensor set inside each Type 1 Hood.
- Mount and wire an electronic motor starter on the output side of each existing motor starter.
- VFDs are protected with a NEMA 1 housing and must be installed inside where ambient temperatures do not exceed 40C/104F degrees. The input and output wiring shall be run in separate conduit to prevent noise interference.
- Connect low voltage plenum rated plug-n-play cables from I/O Processor to keypad, sensors, and VFDs for each hood.
- Start-up the system by pressing the light and fan switch on keypad to verify the hood lights turn on and the fans go to minimum speed. Correct fan rotation if necessary.
- Program the system based on the application, using the menu (i.e. Temperature span, minimum speed, number of sensors).

## Facilities Recommended for This Measure

- American History High School
- Bard Early College High School
- Central High School
- Early Childhood Center - Central
- East Side High School
- Gladys Hillman-Jones Middle School
- John F. Kennedy School
- Science Park High School

- University High School
- West Side High School

## Benefits

- Electrical and fuel energy savings
- Occupant comfort improvement due to quieter fan operation and reducing load from cooking equipment
- Improves reliability of hood system by soft-starting the fans (less stress on belts and bearings)
- Improves fire-safety of hood system with automatic on/off feature based on heat
- Improves fire-safety of hood system with early warning alarm in event exhaust temperature approached activation point of fire suppression system

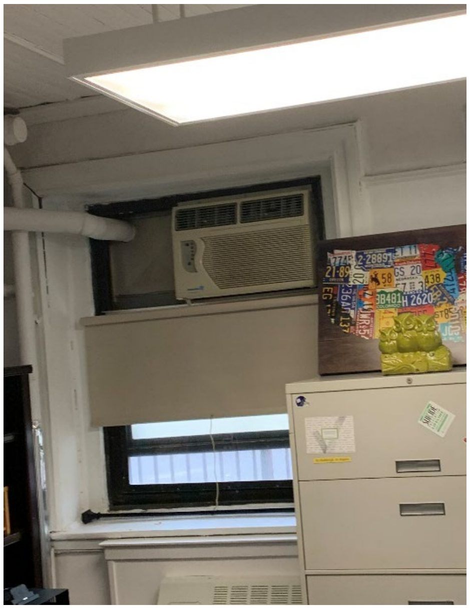
# ECM 25: Plug Load Controls

## ECM Summary

The amount of plug load devices is ever increasing in today's schools. Unfortunately, as the number of these devices increase, electricity consumption also increases. Newer teaching tools such as smart boards, flat screen TVs, and projectors are all devices consuming plug load energy. Newly deployed water coolers and existing water fountains are another source of plug load energy use. Managing plug load equipment provides an opportunity for optimizing energy savings. This measure adds a plug load management system that will effectively manage all plug load devices. The device will provide energy management through a user interface, where opportunity will exist to turn equipment / appliance on / off or change schedule to optimize energy savings.

## Existing System

At the Newark Public Schools, computers, smart boards, charging carts, appliances (microwave, refrigerator, etc.), printers and window air-conditioning units are part of the building plug load. A majority of this equipment is regularly left in the 'on' state at all times allowing the individual machine to revert to the 'Sleep' mode based on an internal timer. This measure will plug the equipment into a networkable device that will allow for scheduling of the energy use of the equipment.



**Abington Ave School**

## Proposed System

Johnson Controls proposes to install a plug load management system that will gain control of numerous plug load equipment across each facility. The system will use an existing Wi-Fi network that will communicate to an energy management user interface. Through the user interface, equipment can be monitored, scheduled and turned on/off. In areas where no Wi-Fi connection exists, plugs can be programmed with the intended schedule for the equipment. Types of equipment/appliances that the plug can be used on:

- Main printers and copiers
- Classroom and smart board projectors
- Window air-conditioning units

## Scope of Work

See the Appendix for a summary of work by building.

Johnson Controls shall provide the following scope of work:

- Provide all plug load control devices as per final schedule of outlets
- Install and connect all plug load devices
- Load and configure plug load software on an owner provided supervisory PC
- Tie the plug load software into the BAS for cooling based applications (window air-conditioning)
- Use standard plug load software for non- HVAC equipment
- Start, test, and commission the system

## Facilities Recommended for This Measure

- Several Schools (Refer to ECM Matrix) – Excludes schools that were part of the previous ESIP phases

## Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Existing kW = Listed Equipment Amperage x Voltage of Equipment

Cost per kWh = Average Site Data Package $ / kWh

Cost of Existing Equipment = Existing kW x Cost per kWh x Effective Full-load Hours

Cost of Proposed Equipment = Existing kW x Cost per kWh x Full-load Hours Using Control

Energy Savings $ = Existing Equipment Costs – Proposed Equipment Costs

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | As part of the ECM design and approval process, specific product selection will be provided for your review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Changes in Infrastructure

No architectural or structural changes to the facility are anticipated with the implementation of this measure.

## Customer Support and Coordination with Utilities

There may be short-term interruptions of access to plug load devices during retrofit installations. All interruptions will be coordinated and scheduled with the staff at least 24 hours in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result from reducing electrical usage by operating existing equipment for shorter durations. The equipment uses no other resources. |
| Waste Production | This measure will produce no waste by products. |
| Environmental Regulations | No environmental impact is expected. |

# ECM 26: Pay for Performance (P4P) Rebate

## Pay for Performance Incentive

Johnson Controls is a partner in the New Jersey Pay for Performance Program. This program allows our customers to obtain substantial rebates for energy savings projects (in excess of what could typically be obtained through the standard NJ SmartStart program) when energy savings exceeds 15% of the baseline usage for each building. We expect that the many of the buildings in the scope will be eligible for this rebate program.

The Pay for Performance for Existing Buildings Program takes a comprehensive, whole building approach to saving energy in existing facilities through incentives that are directly linked to savings. Pay for Performance program relies on a network of partners who provide technical services under direct contract to you. Acting as your energy expert, your partner will develop an energy reduction plan for each building with a whole building technical component of a traditional energy audit, an energy model, a financial plan for funding the energy-efficient measures, and a construction schedule for installation.

Johnson Controls is one of the leading ESCOs in the state of New Jersey when it comes to successful completion of the Energy Reduction Plan which is required for participation in the program and culminates with receiving the first of three incentives. Johnson Controls will use this expertise to gain as many incentive dollars for the project as possible. At the same time, we feel the knowledge of the Pay for Performance Program allows us to be reasonable in our incentive estimates during the RFP Response and create a realistic expectation for the school district.

## Scope of Work

The following services will be provided during the development of the ESP for the school district:

- Coordinate with the school district to complete and submit the Pay for Performance Application.
- Develop and submit Energy Reduction Plan to Pay for Performance Case Manager.
- Complete and submit Request for Incentive #1.
- Conduct necessary reviews with Pay for Performance Case Manager.

During and after installation of measures is complete the following services will be provided:

- Compile Installation Report for submission.
- Complete and submit request for Incentive #2.
- Conduct necessary reviews with Pay for Performance Case Manager to ensure equipment has been installed according to scope of work submitted in ERP and ESIP.

After Year 1 of performance period:

- Complete post construction benchmarking report.
- Complete and submit with request for Incentive #3. The rebate estimate for Incentive #3 is not included in the project cash flow. However, Johnson Controls will submit the necessary paperwork and information when the time is appropriate to apply for Incentive #3.
- Conduct necessary reviews for Incentive #3.

## Benefits

- Source of revenue throughout the project development and implementation.
- Public acknowledgement of District's efforts toward energy responsibility.

# ECM 27: Student Engagement and Teacher Professional Development Program

## Student Engagement and Career Development Program

Johnson Controls enhances student achievement by improving the physical environment in K-12 schools. We also help to inspire students by encouraging them to build a brighter future for themselves and their community. When students are exposed to energy efficiency projects and programs, they learn to protect the environment and discover potential career options. By showing them a future of possibilities, students are more likely to remain engaged in school. An added bonus: when encouraged to conserve, school districts realize even greater project savings.

Our Student Engagement Program gives students a variety of options to learn about energy conservation and energy saving technologies, as well as to explore established and emerging careers in the energy services field. Newark Public Schools can select from a menu of courses and activities that best complement your existing energy awareness and career readiness curriculum.

Together, we can create a tailored plan that will address each grade level. Our program director, Judith Mouton, MA, Ed., along with Paul Napoli, will collaborate with your staff to develop customized curricula on energy awareness and student workforce preparedness. Johnson Controls will also be partnering with Health Link International (HLI) to deliver the programs to the Newark Public Schools community.

## Benefits Beyond the Classroom

The program provides a forum for raising energy awareness among students, teachers, staff, and the community. It is based on the STEAM (Science, Technology, Engineering, the Arts, and Math) framework to promote realistic, life-long learning skills. This approach better prepares students for post-secondary education and gives them the skills and knowledge they will need to be successful innovators in a technology-driven workforce.

A culture of sustainability also helps attract and retain quality teachers by offering fresh, timely classroom-ready STEAM materials and plans that are aligned with the existing curriculum and state academic standards. Students can participate in energy saving contests and activities, chat with experts, and exchange ideas with students nationwide. Students can also receive credit for participating in high school, trade school, and college school-to-work programs, preparing them for STEAM careers.

## STEM/STEAM-Based Curriculum

For over 20 years, HealthLink International (HLI) has been a new vogue innovative, skills training and career development institute. HLI began designing workforce investment training programs focusing on those transitioning from welfare-to-work in conjunction with Thomas Jefferson University, Community College of Philadelphia, and MEDIQ/prn. Later realizing the need to start at an earlier age of exposing young people to health and science careers and the skills and academic training needed to pursue those careers, HLI began a program for high school students: The Health/Science Career Exploration and College Exposure Program in conjunction with the Philadelphia School District, Cheyney University, Drexel University, The University of the Sciences and various health and science professionals. HLI continues to reach out and train across the spectrum from students for college preparatory, K-12 to adult learners. Through these programs, HLI provides skills training, career development, college exposure, and health/STEAM exploration to multiple constituencies: adults, primary schools, secondary schools, and high schools. HLI has partnered with other districts to bring the Full Health/STEAM Ahead fall, spring, and summer programs to rising 4th, 5th, and 6th graders.

## Full Health/STEAM Ahead K-12

The Health/STEAM programs will be coordinated by (HLI) in conjunction with the Newark Public Schools and Johnson Controls. The Health/STEAM Programs will respond to the need for an early introduction and enhancement of student awareness and interest in Health/STEAM fields as well as introduce them to Health/STEAM careers by providing innovative, enriching educational programs. As an initial phase, the program will be implemented alongside the Principals and staff at Chancellor Avenue School and Technology High School. The program is anticipated to take place during the summer of 2021.

HLI's role will be the overall management and administration of the program curriculum, goals, and staff. The educator's role will be to assist in administering the program, mentor, guide, encourage, and share knowledge and experiences. HLI seeks educators and staff who understand they are the platform upon which students can build, learn, and expand their horizons. The joint mission of HLI and Johnson Controls in conjunction with Newark Public Schools, will provide students with hands-on experience applying technology and engineering, creating a Full Health/STEAM Ahead learning experience.

The program's mission is to provide Health/STEAM education and hands-on exposure and experiences by:

- encouraging students to step out of their comfort zone into an environment of free exploration and scientific discovery
- providing an atmosphere which will enable students to gain the confidence they need to succeed
- inspiring students to dream beyond their current situation
- exposing students to innovative and creative Health/STEAM career opportunities
- exposing students to real-world problems in communities and help enable them to identify innovative and creative solutions
- identifying interdisciplinary team solutions for community problems

The program goal is to provide a platform that enables children at a very early age to experience, know, and feel that they are the future designers and architects of the world's futurity. They will be responsible for envisioning and defining the future. The hope and the plan is that they can and will be equipped to be the creators, builders, designers, engineers, generators of a new, productive, efficient, considerate, just and kind world.

Program Impact Goal:

- Improve critical and creative thinking skills
- Improve social skills
- Improve problem-solving skills
- Introduce a hands-on experience in the areas of health, science, technology, engineering, agriculture, mathematics
- Embrace science and technology as future career possibilities

Success will be measured by evaluation tools and matrix developed by HLI to determine and monitor the impact of Health/STEAM programs.

# ECM 28: HVAC Training Center

## Career Development Program developed for High School Students at Newark Public Schools

In support of the partnership with the Newark Public Schools, a hands-on Career Development program for the school district is included in the scope of the ESIP. As part of this initiative, a full HVACR lab will be provided and installed at no cost, complete with building equipment and systems, along with learning curriculum and training for the designated instructors. Students can leverage these technologies to learn about HVACR maintenance, clean energy programs, digital controls and more. Most importantly, students get to work on the kind of energy-efficient HVACR equipment that they will see on the job, plus Pathways Lab students leave the program with industry certifications that allow them to directly join the workforce with competitive salaries. Currently, the lab is proposed to be located at School of Architecture and Interior Design (former St. James Hospital site to be opened in 2022); however, this location could change based on space availability and the target audience.

**The actual Lab will include the following commercial equipment:**

- HVACR equipment and technology, including variable air volume boxes and air-handling unit
- Energy management systems
- Digital control systems

**Course Content Includes:**

| JOB READINESS | REPAIR & MAINTENANCE | HVAC FUNDAMENTALS |
|---|---|---|
| • This course will build skills, provide certifications and help students gain access to high demand jobs in the future<br>• Employability Skills<br>• Jobs in Repair & Maintenance Industry | • Heath & Safety<br>• Lead Safety<br>• Basic Electricity& Applications<br>• Basic Plumbing& Piping<br>• General Building Maintenance<br>• Pumps & Motors Maintenance<br>• Green Lighting | • Indoor Air Quality & Cleaning<br>• HVAC System Fundamentals<br>• HVAC Controls Fundamentals<br>• HVAC Equipment & Preventative Maintenance<br>• HVAC Air and Water Distribution Systems Maintenance |

### Certifications the students can receive:

Building Maintenance Repair

- EPA Universal Certification
- OSHA 10 General Instruction
- OSHA Fall Protection
- NCCER Core Construction Skills
- ESCO / HVAC Excellence
- Johnson Controls and ECA Certifications of Completion

Students who complete the first level of training can go on to the next certification level, which includes troubleshooting. The final certification involves automation and controls – an in-demand career with a commensurate salary.

**Closing the Opportunity Gap:**

A typical student would have to spend between $50K to $100K to participate in a commercial HVACR program like this. The earning potential of certificate-holders who have completed the first two years of instruction (depending on time spent in class) can expect a starting salary to range from $37,000 to $64,000 for entry-level jobs based on New Jersey's job opening database.

Based off the ideal class size and constraints of a typical high school day, we would anticipate the capability of graduating 20 students per year starting in Year 2 of our program. Over the term of this program, this partnership would positively impact the lives of 400 students and their families.

Especially for those who remain in Newark, beyond the personal impact, salary dollars reinvested back into the local Newark economy really add up over time.:

# Measures Considered but Not Included

The following measures identified in this section have been evaluated for feasibility, cost and savings. Currently, they do not fit within the financial model of the ESIP program. However, if Newark contributes additional funding to the project, for example, monies provided by the Elementary and Secondary Emergency Education Relief (ESSER) fund, Johnson Controls is positioned to quickly take these measures and move them into the scope of the overall project. Through the ESIP process, Johnson Controls has identified upwards of $85M of improvements that are described below.

## Replace/Install Unit Ventilators

### ECM Summary

Unit ventilators are used throughout classrooms to provide heating and, sometimes, cooling to the areas. In buildings where the unit ventilators are older and in poor condition, full unit replacement may be required to produce energy savings and improve controllability and comfort of occupying areas. There are also operational cost savings since the new units do not require continuous maintenance as the old ones typically do. The new units will distribute the air in a much more efficient manner by using premium efficiency motors, tighter unit construction eliminating leakage, and more efficient heating and cooling coil designs. Installation of new unit ventilators will also allow for better control of the outside air due to improved damper and factory-mounted controls. In addition to energy and operational cost savings the units will provide a more pleasant indoor environment resulting in increased productivity and occupant comfort.

### Proposed System

In schools and classrooms where steam radiators provide the main heating source, the only means of ventilation in these spaces is by opening windows. However, opening windows in the midst of the heating season introduces large volumes of cold air that the systems must now overcome, creating energy, comfort and operational issues. Johnson Controls recommends replacing the steam radiators in these areas with unit ventilators which will provide a better means of introducing and controlling outside air as well as better overall control of the space conditions within the classrooms.

The existing unit ventilators will be replaced with new unit ventilators featuring energy-efficient motors. In addition, careful attention will be taken during the installation of the new units to ensure a tight seal at the outside air intake. Additional insulation and sealing will be done around the wall box penetration to eliminate unconditioned air from entering the classroom spaces. A properly installed unit ventilator will increase comfort during occupied periods and reduce energy losses.

New unit ventilators will include hot water or steam heating coils, high-efficiency ECM motors, a DDC-ready control package, control valves and dampers. Damper configurations will be determined during the Design Phase of the project. New room thermostats will be installed, with individual and group control and occupancy scheduling enabled through an integrated DDC building management system. Unit ventilators that are not identified for replacement will receive new DDC controls and new hot water or steam valves and actuators. The greater degree of control enabled through this measure will enable the implementation of additional energy savings strategies including enthalpy economizer mode and demand-controlled ventilation during non-economizer operation.

During the design phase, different approaches and technologies will be evaluated to improve the indoor air quality. Some examples are listed below:

- Increasing Ventilation Rates: Increasing the amount of clean outdoor air and increasing the amount of filtered recirculated air decreases pathogen exposure probability by diluting and removing aerosols.

- Improving Filtration: Adding filters, including HEPA filters and filters with the highest minimum efficiency reporting value (MERV) rating can trap more particles and increase your building's clean air percentage.
- Disinfecting Air with UV-C Lighting: Ultraviolet germicidal irradiation (UVGI) is a disinfection method that uses UV-C light to inactivate viral and bacterial microorganisms in the air so they are unable to replicate. UVGI can be used to disinfect air passing through air-handling units and by circulating room air through UV-C troffers in the ceiling.
- Room Control: Temperature, room pressurization, and relative humidity also aid in destabilizing airborne viral transmission by reducing cross contamination and creating protective environments for occupants.

## Facilities Recommended for This Measure

Existing unit ventilator replacements:

- Dr. E. Alma Flagg School
- Sussex Avenue School
- Dr. William H. Horton School
- Gladys Hillman-Jones Middle School
- Harold Wilson
- NJ Regional Day School
- Peshine Avenue School
- University High School
- Camden Street School
- Ivy Hill Elementary School
- Mount Vernon School
- Thirteenth Avenue School

Replace Steam Radiators with Unit Ventilators:

- 39 Schools, approximately 1,184 classrooms and offices

# Install / Replace Rooftop Units with Addition of Indoor Air Quality Improvements

## ECM Summary

There are numerous packaged multizone rooftop units that heat and cool the schools. These rooftop units have surpassed their useful service life and have very poor cooling energy efficiencies (8.5 to 9.0 EER). The high-efficiency units of today have cooling efficiencies of 12 to 14 EER with digital controls, air side economizers and high-efficiency fan motors.

In addition, many of the zone damper actuators were found to be disconnected and not able to provide the proper temperature control to the spaces served.

**Seasons-4 Rooftop Multizone Units – ECC-Central**

## Proposed System

Although refurbishment is an option, because of what would be needed to bring the units back to full and proper operating condition, it is more cost-effective and beneficial to the school district to replace these units with new, high-efficiency units.

During the design phase, different approaches and technologies will be evaluated to improve the indoor air quality. Some examples are listed below:

- Increasing Ventilation Rates: Increasing the amount of clean outdoor air and increasing the amount of filtered recirculated air decreases pathogen exposure probability by diluting and removing aerosols.
- Improving Filtration: Adding filters, including HEPA filters and filters with the highest minimum efficiency reporting value (MERV) rating can trap more particles and increase your building's clean air percentage.
- Disinfecting Air with UV-C Lighting: Ultraviolet germicidal irradiation (UVGI) is a disinfection method that uses UV-C light to inactivate viral and bacterial microorganisms in the air so they are unable to replicate. UVGI can be used to disinfect air passing through air-handling units and by circulating room air through UV-C troffers in the ceiling.
- Room Control: Temperature, room pressurization, and relative humidity also aid in destabilizing airborne viral transmission by reducing cross contamination and creating protective environments for occupants.

## Facilities Recommended for This Measure

- Early Childhood Center - Central

# Replace / Refurbish Air-Handling Units with Addition of Indoor Air Quality Improvements

## ECM Summary

Some air-handling units that are installed in the buildings are in poor condition and require replacement. This measure proposes to replace the older, existing units with units that will have increased efficiency and reliability.

## Existing System

Various air-handling unit have surpassed their useful service life and have very poor cooling energy efficiencies (7.0 to 8.0 EER). The high-efficiency units of today have cooling efficiencies of 12 to 14 EER with digital controls, air side economizers and high-efficiency fan motors.

**Thirteenth Ave School**

**Chancellor Ave School**

## Proposed System

The heating and cooling efficiencies of the existing air-handling units could be vastly improved by replacing them with high-efficiency heating and cooling units that feature digital controls, air side economizers and high-efficiency fan motors.

As part of this scope the existing units will be disconnected, removed and properly disposed of including electrical, gas and control connections. New units will be reconnected to existing electrical and gas systems along with any BAS controls.

During the design phase, different approaches and technologies will be evaluated to improve the indoor air quality. Some examples are listed below:

- Increasing Ventilation Rates: Increasing the amount of clean outdoor air and increasing the amount of filtered recirculated air decreases pathogen exposure probability by diluting and removing aerosols.
- Improving Filtration: Adding filters, including HEPA filters and filters with the highest minimum efficiency reporting value (MERV) rating can trap more particles and increase your building’s clean air percentage.
- Disinfecting Air with UV-C Lighting: Ultraviolet germicidal irradiation (UVGI) is a disinfection method that uses UV-C light to inactivate viral and bacterial microorganisms in the air so they are unable to replicate. UVGI can be used to disinfect air passing through air-handling units and by circulating room air through UV-C troffers in the ceiling.

- Room Control: Temperature, room pressurization, and relative humidity also aid in destabilizing airborne viral transmission by reducing cross contamination and creating protective environments for occupants.

Air-handling units included will be outside air balanced prior to installation to determine the actual outside air ventilation rates. The air-handling units will be balanced again after installation to verify the new ventilation rates.

## Facilities Recommended for This Measure

- Thirteenth Avenue School
- Chancellor Avenue School
- West Side High School

# Add Ventilation to Gyms and Auditoriums

## ECM Summary

In the buildings where the primary heating source in the spaces is steam, there is limited ventilation in areas beyond the classrooms, such as gyms and auditoriums. These areas are capable of holding large amounts of people so it is important to provide appropriate ventilation.

Providing a means of mechanical ventilation using rooftop units or air-handling units, the new units will distribute the air in an efficient manner by using premium efficiency motors, tight unit construction eliminating leakage, and efficient heating and cooling coil designs. Installation of new mechanical equipment will also allow for better control of the outside air due to controlled damper operation and DDC controls. In addition to energy and operational cost savings the units will provide a more pleasant indoor environment.

## Proposed System

As of now, Johnson Controls is estimating a total of 30 gyms and auditoriums where ventilation will be proposed. Therefore, this budget may need to be adjusted depending on the final count.

During the design phase, different approaches and technologies will be evaluated to improve the indoor air quality. Some examples are listed below:

- Increasing Ventilation Rates: Increasing the amount of clean outdoor air and increasing the amount of filtered recirculated air decreases pathogen exposure probability by diluting and removing aerosols.
- Improving Filtration: Adding filters, including HEPA filters and filters with the highest minimum efficiency reporting value (MERV) rating can trap more particles and increase your building's clean air percentage.
- Disinfecting Air with UV-C Lighting: Ultraviolet germicidal irradiation (UVGI) is a disinfection method that uses UV-C light to inactivate viral and bacterial microorganisms in the air so they are unable to replicate. UVGI can be used to disinfect air passing through air-handling units and by circulating room air through UV-C troffers in the ceiling.
- Room Control: Temperature, room pressurization, and relative humidity also aid in destabilizing airborne viral transmission by reducing cross contamination and creating protective environments for occupants.

# Domestic Water Heater Replacements

## ECM Summary

This ECM replaces existing domestic water heating systems with gas fired, high-efficiency, condensing, hot water heaters. The domestic water heating in the school district's buildings was observed to be provided by a mix of gas fired and electric domestic water heaters as well as steam converters.

## Existing System

As existing domestic hot water heaters age, they typically experience a loss in efficiency, failing electric heating elements and an increase in maintenance costs. The existing domestic hot water units were found to be approaching their useful life.

## Proposed System

This ECM would replace these existing domestic water heating systems with gas fired, high-efficiency, condensing hot water heaters with the required storage. Condensing, domestic water heaters can substantially improve the operating efficiency of the domestic water heating system. The natural gas-to- hot water efficiency of new condensing domestic water heaters with digital controls is approximately 94%.

## Scope of Work

Demolition, removal and disposal:

- Safe off the existing domestic hot water heater tanks and reserve for reuse (as applicable, see summary table below)
- Demo and remove the existing domestic hot water from the boiler room
- Safe off electrical power feed.

Furnish and install the following:

- Furnish and install concrete equipment pads for domestic hot water heater and tanks (as applicable, see summary table below)
- Provide and install hot water heater and tanks (as applicable, see summary table below)
- Provide and install the required new relief piping for the new heater, Extend the piping to the floor
- Provide and install the required new natural gas pipe, valves and fittings to connect the existing gas piping to the heater
- Provide and install the required copper tube, fittings and valves to connect the new domestic hot water to the existing tanks (as applicable, see summary table below)
- Reconnect the 120-volt feeder from the existing hot water return pump to the new hot water return pump, connect the circuit to the new heater
- Provide and install fiberglass pipe insulation on the new and disturbed hot/cold water piping from the heater to the interior boiler room wall. Insulation shall be 1" wall with all service jacket with PVC fitting covers
- Provide and install the required new double wall domestic hot water heater exhaust venting from the new domestic hot water to the existing chimney (as applicable, see summary table below)
- Provide and install controls interface between the domestic hot water heat pump and the existing hot water system as required

- Provide factory start-up of the heater

## Facilities Recommended for This Measure

- Chancellor Ave
- Early Childhood Center – Central
- Hawthorne Ave School
- John F. Kennedy
- Lincoln Ave
- Louise A Spencer
- Mount Vernon
- Roberto Clemente

## Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Existing Heating Cost =Existing kWh Usage x $/kWh or Existing Therm Usage x $/Therm

Proposed Heating Cost = Heating Therms x $/Therm

Energy Savings $ = Existing System Cost – Proposed System Cost

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections. |
| Equipment Identification | As part of the measure design and approval process, specific product selection will be provided for the customer's review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Changes in Infrastructure

No architectural or structural changes to the facility are anticipated with the implementation of this measure.

## Customer Support and Coordination with Utilities

Minor support will be required for the interruption of utilities for brief tie-in periods. All interruptions will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result from using less costly fuel to heat the domestic hot water. |
| Waste Production | This measure will produce waste by products. Old units shall be disposed of in accordance with all federal, state and local codes. |
| Environmental Regulations | Environmental impact is expected; all regulations will be adhered to in accordance with federal and local code requirements. |

# Boiler Controllers

## ECM Summary

The existing boilers in operation cycle on and off based upon water temperature setpoints. This measure incorporates a controller to optimize boiler operation by prolonging the boiler combustion cycle and minimizing boiler purge before and after the combustion cycle. As a result, the boilers will fire for longer durations but less frequently resulting in reduced fuel consumption.

## Scope of Work


Johnson Controls proposes the installation of new Intellidyne boiler controllers for the boiler systems not already chosen for either boiler or burner replacements. When installed, these controllers reduce fuel consumption, wear on parts, flue emissions, and electrical usage. The controller saves energy by adjusting the burner run pattern to match the system's heat load. Its action is similar to the industry-accepted method of outdoor air temperature reset control, but does not require an outdoor air temperature sensor or the need to profile the building in order to adjust the reset controller properly. The controller determines the heat load by using an easily installed strap-on temperature sensor that monitors the boiler's out-flow water temperature and the rate that this temperature is changing. The controller increases system efficiency thus the heating system uses less fuel to generate the same amount of heat. This is done by dynamically changing the aquastat's effective dead-band based upon the measured heating load. This causes the average water temperature to be varied (depending upon the measured load) and is accomplished by extending the burner's off-time. Extending the off-time also results in longer burns that are more efficient and a reduction in burner on/off cycling.

- Provide and install a new IntelliCon controller for each boiler
- Provide programming for each unit
- Provide start-up and warranty
- Provide training for maintenance personnel

## Savings Methodology

The savings approach is based upon reducing the amount of boiler on time without reducing the heating response time or system capacity. As a result, the boiler will fire for a longer duration but less frequently resulting in reduced fuel consumption. Based upon the size of the boiler plant, the demand profile of the building and the type and condition of the boiler controls a model of the boiler operation is constructed. Using this model the savings are calculated using values for combustion cycle and off cycle extension.

Approximate energy savings factor of 0.13 based on average % savings for test sites represented in Table 2 (page 3) of NYSERDA Study: A Technology Demonstration and Validation Project for Intellidyne Energy Saving Controls; Intellidyne LLC & Brookhaven National Laboratories; 2006 (http://www.cleargreenpartners.com/attachments/File/NYSERDA_Report.pdf)

## Benefits

- Natural gas energy savings.

# New Pump/Motor Skid with VFD

## Existing Conditions

This measure will install variable speed drive(s) on electric motor(s) for domestic water pumps at Chancellor Ave School and East Side High School. Varying the speed of a motor to match the actual load improves control as well as reduces electrical motor power (kW), water and electrical energy savings.

A variable speed booster system with a PLC based controller is capable of controlling up to a four pump package system using a user-friendly color touchscreen to monitor the system conditions, and adjust the system settings. This system monitors the system discharge pressure via a 4-20 mA signal pressure transducer. This provides a precise pressure control and user flexibility. In addition to this sensor, a suction pressure transducer and/or a flow meter can be added to extend the control and flexibility of the system. The main objective of this pumping package is to maintain a constant pressure, adjusting the speed and number of pumps to run according to the building's demand.

## Scope of Work

It is our recommendation that new variable speed drive(s) along with inverter duty, high- efficiency motors be installed on the domestic water pumps at Chancellor Ave School and East Side High School. The variable speed drives will include bypass to allow motor to operate at full speed in HAND, in the event of variable speed drive failure. The variable speed drive will be supplied complete with BACNet communications card for integration with existing energy management system or newly installed energy management system . The system is capable of staging pumps on and off based on pressure and/or flow, while alternating pumps to keep the run times balanced between them.

- Remove each existing pump motor starter, and safely disconnect electrical supply.
- Replace existing motors with new, inverter duty motors.
- Properly dispose of all removed equipment and waste materials.
- Furnish and install new variable speed drives.
- Provide electrical power wiring from the main electrical panel to each new variable speed drive.
- Reuse existing electrical wiring where possible.
- Modify electrical power wiring distribution panel as needed.
- Extend communication bus to/from each variable speed drive to/from existing energy management system. Perform any required programming and graphics modifications.
- Start-up and commissioning of VFDs.

## Savings Methodology

Energy Savings (kWh) = 0.746 * *HP * *HRS * (ESF/ηmotor) Demand Savings (kW) = 0.746 * *HP * (DSF/ηmotor)

HP = nameplate motor horsepower or manufacturer spec. sheet per application

ηmotor = Motor efficiency at the peak load. Motor efficiency varies with load. At low loads relative to the rated hp (usually below 50%) efficiency often drops dramatically

ESF = Energy Savings Factor. The energy savings factor is calculated by determining the ratio of the power requirement for baseline and VFD control at peak conditions

DSF = Demand Savings Factor. The demand savings factor is calculated by determining the ratio of the power requirement for baseline and VFD control at peak conditions

HRS = annual operating hours

## Benefits

- Fuel savings generated through an increased efficiency.
- Lower utility expenditures.
- Reduced operations and maintenance cost, new unit will be under warranty.
- Improved system reliability.

# Section 5. Measurement and Verification

## M&V Methodologies

This section contains a description of the types of Measurement and Verification (M&V) methodologies that Johnson Controls will use to guarantee the performance of this project.

They have been developed and defined by the following independent authority:

- International Performance Measurement and Verification Protocol (IPMVP)

There are four guarantee options that may be used to measure and verify the performance of a particular ECM. Each one is described below.

**Option A – Retrofit Isolation: Key Parameter Measurement**

Energy savings are determined by field measurement of the key parameters affecting the energy use of the system(s) to which an improvement measure was applied separate from the energy use of the rest of the facility. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the measured parameter, and the length of the reporting period.

Measurement of key parameters means that those parameters not selected for field measurement will be estimated. Estimates can be based on historical data, manufacturer's specifications, or engineering judgement. Documentation of the source or justification of the estimated parameter will be described in the M&V plan in the contract. Energy savings are determined through engineering calculations of the baseline and post-retrofit energy used based on the combination of measured and estimated parameters, along with any routine adjustments.

**Option B – Retrofit Isolation: All Parameter Measurement**

Like Option A, energy savings are determined by field measurement of the parameters of the systems to which an improvement measure was applied separate from the energy use of the rest of the facility. However, all of the key parameters affecting energy use are measured; there are no estimated parameters used for Option B. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the savings and the length of the reporting period. Energy savings is determined through engineering calculations of the baseline and post-retrofit energy used based on the measured parameters, along with any routine adjustments.

**Option C – Whole Building Metering/Utility Bill Comparisons**

Option C involves the use of utility meters or whole building sub-meters to assess the energy performance of a total building. Option C assesses the impact of any type of improvement measure, but not individually if more than one is applied to an energy meter. This option determines the collective savings of all improvement measures applied to the part of the facility monitored by the energy meter. Also, since whole building meters are used, savings reported under Option C include the impact of any other change made in facility energy use (positive or negative).

Option C may be used in cases where there is a high degree of interaction between installed improvement measures or between improvement measures and the rest of the building or the isolation and measurement of individual improvement measures is difficult or too costly.

This Option is intended for projects where savings are expected to be large enough to be discernable from the random or unexplained energy variations that are normally found at the level of the whole facility meter. The larger the savings, or the smaller the unexplained variations in the baseline, the easier it will be to identify savings. Also, the longer the period of savings analysis after installing the improvement measure, the less significant is the impact of short-term unexplained variations. Typically, savings should be more than 20% of the baseline energy use if they are to be separated from the noise in the baseline data.

Periodic inspections should be made of all equipment and operations in the facility after the improvement measure installation. These inspections will identify changes from baseline conditions or intended operations. Accounting for changes (other than those caused by the improvement measures) is the major challenge associated with Option C-particularly when savings are to be monitored for long periods.

Savings are calculated through analysis of whole facility utility meter or sub-meter data using techniques from simple comparison to regression analysis.

**Option D – Calibrated Simulation**

Option D involves the use of computer simulation software to predict energy use, most often in cases where baseline data does not exist. Such simulation models must be calibrated so that it predicts an energy use and demand pattern that reasonably matches actual utility consumption and demand data from either the base-year or a post-retrofit year.

Option D may be used to assess the performance of all improvement measures in a facility, akin to Option C. However, different from Option C, multiple runs of the simulation in Option D allow estimates of the savings attributable to each improvement measure within a multiple improvement measure project.

Option D may also be used to assess just the performance of individual systems within a facility, akin to Option A and B. In this case, the system's energy use must be isolated from that of the rest of the facility by appropriate meters.

Savings are calculated using energy use simulation models, calibrated with hourly or monthly utility billing data and/or end-use metering.

## Selecting M&V Options for a Specific Project

The tailoring of your specific M&V Option is based on the level of M&V precision required to obtain the desired accuracy level in the savings determination and is dependent on:

- The complexity of the ECM
- The potential for changes in performance
- The measured savings value

The challenge of the M&V plan is to balance three related elements:

- The cost of the M&V Plan
- Savings certainty
- The benefit of the particular conservation measure

Savings can also be non-measured. If savings are non-measured, these savings are mutually agreed upon as achieved at substantial completion of the respective energy conservation measure and shall not be measured during the term of the performance contract.

## Recommended Performance Verification Methods

Johnson Controls performance verification methods are designed to provide the facility's administration with the level of M&V necessary to protect them from an under-performing ECM, yet have a minimal impact on the project's financial success.

The selection of the M&V methods to be used is based on the criteria as detailed by IPMVP and Johnson Controls experience with hundreds of successful performance contracts in the K-12, state, and local government sectors. Following is a table illustrating how the savings of the major ECMs proposed for this project will be verified.

| Measure | M&V Option | M&V Methodology |
|---|---|---|
| Lighting Upgrades | A | Pre – lighting wattage from manufacturer readings, assumed operating hours aligned with the occupancy schedule and confirmed with the school district.<br>Post – Measure wattage on a sample of new lighting fixtures. |
| Weather Stripping & Air Sealing | Non-Measurable | Pre – Site visit to determine the location and sizes of the building cracks/doors where the weather stripping will be installed.<br>Post – Verify the location and sizes where weather stripping will be installed with as-built and manufacturer specs. |
| Pipe Insulation | Non-Measurable | Pre – Site audit to collect the information of the heating pipes and valves such as the size and surface temperature.<br>Post – Use the final as-built to verify if the insulation is installed as expected. Infrared test may be performed to check if the surface temperature with the insulation is close to the ambient temperature. |
| Water Conservation | A | Pre – Site audit to determine the occupant demographic and measure the water flow rates of existing water fixtures.<br>Post – Measure water flow rates on a sample of new water fixtures. |
| Building Controls Upgrade | A | Pre – Site audit to collect pre-retro schedules, space setpoints and heating/cooling sequences.<br>Post – Setup trending on points in BAS and track to verify the schedules and temperate setpoints. |
| Install / Replace Air-Handling Units and Package Units with Addition of Indoor Air quality improvements | Non-Measurable | Pre – Site audit to collect the information of the air-handling units and packaged units that will be replaced.<br>Post – Verify the new air-handling units and packaged units with manufacturer specification and final as-built to ensure they are installed as expected. |
| Install / Replace Rooftop Units with Addition of Indoor air quality improvements | Non-Measurable | Pre – Site audit to collect the information of the rooftop units that will be replaced.<br>Post – Verify the new rooftop units with manufacturer specification and final as-built to ensure they are installed as expected. |
| Chiller Replacement | Non-Measurable | Pre – Site audit to collect the name plate efficiency information of the existing chillers. The efficiency will be derated based on age and engineering judgement. Floor cooling ton-hours will be established from operator logs and conversation w/ customer.<br>Post – Post-installation chiller efficiency will be verified with manufacturer specification. |
| Boiler Replacement & Steam Boiler to Hot Water Boiler Conversion | A | Pre – Existing boiler efficiency and annual heating load are determined through the site audit and annual natural gas bills.<br>Post – One-time combustion efficiency test on new boilers and boiler operation parameters verified through BAS. |

| Measure | M&V Option | M&V Methodology |
|---|---|---|
| Boiler Burner Upgrades | Non-Measurable | Pre – Site audit to collect the information of the burners that will be replaced.<br>Post – Verify the installed burners with manufacturer specification and final as-built to ensure they are installed as expected. |
| Decommission Boiler | Non-Measurable | Pre – Site audit to collect the information of the boilers where decommissioning is necessary.<br>Post – Verify the decommissioning process with final as-built to ensure it is implemented properly. |
| Steam Trap Replacement | A | Pre – Site audit to collect the information of the steam traps such as type, size and steam pressure.<br>Post – Use the final as-built to verify if the steam traps are installed as expected. Infrared test may be performed to ensure the new steam traps function well. |
| VFD on Pumps | Non-Measurable | Pre – Site audit to collect the information of the pumps.<br>Post – Use the final as-built to verify if the VFDs are installed as expected. |
| Premium Efficiency Motors | Non-Measurable | Pre – Site audit to collect the information of the motors that will be replaced.<br>Post – Use the final as-built to verify if the new PE motors are installed as expected. |
| Transformer Replacement | Non-Measurable | Pre – Site audit to collect the information of the existing transformers.<br>Post – Verify the installed equipment and their efficiency to ensure they are installed as expected. |
| Combined Heat and Power (CHP) | A | Pre – Determine the size of the CHP and operation hours using existing building heating load and electric consumption.<br>Post – kW meter, Btu meter and natural gas meter will be installed and points will be mapped in BAS to track and measure the output of the CHP. |
| Roof Upgrades | Non-Measurable | Pre – Site visit to determine the location and sizes of the roof areas where upgrade is needed.<br>Post – Verify the location, sizes and efficiencies where new roof is installed with as-built and manufacturer specs. |
| Walk-in Refrigeration Evaporator Fan Controls | Non-Measurable | Pre – Site audit to collect the information of the refrigeration compressors where controls will be installed.<br>Post – Use the final as-built to verify if the controls are installed and functioning as expected. |
| Kitchen Exhaust Hood Controls | Non-Measurable | Pre – Site audit to collect the information of the existing kitchen hoods where controls will be installed.<br>Post – Verify the installed controls and their operation schedule to ensure they are functioning as expected. |
| Plug Load Controls | Non-Measurable | Pre – Site audit to collect the information of the plug load equipment such as watt and quantity.<br>Post – Verify the installed controls through final as-built and check the schedule through the plug load control platform. |
| Solar PV – Power Purchase Agreement | Non-measurable | Pre – The potential Solar PV kWh generation is determined through the existing annual electric consumption and the annual savings from the other ECMs. The annual kWh generation are mutually agreed upon between Johnson Controls and the school district.<br>Post – Verify the solar PPA rates through the PPA invoices. |

## M&V Services

M&V Services will be provided in association with the guarantee provided by Johnson Controls. The guarantee will be in effect for each year that the school elects to participate in the M&V Services. The cost of the M&V services is included in the business case in the "Annual Services" column as outlined in the table below:

| Year | Annual Amount ($/yr) |
|---|---|
| 1 | $216,778 |
| 2 | $216,778 |
| 3 | $216,778 |
| **Total** | **$650,334** |

Johnson Controls will provide the M&V Services set forth below in connection with the Assured Performance Guarantee.

1. During the Installation Period, a Johnson Controls Performance Specialist will track Project Benefits. Johnson Controls will report the Project Benefits achieved during the Installation Period to customer within 60 days of the commencement of the Guarantee Term.
2. For specified improvement measures, Johnson Controls will:
    a. conduct pre and post-installation measurements required under this Agreement;
    b. confirm the BAS employs the control strategies and setpoints specified in this Agreement;
    c. analyze actual as-built information and adjust the Baseline and/or Measured Project Benefits to conform to actual installation conditions (e.g., final lighting benefits calculations will be determined from the as-built information to reflect the actual mix of retrofits encountered during installation);
    d. confirm that the appropriate metering and data points required to track the variables associated with the applicable improvement measures' benefits calculation formulas are established; and
    e. set up appropriate data capture systems (e.g., trend and totalization data on the facility management system) necessary to track and report Measured Project Benefits for the applicable improvement measure. Trend data records maintained in the ordinary course of system operation shall be used and relied upon by Johnson Controls in connection with Project Benefit calculations. Johnson Controls will use commercially reasonable efforts to ensure the integrity of the data collected to calculate the required metrics. In the event data are lost due to equipment failure, power failure or other interruption in data collection, transmission or storage, Johnson Controls will use reasonable engineering methods to estimate or replace the lost data.
3. During the Guarantee Term, a Johnson Controls Performance Specialist will monitor the on-going performance of the improvement measures, as specified in this agreement, to determine whether anticipated Measured Project Benefits are being achieved. In this regard, the Performance Specialist will periodically assist customer, on-site or remotely, with respect to the following activities:
    a. review of information furnished by customer from the facility management system to confirm that control strategies are in place and functioning;
    b. advise customer's designated personnel of any performance deficiencies based on such information;
    c. coordinate with customer's designated personnel to address any performance deficiencies that affect the realization of Measured Project Benefits; and
    d. inform customer of opportunities to further enhance project performance and of opportunities for the implementation of additional improvement measures.

4. Within 60 days of each anniversary of the commencement of the Guarantee Term, Johnson Controls will provide customer with an annual report containing:
    e. an executive overview of the project's performance and Project Benefits achieved to date;
    f. a summary analysis of the Measured Project Benefits accounting; and
    g. Depending on the M&V Option, a detailed analysis of the Measured Project Benefits calculations.
5. Johnson Controls will assist the school in applying for rebate incentives. This includes submitting application forms and data on behalf of the school and following up with the program administrators to answer any questions or provide additional information. Work is expected to take place during the construction period, Year 1 and Year 2 only. **Note: Rebates are not guaranteed**.

# Section 6. Customer Support

## Maintenance Impacts/ On-Going Service

New pieces of equipment that are installed as part of the ESIP project will be provided with the standard manufacturer warranty. Once installation of the equipment is complete, the remaining warranty period will be transferred to Newark Public Schools; any warranty issues will be handled directly with the equipment manufacturer rather than with Johnson Controls.

The installation of the recommended measures will reduce the amount of emergency maintenance required by the school through the installation of new equipment; however, preventative maintenance is still required in order to ensure the correct operation of the equipment for the expected lifetime. A service agreement cannot be included as part of this project per the New Jersey Local Finance Notice 2009-11. Once the scope is finalized and bids are received, Johnson Controls will assist the school in preparing bids for any preventative service agreement that is felt necessary for the new equipment. The service agreement will cover recommended maintenance per each equipment manufacturer. Training on the proper maintenance and operation of each piece of equipment has also been included as part of the ESP project which will allow the school to complete the majority of maintenance and repair in-house in order to use school resources.

To ensure the school is fully capable of achieving its energy savings and use the new HVAC and BAS, Johnson Controls is including training for School employees.

Johnson Controls recommends the school go out to bid for the following third-party service contracts in order to achieve the continuous savings throughout the term of the ESIP Program:

- BAS Agreement including updates to subscription services.
- Cogeneration Service Agreement to allow for emergency service and preventative maintenance on the new cogeneration systems.

## Design and Compliance Issues

Johnson Controls will enlist a design engineering firm to oversee and complete all design engineering for the purposes of public bidding of the work as well as completing construction drawings.

As part of the ESIP development, Johnson Controls completed a thorough analysis of the building electrical and mechanical systems including light level readings throughout the spaces. The existing light levels are typically within 10-20% of current IES recommendations which is reasonable given the varying age of lamps throughout the school. The proposed lighting solution will continue to adhere to current IES and NJ Education Code guidelines for light levels which in many cases may increase the current light levels to the spaces. At this time, Johnson Controls did not observe any compliance issues in the development of this ESIP.

## Customer Risks

Asbestos reports will be obtained for all schools as part of Johnson Controls safety policy. Based on the reports, asbestos materials will have to be abated prior to any work being performed. If any additional asbestos is found during the installation of the measures, Johnson Controls will stop work and notify the school. Any work associated with testing or remediation of asbestos containing material will be the responsibility of Newark Public Schools.

Johnson Controls does not guarantee the rebate or state incentive structure. If the programs change or the incentive amounts differ, Newark Public Schools will be responsible to make-up the difference in received incentives for the financing. The difference could result from over performance of ECMs, other rebates/ incentives that may be available, restructuring the loan payment for Years 1 and 2, or capital contributions by the school.

# Section 7: Implementation Schedule

A preliminary installation schedule for the measures implemented as part of the ESIP is included below to provide a reasonable expectation for the timeline of construction. Once final bids are received and financing of the project is complete, the installation will be finalized in much greater detail and reviewed with the team from Newark Public Schools to ensure agreement. A high level review of the next steps in the process is shown below as well as the estimated time frame to complete each step:

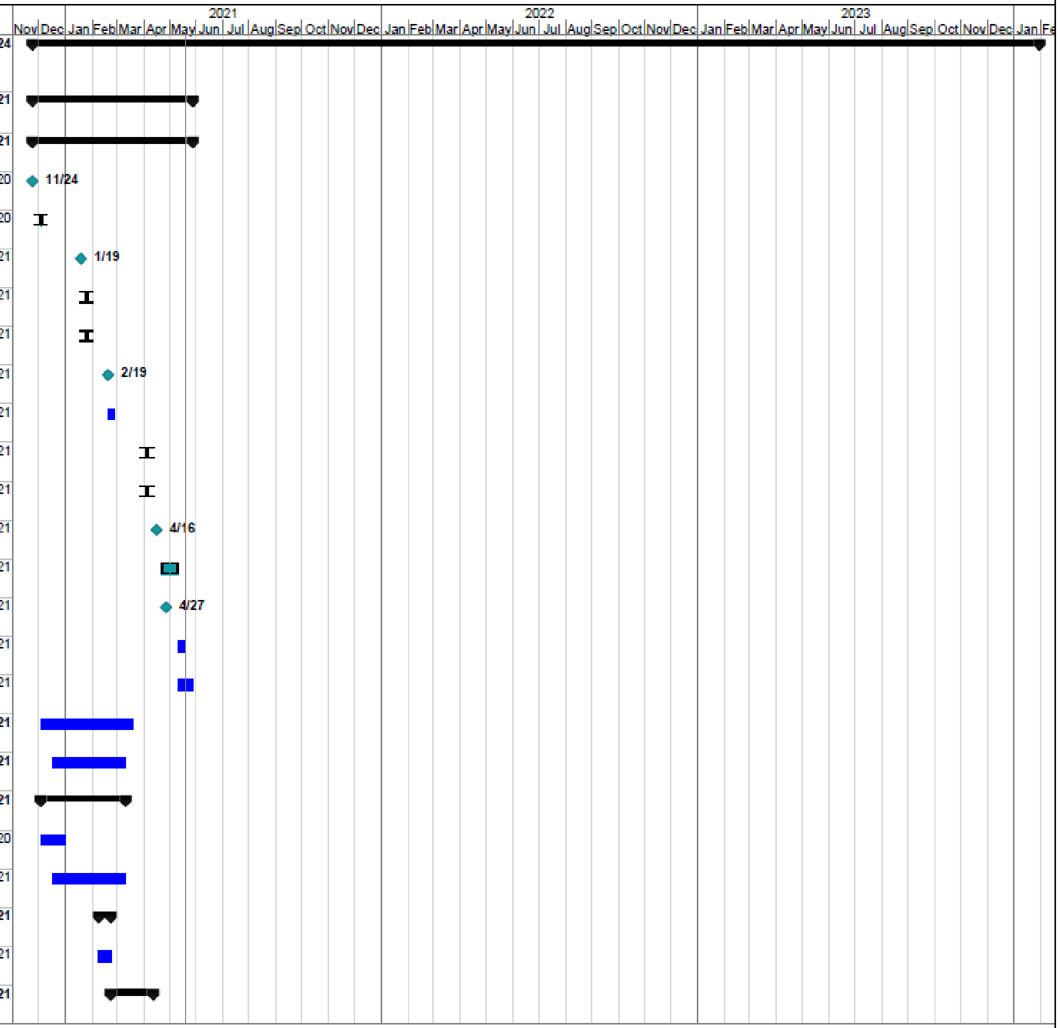
- Accept ESIP Pending necessary Reviews – April 27, 2021
- Complete Third Party Engineering Review of ESIP – May 10, 2021
- Complete Board of Public Utilities Review of ESIP – May 18, 2021
- Submit Application to Local Finance Board – May 19, 2021
- Approval resolution to contract with Johnson Controls – May 27, 2021
- Present to Local Finance Board – planned for June 9, 2021
- Expected Finance Close – July 29, 2021

The project plan on the following page details the Installation Phase schedule.

Johnson Controls

**Newark Public Schools**
**ESP Development & Installation Schedule**

| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 1 | **Newark Public Schools ESIP** | 830 days | Tue 11/24/20 | Mon 1/29/24 |
| 2 | **Phase 1: Investment Grade Audit/ Energy Savings Plan** | 133 days | Tue 11/24/20 | Thu 5/27/21 |
| 3 | **Major Milestone** | 133 days | Tue 11/24/20 | Thu 5/27/21 |
| 4 | ESCO Selection | 0 hrs | Tue 11/24/20 | Tue 11/24/20 |
| 5 | Customer Kick-off Workshop | 2 hrs | Thu 12/3/20 | Thu 12/3/20 |
| 6 | Advertise Solar PPA Bid | 0 hrs | Tue 1/19/21 | Tue 1/19/21 |
| 7 | ECM Verification Workshop | 1 hr | Mon 1/25/21 | Mon 1/25/21 |
| 8 | Baseline Utility Workshop | 1 hr | Mon 1/25/21 | Mon 1/25/21 |
| 9 | Solar PPA Bid Opening | 0 hrs | Fri 2/19/21 | Fri 2/19/21 |
| 10 | Evaluate Solar Bids and Make Recommendation to the District | 1 wk | Fri 2/19/21 | Thu 2/25/21 |
| 11 | Measurement & Verification Workshop | 1 hr | Mon 4/5/21 | Mon 4/5/21 |
| 12 | Business Case Workshop | 4 hrs | Mon 4/5/21 | Mon 4/5/21 |
| 13 | IGEA Results Presented to Distrct | 0 hrs | Fri 4/16/21 | Fri 4/16/21 |
| 14 | 3rd Party Engineering Review | 2.8 wks | Wed 4/21/21 | Mon 5/10/21 |
| 15 | District Formal Approval of Solar PPA Provider | 0 hrs | Tue 4/27/21 | Tue 4/27/21 |
| 16 | Submit Energy Savings Plan to BPU for Review & Approval | 6 days | Tue 5/11/21 | Tue 5/18/21 |
| 17 | Customer Approval & Acceptance of ESP & JCI Contract | 13 days | Tue 5/11/21 | Thu 5/27/21 |
| 18 | **Detailed Site Visits** | 15 wks | Thu 12/3/20 | Thu 3/18/21 |
| 19 | **Scope Design & Construction Cost Estimating** | 12 wks | Thu 12/17/20 | Thu 3/11/21 |
| 20 | **Detailed Energy Analysis** | 70 days | Thu 12/3/20 | Thu 3/11/21 |
| 21 | Update Utility Bills | 4 wks | Thu 12/3/20 | Thu 12/31/20 |
| 22 | Energy Saving Calculations | 12 wks | Thu 12/17/20 | Thu 3/11/21 |
| 23 | **Data Logging** | 10 days | Mon 2/8/21 | Mon 2/22/21 |
| 24 | Field Measurements | 2 wks | Mon 2/8/21 | Mon 2/22/21 |
| 25 | **ESP Report Development** | 35.5 days | Mon 2/22/21 | Mon 4/12/21 |




 5/18/21

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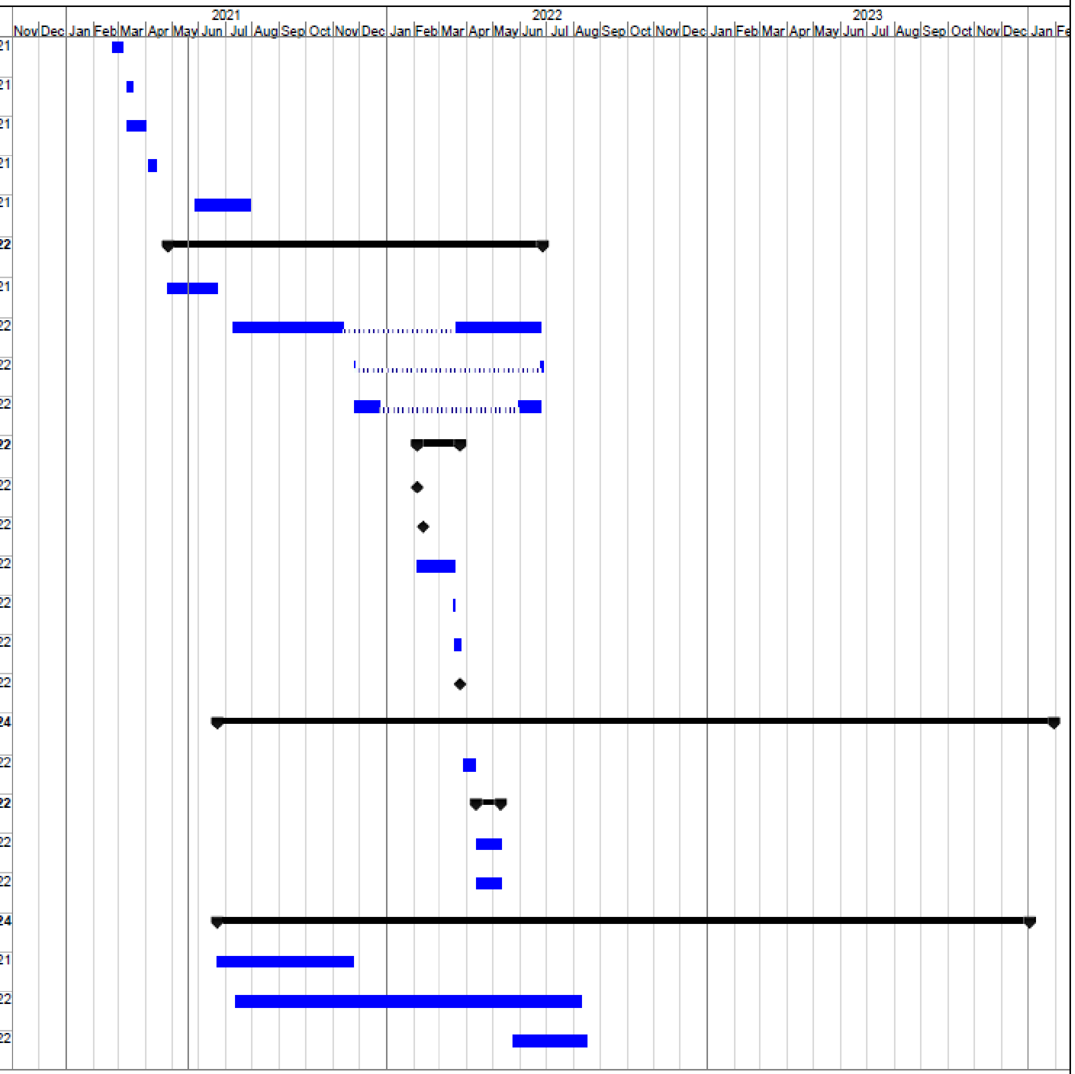
**Newark Public Schools**
**ESP Development & Installation Schedule**

| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 26 | Detailed Scope Write-up | 2 wks | Mon 2/22/21 | Fri 3/5/21 |
| 27 | Detailed Energy Savings Analysis | 4 days | Thu 3/11/21 | Wed 3/17/21 |
| 28 | Develop Business Case | 3 wks | Thu 3/11/21 | Thu 4/1/21 |
| 29 | Energy Savings Plan Appendix | 1 wk | Mon 4/5/21 | Mon 4/12/21 |
| 30 | **Project Financing** | 9 wks | Fri 5/28/21 | Thu 7/29/21 |
| 31 | **Phase 2: Design** | **304.01 days** | **Tue 4/27/21** | **Mon 6/27/22** |
| 32 | Solar PPA Design, TREC Apps, Interconnects | 8 wks | Tue 4/27/21 | Mon 6/21/21 |
| 33 | Final Design Engineering | 32 wks | Fri 7/9/21 | Fri 6/24/22 |
| 34 | Final Design Review Workshop | 2 days | Wed 11/24/21 | Mon 6/27/22 |
| 35 | Bid Specification Development | 8 wks | Wed 11/24/21 | Fri 6/24/22 |
| 36 | **Phase 3: Procurement** | **35 days** | **Fri 2/4/22** | **Fri 3/25/22** |
| 37 | Advertise Bids | 0 days | Fri 2/4/22 | Fri 2/4/22 |
| 38 | Pre-Proposal Conference & Site Visits | 0 days | Fri 2/11/22 | Fri 2/11/22 |
| 39 | Bid Duration for Subcontractors | 6 wks | Fri 2/4/22 | Fri 3/18/22 |
| 40 | Opening of Bids | 1 hr | Thu 3/17/22 | Fri 3/18/22 |
| 41 | Evaluation of Bids and Confer on Selection of Sub-Contractors | 1 wk | Fri 3/18/22 | Fri 3/25/22 |
| 42 | Subcontractor Selection | 0 days | Fri 3/25/22 | Fri 3/25/22 |
| 43 | **Phase 4: Construction** | **680 days** | **Tue 6/22/21** | **Mon 1/29/24** |
| 44 | Issue Subcontracts | 2 wks | Mon 3/28/22 | Mon 4/11/22 |
| 45 | **Pre- Construction Activities** | **20 days** | **Tue 4/12/22** | **Tue 5/10/22** |
| 46 | Mobilization / Planning / Engineering | 4 wks | Tue 4/12/22 | Tue 5/10/22 |
| 47 | Shop Drawing Approval | 4 wks | Tue 4/12/22 | Tue 5/10/22 |
| 48 | **Installation of Recommended ECMs** | **660.02 days** | **Tue 6/22/21** | **Tue 1/2/24** |
| 49 | Roofing Upgrades | 5.5 mons | Tue 6/22/21 | Mon 11/22/21 |
| 50 | Solar PPA Construction | 14 mons | Tue 7/13/21 | Mon 8/8/22 |
| 51 | Air Handling Unit Replacements | 12 wks | Tue 5/24/22 | Tue 8/16/22 |

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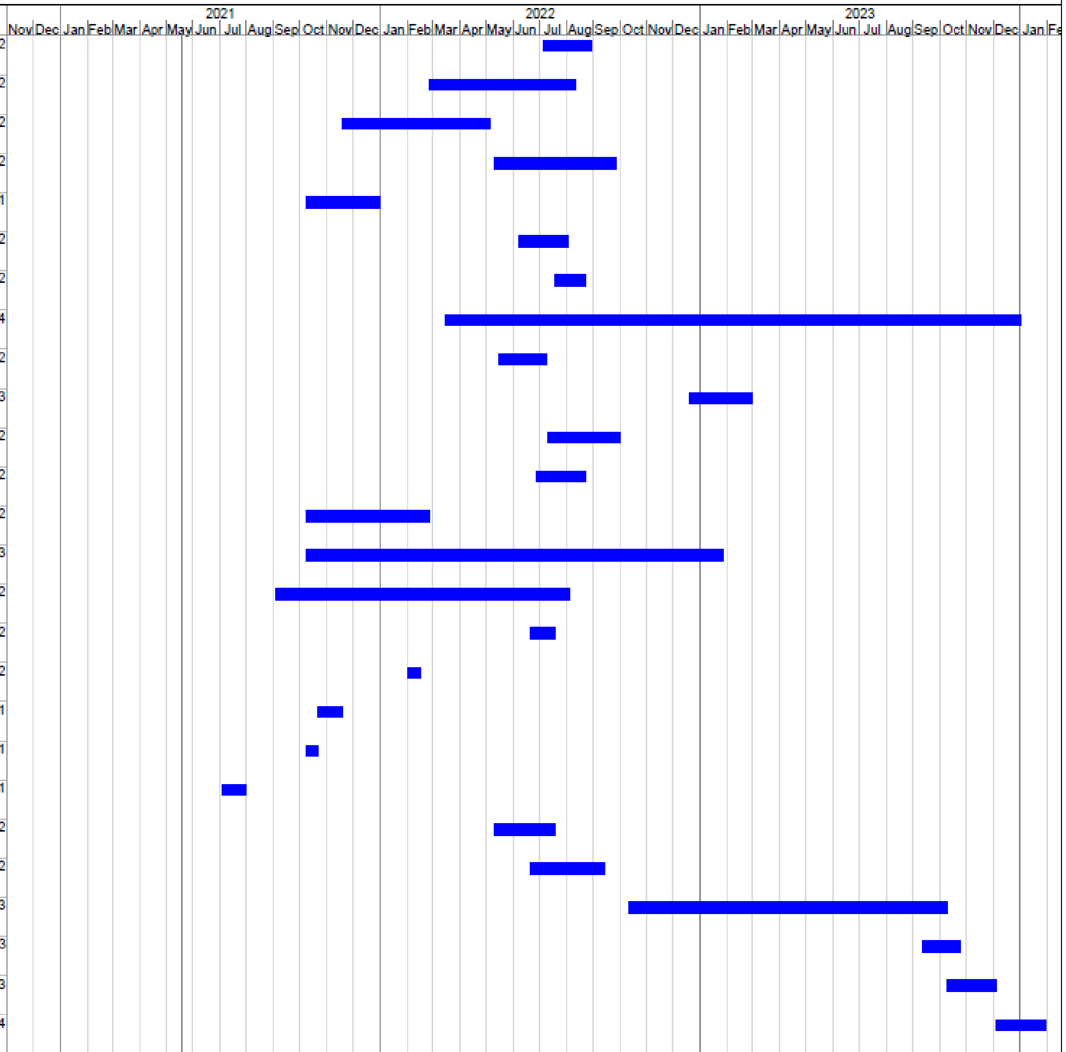
Johnson Controls

**Newark Public Schools**
**ESP Development & Installation Schedule**

| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 52 | Rooftop Unit Replacements | 8 wks | Tue 7/5/22 | Tue 8/30/22 |
| 53 | Pipe and Valve Insulation | 24 wks | Fri 2/25/22 | Thu 8/11/22 |
| 54 | Infiltration Reduction | 24 wks | Fri 11/19/21 | Thu 5/5/22 |
| 55 | Steam Trap Replacements | 20 wks | Tue 5/10/22 | Tue 9/27/22 |
| 56 | Plug Load Controls | 12 wks | Fri 10/8/21 | Thu 12/30/21 |
| 57 | VFDs/Motor Replacements | 8 wks | Tue 6/7/22 | Tue 8/2/22 |
| 58 | Transformer Replacements | 5 wks | Tue 7/19/22 | Tue 8/23/22 |
| 59 | Building Automation Controls Upgrade/Enterprise Mgt System | 94 wks | Tue 3/15/22 | Tue 1/2/24 |
| 60 | Asbestos Abatement | 8 wks | Mon 5/16/22 | Fri 7/8/22 |
| 61 | Chiller Replacements | 10 wks | Tue 12/20/22 | Tue 2/28/23 |
| 62 | Boiler Replacements | 12 wks | Mon 7/11/22 | Fri 9/30/22 |
| 63 | Burner Replacements | 8 wks | Tue 6/28/22 | Tue 8/23/22 |
| 64 | Water Conservation | 20 wks | Fri 10/8/21 | Thu 2/24/22 |
| 65 | Interior/Exterior Lighting Upgrades - Non-Direct Install | 68 wks | Fri 10/8/21 | Thu 1/26/23 |
| 66 | Interior/Exterior Lighting Upgrades - Direct Install | 48 wks | Fri 9/3/21 | Thu 8/4/22 |
| 67 | Pool Upgrades | 4 wks | Tue 6/21/22 | Tue 7/19/22 |
| 68 | Walk-in Box Controls | 2 wks | Tue 2/1/22 | Tue 2/15/22 |
| 69 | Kitchen Hood Controls | 4 wks | Fri 10/22/21 | Thu 11/18/21 |
| 70 | Wind Turbine | 2 wks | Fri 10/8/21 | Thu 10/21/21 |
| 71 | Student Engagement | 4 wks | Mon 7/5/21 | Fri 7/30/21 |
| 72 | HVAC Lab | 10 wks | Tue 5/10/22 | Tue 7/19/22 |
| 73 | Combined Heat & Power | 12 wks | Tue 6/21/22 | Tue 9/13/22 |
| 74 | Punch List Items | 52 wks | Tue 10/11/22 | Mon 10/9/23 |
| 75 | Equipment Initial Training | 6 wks | Tue 9/12/23 | Mon 10/23/23 |
| 76 | System Commissioning | 8 wks | Tue 10/10/23 | Mon 12/4/23 |
| 77 | Project Close Out | 8 wks | Tue 12/5/23 | Mon 1/29/24 |

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# Section 8. Sample Energy Performance Contract

A sample Energy Performance Contract has been provided electronically to the school for review.

# Appendix 1. Energy Savings Calculations

## Energy Savings

Energy savings were calculated using an Excel-based bin calculation workbook developed by Johnson Controls; all savings calculations and field measurements will be provided electronically.

# Appendix 2. Detailed Building Descriptions

# Appendix 3. Recommended Project – ESIP

## Energy Savings and Cost Summary

The table below provides a summary of the costs and savings associated with the measures recommended in the ESP. The savings have been calculated based on the savings methodology detailed throughout this report and included in the Appendix of this report. Costs for each measure have been estimated based on project implementation experience and industry standards.

| ID # | Energy Conservation Measure | ECM Hard Cost | Year 1 Utility Savings* | Simple Payback |
|---|---|---|---|---|
| 1 | Lighting LED and Lens Upgrades - All buildings (Includes DI) | $7,690,802 | $1,168,659 | 6.6 |
| 2 | Weather Stripping & Air Sealing | $1,676,765 | $185,269 | 9.1 |
| 3 | Pipe & Valve Insulation | $1,074,114 | $109,552 | 9.8 |
| 4 | Water Conservation | $2,463,010 | $345,877 | 7.1 |
| 5 | Building Controls Upgrades | $23,894,038 | $891,116 | 26.8 |
| 6 | Enterprise Management System | $944,300 | $0 | N/A |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of Indoor Air Quality Improvements- American History HS | $175,000 | $0 | N/A |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Cleveland Elementary School | $50,671 | $0 | N/A |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Dr. E. Alma Flagg School | $749,765 | $0 | N/A |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Gym H&V Refurb - Luis Muñoz Marin School | $19,400 | $596 | 32.6 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Package Unit Replacement - Luis Muñoz Marin School | $95,318 | $738 | 129.1 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Avon Avenue Elementary School | $175,786 | $2,111 | 83.3 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Harold Wilson | $749,765 | $0 | N/A |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Louise A. Spencer School | $47,600 | $859 | 55.4 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Auditorium HVAC Upgrades - University High School | $588,000 | $811 | 725.3 |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Kitchen-Café AHU - University High School | $150,071 | $0 | N/A |
| 7 | Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Camden Street School | $90,000 | $1,482 | 60.7 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Ivy Hill Elementary School | $32,365 | $726 | 44.6 |

| ID # | Energy Conservation Measure | ECM Hard Cost | Year 1 Utility Savings* | Simple Payback |
|---|---|---|---|---|
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Penthouse RTU Replacement - East Side High School | $130,259 | $0 | N/A |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Dr. William H. Horton School | $557,882 | $5,840 | 95.5 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Luis Muñoz Marin School | $69,729 | $1,135 | 61.4 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Hawthorne Avenue School | $297,812 | $2,635 | 113.0 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Bard Early College High School | $165,470 | $1,124 | 147.2 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Early Childhood Center - West | $979,059 | $9,227 | 106.1 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - Mount Vernon School | $112,835 | $2,307 | 48.9 |
| 8 | Install / Replace Rooftop Units with Addition of IAQ Improvements - South 17th Street School | $668,824 | $8,308 | 80.5 |
| 9 | Chiller Replacement - Gladys Hillman-Jones Middle School | $420,129 | $5,457 | 77.0 |
| 9 | Chiller Replacement - Belmont Runyon School | $637,071 | $6,116 | 104.2 |
| 9 | Chiller Replacement - Louise A. Spencer School | $450,365 | $1,551 | 290.3 |
| 9 | Chiller Replacement - Harold Wilson | $425,071 | $3,006 | 141.4 |
| 9 | Chiller Replacement - Dr. E. Alma Flagg School - Savings Only | $0 | $3,494 | 0.0 |
| 10 | Boiler Replacement - East Side High School | $2,024,471 | $10,172 | 199.0 |
| 10 | Boiler Replacement - Lafayette Street School | $1,219,765 | $23,653 | 51.6 |
| 10 | Boiler Replacement - Salomé Ureña Elementary School | $1,222,118 | $1,537 | 795.4 |
| 10 | Boiler Replacement - Roberto Clemente Elementary School | $1,166,824 | $1,125 | 1,037.5 |
| 10 | Boiler Replacement - Benjamin Franklin School | $1,219,765 | $1,969 | 619.3 |
| 10 | Boiler Replacement - Chancellor Avenue School | $1,083,882 | $6,154 | 176.1 |
| 10 | Boiler Replacement - Harold Wilson | $667,882 | $30,727 | 21.7 |
| 10 | Boiler Replacement - Dr. E. Alma Flagg School | $676,882 | $31,143 | 21.7 |
| 10 | Boiler Replacement - Louise A. Spencer School | $1,203,882 | $6,252 | 192.6 |
| 10 | Boiler Replacement - University High School | $2,128,000 | $10,808 | 196.9 |
| 10 | Boiler Replacement - Harriet Tubman School | $565,647 | $1,448 | 390.8 |
| 10 | Boiler Replacement – McKinley Elementary School | $1,033,882 | $7,248 | 142.6 |
| 10 | Boiler Replacement - Abington Avenue - Savings Only | $0 | $827 | 0.0 |
| 10 | Boiler Replacement - Reimburse Newark Vocational High School | $1,100,000 | $13,927 | 79.0 |
| 11 | Convert Steam Boiler to Hot Water Boiler - Gladys Hillman-Jones Middle School | $986,824 | $9,110 | 108.3 |
| 12 | Boiler Burner Upgrades - Early Childhood Center - South | $130,800 | $634 | 206.5 |
| 12 | Boiler Burner Upgrades - Peshine Avenue School | $80,918 | $2,591 | 31.2 |
| 12 | Boiler Burner Upgrades - Mount Vernon School | $165,153 | $0 | N/A |
| 12 | Boiler Burner Upgrades - South 17th Street School | $156,682 | $1,829 | 85.7 |

| ID # | Energy Conservation Measure | ECM Hard Cost | Year 1 Utility Savings* | Simple Payback |
|---|---|---|---|---|
| 13 | Decommission Boilers - Thirteenth Avenue School | $39,953 | $8,441 | 4.7 |
| 14 | Pool Upgrades - Early Childhood Center - South | $170,123 | $0 | N/A |
| 14 | Pool Upgrades - John F. Kennedy School | $153,565 | $0 | N/A |
| 15 | Steam Trap Replacement | $2,949,864 | $270,992 | 10.9 |
| 16 | Variable Speed Drives on Pumps | $481,092 | $29,205 | 16.5 |
| 17 | Premium Efficiency Motors | $330,765 | $22,310 | 14.8 |
| 18 | Energy-Efficient Transformers - First Avenue School | $62,376 | $4,027 | 15.5 |
| 18 | Energy-Efficient Transformers - Gladys Hillman-Jones Middle School | $78,006 | $5,934 | 13.1 |
| 18 | Energy-Efficient Transformers - Rafael Hernandez Elementary School | $5,643 | $296 | 19.1 |
| 18 | Energy-Efficient Transformers - Belmont Runyon School | $59,606 | $4,088 | 14.6 |
| 18 | Energy-Efficient Transformers - NJ Regional Day School | $21,749 | $1,372 | 15.9 |
| 19 | Combined Heat and Power – East Side High School and Science Park High School | $566,134 | $13,118 | 43.2 |
| 20 | Aris Wind Turbine | $34,000 | $0 | N/A |
| 21 | Solar Power Purchase Agreement - Roofs through Combo PPA and ESIP | $0 | $1,950,659 | 0.0 |
| 22 | Roof Upgrades - Roofs through Combo PPA and ESIP | $7,567,649 | $11,138 | 679.4 |
| 23 | Walk-in Refrigerator/Freezer Evaporator Fan Controls | $63,000 | $8,907 | 7.1 |
| 24 | Kitchen Hood Exhaust Fan Control | $216,050 | $14,316 | 15.1 |
| 25 | Plug Load Controls | $209,208 | $34,780 | 6.0 |
| 26 | Pay for Performance Rebate Application Development | $262,500 | $0 | N/A |
| 27 | Student Engagement and Teacher Professional Development Programs - DW | $0 | $0 | N/A |
| 28 | HVAC Training Center - DW | $0 | $0 | N/A |
| **Total** | | **$75,685,935** | **$5,298,730** | **14.3** |

*Year 1 utility savings in the above table include a 2.2% escalation on electric, water and oil utilities and 2.4% escalation on natural gas for guaranteed savings. Because utility baseline data from 2019 was used and coupled with a 30 month construction period, utility rate escalation has been applied starting at the beginning of the construction period. The construction period is anticipated to begin late in calendar year 2021.

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## Operational Savings Estimates

The lighting retrofits recommended for this project will reduce the amount of lamps that need to be replaced each year due to the longer lasting lamps and new technology fixtures. The LED lighting recommended for the exterior fixtures will last much longer than the current lighting and will generate material cost savings.

A brief description of the operational savings estimated for this project is included below. Johnson Controls has worked with the school district to quantify the exact sources of savings by going through past invoices and expenses. The operational savings will not be escalated.

**Operational Savings for Financial Model**

| ECM Description | Annual Savings | Years to Carry |
|---|---|---|
| Lighting LED and Lens Upgrades | $268,498 | 5 |
| Building Controls Upgrades | $237,000 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of Indoor Air Quality Improvements- American History HS | $1,500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Cleveland Elementary School | $1,500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Dr. E. Alma Flagg School | $5,000 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Gym H&V Refurb - Luis Muñoz Marin School | $500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Package Unit Replacement - Luis Muñoz Marin School | $500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Avon Avenue Elementary School | $750 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Harold Wilson | $5,000 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Louise A. Spencer School | $1,500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Auditorium HVAC Upgrades - University High School | $1,500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Kitchen-Café AHU - University High School | $500 | 2 |
| Install / Replace Air-Handling Units and Package Units with Addition of IAQ Improvements - Camden Street School | $750 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Ivy Hill Elementary School | $500 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Penthouse RTU Replacement - East Side High School | $500 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Dr. William H. Horton School | $750 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Luis Muñoz Marin School | $500 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Hawthorne Avenue School | $750 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Bard Early College High School | $500 | 2 |

| ECM Description | Annual Savings | Years to Carry |
|---|---|---|
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Early Childhood Center - West | $1,000 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - Mount Vernon School | $500 | 2 |
| Install / Replace Rooftop Units with Addition of IAQ Improvements - South 17th Street School | $750 | 2 |
| Chiller Replacement - Gladys Hillman-Jones Middle School | $3,800 | 2 |
| Chiller Replacement - Belmont Runyon School | $3,800 | 2 |
| Chiller Replacement - Louise A. Spencer School | $3,800 | 2 |
| Chiller Replacement - Harold Wilson | $3,500 | 2 |
| Boiler Replacement - East Side High School | $7,000 | 2 |
| Boiler Replacement - Lafayette Street School | $3,500 | 2 |
| Boiler Replacement - Salomé Ureña Elementary School | $3,500 | 2 |
| Boiler Replacement - Roberto Clemente Elementary School | $3,500 | 2 |
| Boiler Replacement - Benjamin Franklin School | $3,500 | 2 |
| Boiler Replacement - Chancellor Avenue School | $3,500 | 2 |
| Boiler Replacement - Harold Wilson | $2,000 | 2 |
| Boiler Replacement - Dr. E. Alma Flagg School | $2,000 | 2 |
| Boiler Replacement - Louise A. Spencer School | $3,500 | 2 |
| Boiler Replacement - University High School | $7,000 | 2 |
| Boiler Replacement - Harriet Tubman School | $1,500 | 2 |
| Boiler Replacement – McKinley Elementary School | $7,500 | 2 |
| Boiler Replacement - Abington Avenue - Savings Only | $2,000 | 2 |
| Convert Steam Boiler to Hot Water Boiler - Gladys Hillman-Jones Middle School | $5,000 | 2 |
| Boiler Burner Upgrades - Early Childhood Center - South | $1,000 | 2 |
| Boiler Burner Upgrades - Peshine Avenue School | $1,000 | 2 |
| Boiler Burner Upgrades - Mount Vernon School | $1,000 | 2 |
| Boiler Burner Upgrades - South 17th Street School | $1,000 | 2 |
| Steam Trap Replacement | $25,000 | 2 |
| **Total** | **$629,148** | |

# Potential Revenue Generation Estimates

## Rebates

As part of the ESP for the Newark Public Schools, several avenues for obtaining rebates and incentives have been investigated which include:

### SmartStart Incentives

New Jersey SmartStart Buildings is a statewide energy efficiency program available to qualified K-12 customers planning to construct, expand, renovate, or remodel a facility, or to replace electric or gas equipment. Incentives are available for prescriptive measures or for custom measures that are selected and incorporated into the project to help offset the added cost to purchase qualifying energy-efficient equipment.

| Incentive Type | Estimated Amount |
|---|---:|
| Lighting Retrofits | $189,545 |
| Rooftop Unit Replacements | $22,538 |
| Boiler Replacements | $63,370 |
| **Total** | **$275,453** |

### Pay for Performance

| Building | Incentive #1* | Incentive #2 | Incentive #3** | Total |
|---|---:|---:|---:|---:|
| Bard Early College High School | $11,487 | $132,997 | $0 | $144,484 |
| Belmont Runyon School | $8,920 | $107,771 | $0 | $116,691 |
| Dr. E. Alma Flagg School | $5,655 | $128,839 | $0 | $134,494 |
| Early Childhood Center - Central | $2,916 | $51,805 | $0 | $54,721 |
| East Side High School | $22,676 | $165,353 | $0 | $188,029 |
| First Avenue School | $14,132 | $158,485 | $0 | $172,617 |
| Harold Wilson School | $5,501 | $77,315 | $0 | $82,816 |
| Louise A. Spencer School | $14,414 | $161,669 | $0 | $176,083 |
| Luis Muñoz Marin School | $14,351 | $152,091 | $0 | $166,442 |
| McKinley Elementary School | $11,171 | $142,649 | $0 | $153,820 |
| NJ Regional Day School | $1,629 | $39,677 | $0 | $41,306 |
| Rafael Hernandez Elementary School | $8,458 | $67,979 | $0 | $76,437 |
| Science Park High School | $20,681 | $239,178 | $0 | $259,859 |
| West Side High School | $10,913 | $107,961 | $0 | $118,874 |
| TOTAL | **$152,904** | **$1,733,771** | **$0** | **$1,886,675** |

* Incentive #1 accounts for participation in LGEA.

** Because of the uncertainty with approval of Incentive #3, the value is not included in the project financials; however, at the appropriate time, if the system meets the performance thresholds outlined in the program guidelines, Johnson Controls will apply for the incentive.

### Combined Heat and Power

Incentives are available for CHP/Cogeneration systems with heat recovery and productive use of waste heat that are located on-site. Cogeneration units that are powered by natural gas and under 500 kW, as in the case of the systems recommended for Newark, are eligible for an incentive of up to $2.00/watt.

The CHP incentive is paid in three increments as outlined below:

- 30% of the incentive upon proof of equipment purchase (Incentive #1)
- 50% upon project completion and verification of installation (Incentive #2)
- Remainder 20% upon acceptance and confirmation the project is achieving the required performance thresholds based on 12 months of operating data (Incentive #3)

| Building | Estimated Incentive #1 | Estimated Incentive #2 | Estimated Incentive #3* | Estimated Total |
|---|---|---|---|---|
| Science Park High School | $21,000 | $35,000 | $0 | $56,000 |
| East Side High School | $21,000 | $35,000 | $0 | $56,000 |
| Total | **$42,000** | **$70,000** | **$0** | **$112,000** |

* Because of the uncertainty with approval of Incentive #3, the value is not included in the project financials; however, at the appropriate time, if the system meets the performance thresholds outlined in the program guidelines, Johnson Controls will apply for the incentive.

**Johnson Controls does not guarantee any rebates carried in this project.**

# Business Case for Recommended Project

**JCI's ENERGY SAVINGS PLAN (ESP) for NEWARK PUBLIC SCHOOLS**
**JCI's CASH FLOW ANALYSIS FORM**
**NEWARK BOARD OF EDUCATION - ENERGY SAVINGS IMPROVEMENT PROGRAM**

ESCO NAME: **Johnson Controls**

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, 2.2% electric, oil and water & sewer per year**; and

1. Term of Agreement: 20 **years (240 Months)**
2. Construction Period [2] (months): 30 **months**
3. Cash Flow Analysis Format:

**Project Cost [1] : $96,416,313**
**Cost of Issuance : $1,750,000**
**Financed Amount : $98,166,313**

Interest Rate to Be Used for Proposal Purposes: 2.25%

| Year | Annual Energy Savings | Annual Solar PPA Savings | Annual Operational Savings | Energy Rebates/ Incentives | Total Annual Savings | Annual Project Costs | Board Costs | Annual Service Costs [3] | Net Cash Flow to Client | Cumulative Cash Flow |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| Installlation | $133,368 | | | | $133,368 | | | | | |
| Installlation | $1,936,387 | | | | $1,936,387 | | | | | |
| Installlation | $2,471,616 | | | | $2,471,616 | | | | | |
| 1 | $3,348,071 | $1,950,659 | $629,148 | $424,678 | $6,352,556 | $10,653,149 | $10,869,927 | $216,778 | $24,000 | $24,000 |
| 2 | $3,424,200 | $2,033,271 | $629,148 | $1,849,449 | $7,936,068 | $7,695,290 | $7,912,068 | $216,778 | $24,000 | $48,000 |
| 3 | $3,502,064 | $2,070,790 | $268,498 | $0 | $5,841,353 | $5,600,574 | $5,817,353 | $216,778 | $24,000 | $72,000 |
| 4 | $3,581,701 | $2,108,785 | $268,498 | $0 | $5,958,985 | $5,934,985 | $5,934,985 | | $24,000 | $96,000 |
| 5 | $3,663,152 | $2,147,262 | $268,498 | $0 | $6,078,913 | $6,054,913 | $6,054,913 | | $24,000 | $120,000 |
| 6 | $3,746,460 | $2,186,229 | | | $5,932,689 | $5,908,689 | $5,908,689 | | $24,000 | $144,000 |
| 7 | $3,831,665 | $2,225,693 | | | $6,057,358 | $6,033,358 | $6,033,358 | | $24,000 | $168,000 |
| 8 | $3,918,811 | $2,265,662 | | | $6,184,473 | $6,160,473 | $6,160,473 | | $24,000 | $192,000 |
| 9 | $4,007,943 | $2,306,143 | | | $6,314,086 | $6,290,086 | $6,290,086 | | $24,000 | $216,000 |
| 10 | $4,099,106 | $2,347,145 | | | $6,446,250 | $6,422,250 | $6,422,250 | | $24,000 | $240,000 |
| 11 | $4,192,346 | $2,388,674 | | | $6,581,020 | $6,557,020 | $6,557,020 | | $24,000 | $264,000 |
| 12 | $4,287,711 | $2,430,740 | | | $6,718,451 | $6,694,451 | $6,694,451 | | $24,000 | $288,000 |
| 13 | $4,385,249 | $2,473,350 | | | $6,858,600 | $6,834,600 | $6,834,600 | | $24,000 | $312,000 |
| 14 | $4,485,010 | $2,516,513 | | | $7,001,523 | $6,977,523 | $6,977,523 | | $24,000 | $336,000 |
| 15 | $4,587,045 | $2,560,237 | | | $7,147,282 | $7,123,282 | $7,123,282 | | $24,000 | $360,000 |
| 16 | $4,691,405 | | | | $4,691,405 | $4,667,405 | $4,667,405 | | $24,000 | $384,000 |
| 17 | $4,798,143 | | | | $4,798,143 | $4,774,143 | $4,774,143 | | $24,000 | $408,000 |
| 18 | $4,907,315 | | | | $4,907,315 | $4,883,315 | $4,883,315 | | $24,000 | $432,000 |
| 19 | $5,018,975 | | | | $5,018,975 | $4,994,975 | $4,994,975 | | $24,000 | $456,000 |
| 20 | $5,133,181 | | | | $5,133,181 | $5,053,866 | $5,053,866 | | $79,315 | $535,315 |
| **Totals** | $88,150,924 | $34,011,154 | $2,063,792 | $2,274,127 | $126,499,997 | $125,314,347 | $125,964,682 | $650,335 | $535,315 | |

**NOTES:**

**(1) Includes: Hard costs and project service fees defined in ESCO's PROPOSED "FORM V"**

**(2) No payments are made by Board during the construction period**

**(3) This figure should equal the value indicated on the ESCOs PROPOSED "FORM V". DO NOT include in the Financed Project Costs.**

# Appendix 4. Building Automation Controls Scope of Work

# Appendix 5. Electric and Natural Gas Breakdown by Building

# Appendix 6. ESSER Funding: Measures Considered but Not Included

# Appendix 7. Third Party ESIP Review Comments & Correspondence